electronics today international

AUGUST 1977

40p

AUDIO SWEEP OSCILLATOR

FREE INSIDE: MARSHALL'S CATALOGUE

ALSO:

TELETEXT KIT REVIEW
ELECTRONIC BONGOS!
PICKUP PRINCIPLES
SOIL MOISTURE INDICATOR

NEWS . . . CONSTRUCTION . . . DEVELOPMENTS . . . AUDIO

WATFORD ELECTRONICS

33 CARDIFF ROAD, WATFORD, HERTS., ENGLAND
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POLYESTER CAPACITORS: Axial lead type. Values are in µF.
400V: 0·001 0·0015 0·0022 0·0033 **8p**; 0·0047 0·0068 0·01 0·015 0·018 **9p**; 0·022 0·033 **10p**; 0·047 0·068 **14p**; 0·1 **15p**; 0·15 0·22 **22p**; 0·33 0·47 **39p**; 0·68 **45p**.
160V: 0·039 0·15 0·22 **13p**; 0·33 0·47 **22p**; 0·68 1·0 **29p**; 1·5 **33p**; 2·2 **38p**; 4·7 **47p**.
DUBILIER: **1000V**: 0·01 0·015 **16p**; 0·022 **18p**; 0·047 **16p**; 0·1 **34p**; 0·47 **43p**; 1·0 **85p**.

POLYESTER RADIAL LEAD Values in µF. **250V**:
0·01 0·015 **6p**; 0·022 0·027 **7p**; 0·033 0·047 0·068 0·1 **8p**; 0·15 **12p**; 0·22 0·33 **14p**; 0·47 **16p**; 0·68 **20p**; 1·0 **24p**; 1·5 **27p**; 2·2 **31p**

FEED THROUGH CAPACITORS
1000 pF 350V **8p**

ELECTROLYTIC CAPACITORS: Axial lead type. Values are in µF.
250V: 100 F **50p**; **100V**: 20 F **63V**: 0·47 1·0 1·5 2·2 2·5 3·3 4·7 6·8 8 10 15 22 **9p**; 47 32 50 **12p**; 63 100 **27p**; **50V**: 1·0 **9p**; 50 100 220 **25p**; 470 **50p**; 1000 2200 **68p**; **40V**: 2·2 33 **9p**; 100 **12p**; 3300 **62p**; **35V**: 33 **7p**; 3·30 470 **50p**; 1000 **49p**; **25V**: 10 22 47 **6p**; 80 100 160 **8p**; 220 250 **13p**; 470 640 **25p**; 1000 **27p**; 1500 **30p**; 2000 **34p**; 3300 **52p**; 4700 **54p**; **16V**: 1·0 40 47 68 **7p**; 100 125 **8p**; 470 **16p**; 1000 1500 **20p**; 2200 **34p**; **10V**: 4 100 **6p**; 540 **10p**; 100 **14p**.
TAG-END TYPE: & **70V**: 2500 **9dp**; 4700 **12½p**; **64V**: 3300 **94p**; **40V**: 4000 **70p**; 2500 **65p**; **25V** 4700 **48p**; **16V**: 4500 **38p**; **40V**: 2000 + 2000 **95p**.

TANTALUM BEAD CAPACITORS
35V: 0·1 F 0·22 0·33 0·47 0·68 1·0 2·2 F 3·3 4·7 6·8 **25V**: 1·5 10 **20V**: 15 **16V**: 10 F **13p** each
10V: 22 F 33 47 **6V**: 47 68 **3V**: 100 F **20p** each

MYLAR FILM CAPACITORS
100V: 0·001 0·002 0·005 0·01 F **5p**
0·015 0·02 0·04 0·05 0·056 F **6p**
0·1 F 0·15 0·2 **7p**. **50V**: 0·47 F **10p**

CERAMIC CAPACITORS 50V
Range: 0·5pF to 10 000pF **3p**
0·015 F 0·022 F 0·033 F
0·047 F **4p** 0·1 F **6p**.

SILVER MICA (Values in pF) 3·3 4·7 6·8 10 12 22 33 47 50 68 75 82 85 100 120 150 220 **9p** each 250 300 330 360 390 600 820 **16p** each 1000 1800 2000 2200 **20p** each

CERAMIC TRIMMER CAPACITORS
2·7pF 4·15pF 5·25pF 8·30pF **20p**

MINIATURE TYPE TRIMMERS
2·5 6pF 3·10pF 10·40pF **22p**
5·25pF 5·45pF 60pF 88pF **30p**

COMPRESSION TRIMMERS
3·40pF 8·80pF 20·140pF 190pF **25p**
50·200pF 100·500pF 125Dpf **39p**

POTENTIOMETERS (AB or EGEN)
Carbon Track. 1W Log & ½W Linear values
1K Ω & 2KΩ (lin only) Single gang **24p**
5KΩ 2MΩ single gang **24p**
5KΩ 2MΩ single gang D.P switch **50p**
5KΩ 2MΩ dual gang stereo **60p**

SLIDER POTENTIOMETERS
0·25W log and linear values 60mm
5KΩ 500KΩ single gang **60p**
10KΩ 500KΩ dual gang **70p**
Self Stick Graduated Bezels **20p**

PRESET POTENTIOMETERS
0·1W 50Ω 5MΩ Miniature Vertical & Horizontal **8p**
0·25W 100Ω 3·3MΩ Horiz. larger **10p**
0·25W 200Ω 4·7MΩ Vert **10p**

RESISTORS — Erie make 5% Carbon Miniature High Stability. Low noise.

RANGE	VAL	1-99	100+
¼W	2·2Ω 4·7M	E24	1.5p	1p
½W	2·2Ω 4·7M	E12	2p	1.5p
1W	2·2Ω 10M	E12	3p	2p
2W	0·5W Metal Film	E12		6p

E.T.I. TV GAMES KIT now available. Complete kit **£23.75** incl. VAT. 75p P&P.
UHF Modulator only **£3.50** incl VAT.
Rifle Attachment Kit **£10.15** incl. VAT.

JACK PLUGS / **SOCKETS**

	Screened chrome	Plastic body	open metal	moulded with contacts	in-line couplers
2·5mm	12p	8p	8p	11p	
3·5mm	15p	10p	8p	12p	
MONO	23p	15p	13p	20p	18p
STEREO	31p	18p	15p	24p	22p

DIN	PLUGS	SOCKETS	In Line
2 PIN Loudspeaker/ 3 4 5 Audio	13p	8p	20p
CO-AXIAL (TV)	14p	14p	14p
PHONO assorted colours / Metal/Screened	9p / 12p	5p 1-way / 8p 2-way / 10p 3-way	15p / —
BANANA 4mm / 2mm / 1mm	10p / 10p / 8p	12p / 10p / 8p	— / — / —

SWITCHES * PUSH BUTTON
Miniature Non Locking
Push to Make **15p** Push to Break **25p**
ROCKER (white) 10A 250V
SP changeover centre off **28p**
ROCKER (black) on-off 10A 250V **23p**
ROCKER (illuminated (white) Lights when on 3A 240V **52p**
ROTARY: (ADJUSTABLE STOP) 1 pole 2 to way 2p 2 6W 3p 2 4W 4p 2 3W **41p**
ROTARY: Mains 250V AC, 3 Amp **42p**

DIL SOCKETS (Low Profile Tex-ass)
8 pin **10p**; 14 pin **12p**; 16 pin **13p**; 24 pin **30p**; 28 pin **45p**; 40 pin **58p**.

OPTO ELECTRONICS *
LEDs — Clip
TIL209 Red **13p**
TIL211 Grn **24p**
TIL220 Red **20p**
2" Red **16p**
2" Amber/Green **20p**
Yellow **20p**
OCP70 **40p**
ORP12 **68p**
ON5777 **54p**
7 Seg Displays
TIL312 & 313 3
C. Anode **125p**
C. Cath **125p**
TIL311 & 315 5
C. Anode **140p**
C. Cath **140p**
DL704 C Cth **99p**
DL707 C A **99p**
DL747 C A **180p**
5 LET 01 **460p**

SWITCHES *
TOGGLE 2A 250V
SPST **26p**
DPDT **35p**
4 pole on-off **58p**

SUB-MIN TOGGLE
SP changeover **59p**
SPST on-off **54p**
DPDT 6 tags **78p**
DPDT Centre off **92p**
DPDT Biased **115p**

SLIDE 250V:
1A DP **14p**
1A DP C O **16p**
1A DP **13p**
4 pole 2 way **24p**

PUSH BUTTON
Spring loaded
SPST on-off **55p**
SPDT C over **65p**
DPDT 6 Tag **85p**

FERRIC CHLORIDE *
Anhydrous
1lb bag
65p + 30p p&p

DALO ETCH Resist Pen **75p***
Spare Tip **75p***

COPPER BOARDS*
Fibre Glass
Single Sided
6×6" **64p**
6×12" **115p**
Double Sided
6×6 **78p**
6×12" **148p**

VOLTAGE* REGULATORS
723C **45p**
TBAb25B **95p**
TO3 Can
1A 5V **150p**
1A 12V **170p**
1A 15V **190p**
1A 18V **210p**
LM309K **150p**
LM323K **625p**
1A -5V **220p**
1A -12V **220p**
Plastic
1A 5V **130p**
1A 12V **130p**
1A 15V **135p**
1A 18V **140p**
1A 24V **140p**
0·1A 8V **48p**

DIODES

	p
AAZ15	15
AEY11	60
BA100	10
BA102	10
BY100	24
BY126	14
BY127	14
OA9	9
OA10	40
OA47	8
OA70	8
OA79	12
OA81	15
OA85	12
OA90	6
OA91	6
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
IN4001 2*	5
IN4003*	6
IN4004 5*	6
IN4006 7*	7
IN4148	4
3A 100V	18
3A 400V*	20
3A 600V*	27
3A 1000V*	30

ZENERS
Range 3·3V to 33V 400mW **9p**
1·3W **18p**

VARICAPS
MVAM2 **135p**
BB104 **40p**
BB105B **40p**
MVAM115 **95p**

BRIDGE RECTIFIERS

plastic case	p
1A 50V	21
1A 100V	24
1A 200V	26
1A 400V	31
1A 600V	34
2A 50V	33
2A 100V	44
2A 200V	46
2A 400V	56
2A 100V	72
2A 400V	79
4A 800V	120
6A 100V	73
6A 400V	92
BY164	56

TRIACS*

3A 400V	113
6A 400V	140
8A 400V	160
10A 500V	195
15A 400V	240
15A 500V	285
30A 400V	398
40430	99
40669	99

TTL 74*

7400	14	7480	50	74161	116	4021AE	105
7401	14	7481	114	74162	116	4022AE	95
7402	16	7482	82	74163	116	4023AE	20
7403	16	7483	95	74164	121	4024AE	85
7404	20	7484	95	74165	120	4025AE	19
7405	22	7485	125	74166	161	4026AE	185
7406	44	7486	36	74167	362	4027AE	60
7407	44	7489	390	74170	186	4028AE	95
7408	22	7490	43	74172	590	4029AE	109
7409	22	7491	80	74173	175	4030AE	58
7410	15	7492	53	74174	173	4033AE	145
7411	25	7493	40	74175	90	4034AE	195
7412	25	7494	85	74176	120	4040AE	110
7413	40	7495	73	74177	116	4042AE	85
7414	74	7496	82	74180	108	4043AE	100
7416	35	7497	262	74181	299	4044AE	95
7417	39	74100	135	74182	85	4045AE	145
7420	16	74104	48	74184	184	4046AE	135
7421	29	74105	48	74185	146	4047AE	99
7422	24	74107	33	74188	650	4048AE	58
7423	30	74109	84	74190	194	4049AE	60
7425	30	74110	54	74191	165	4050AE	55
7426	35	74111	76	74192	120	4054AE	120
7427	36	74116	193	74193	120	4055AE	134
7428	48	74118	115	74194	120	4056AE	135
7430	18	74120	105	74195	95	4060AE	115
7432	28	74121	34	74196	118	4067AE	380
7433	48	74122	50	74197	118	4068AE	22
7437	30	74123	73	74198	248	4069AE	22
7438	33	74125	89	75150	000	4070AE	55
7440	17	74126	65	75491	80	4071AE	23
7441	74	74128	81	75492	90	4072AE	23
7442	74	74132	75	**CMOS***		4076AE	155
7443	130	74136	56	**(RCA)**		4077AE	60
7444	122	74141	72	4000AE	15	4078AE	22
7445	94	74142	315	4001AE	17	4081AE	22
7446	116	74143	314	4002AE	17	4082AE	23
7447	82	74144	314	4006AE	115	4502AE	135
7448	80	74145	90	4007AE	18	4507AE	55
7450	17	74147	275	4009AE	60	4510AE	135
7451	17	74148	160	4010AE	60	4511AE	175
7453	17	74150	128	4011AE	19	4512	115
7454	17	74151	79	4012AE	18	4516AE	140
7460	17	74153	82	4013AE	55	4518AE	130
7470	32	74154	150	4015AE	99	4519AE	65
7472	28	74155	76	4016AE	55	4520AE	130
7473	32	74157	95	4017AE	140	4528AE	140
7474	36	74158	80	4018AE	105	4532AE	128
7475	36	74159	225	4019AE	60	4539AE	120
7476	36	74160	116	4020AE	125	4585AE	105

LINEAR IC'S

702	75
709C 14 pin	30
710*	46
741C 8 pin	22
747C	72
748C	36
753	150
8038CC*	345
AY 1-0212	570
AY 1 5051	125
AY 1-6721Q	195
AY 3-8500*	720
AY 5 1224*	349
AY 5 1 3D*	490
AY 5 3500*	810
AY 5-4007	650
BXI	249
CA3011*	82
CA3014*	137
CA3018	72
CA3020	170
CA3023	170
CA3028A*	102
CA3035	170
CA3036	180
CA3043	190
CA3046	80
CA3048	220
CA3075	175
CA3080	80
CA3081	190
CA3089E	210
CA3090A	420
CA3123E	200
CA3130*	94
CA3140	95
LM300H	170
LM301A	39
LM308	140
LM318	195
LM379	395
LM380	98
LM381	170
LM382	125
LM390C	65
LM3909N	70
M252AA*	950
M253*	997
MC724*	175
MC846P	150

MC1303L	148
MC1304P	260
MC1310P	185
MC1312PQ	195
MC1458P*	90
MC1496	101
MC1710CG	79
MFC6040*	97
MK50253*	550
MK50326*	775
MM5112N*	350
MM50326*	750
NE550	160
NE558A	210
NE555*	41
NE556DB*	99
NE560*	325
NE561*	395
NE562B*	395
NE565A*	175
NE566*	170
NE567V*	182
RAM2102 2*	247
ROM2513*	750
SG3402*	255
SL414A	220
SN72733	125
SN76003	240
SN76013	150
SN76023	150
SN76033	235
SN76115	215
SN76227	175
TAA621A	238
TAA661A	155
TAA700	353
TAA960	300
TAD100	150
TAD110	170
TBA120S	90
TBA540Q	220
TBA550Q	355
TBA641B X11	225
TBA651	170
TBA800	90
TBA810S	110
TBA820	80
TBA920Q	350
TDA2020	320
ZN414	110
ZN424	125

TRANSISTORS

	p
AC117	35
AC125*	22
AC126*	18
AC127*	18
AC128*	18
AC131*	22
AC131K*	38
AC142*	20
AC142K*	38
AC176*	18
AC187*	18
AC188*	19
ACY17	35
ACY18	28
ACY19	25
ACY20	24
ACY21	29
ACY22	16
ACY28	21
ACY29	78
ACY40	24
ACY44	39
AD149*	54
AD161*	38
AD162*	38
AF114*	20
AF115*	20
AF116*	20
AF117*	23
AF118*	47
AF121*	33
AF124*	30
AF125*	30
AF126*	30
AF127*	30
AF139*	40
AF178*	70
AF179*	70
AF180*	70
AF181*	48
AF185*	60
AF186*	48
AF239*	37
AS126*	40
ASY29*	40
BC107*	9
BC107B*	10
BC108*	9
BC108B*	12
BC108C*	12
BC109*	9
BC109B*	12
BC109C*	12
BC113	20
BC114	20
BC115	20
BC116	20
BC117	20
BC118	15
BC119	25
BC135	13
BC136	15
BC137	15
BC140*	34
BC142*	24
BC143*	24
BC147	7
BC148	7
BC149	9
BC153	25
BC154	20
BC157	10
BC158	12
BC159	13
BC160*	32
BC167	12
BC168	12
BC169C	14
BC170	11
BC171	11
BC172	11
BC177*	18
BC178*	18
BC179*	18
BC182	10
BC182L	12
BC183	10
BC183L	11
BC184	11
BC184L	12
BC186	22
BC187*	23
BC212	12
BC212L	13
BC213	11
BC213L	13
BC214	14
BC214L	16
BC307B	15
BC328	18
BC338*	21
BC441*	37
BC461*	47
BC462*	37
BC547	20
BC548	20
BC549C	20
BC558	28
BCY30*	55
BCY32*	65
BCY34*	80
BCY39*	88
BCY40*	90
BCY55*	204
BCY59*	18
BCY70*	17
BCY71*	20
BCY72*	15
BD115*	52
BD121*	98
BD123*	95
BD124*	105
BD131*	36
BD132*	39
BD133*	60
BD135	45
BD136	40
BD137	42
BD138	47
BD139	54
BD140	57
BD142	53
BD145*	55
BDY13*	195
BDY60*	128
BDY61*	147
BF115*	22
BF154*	22
BF156*	29
BF173*	25
BF177*	26
BF178*	28
BF179*	33
BF180*	33
BF181*	33
BF182*	33
BF183*	33
BF184*	28
BF185*	30
BF194	10
BF195	10
BF196	14
BF197	15
BF198	15
BF200	37
BF224A	15
BF244B	34
BF256*	34
BF257*	34
BF258*	38
BF259*	48
BF594	30
BF595	28
BFR39	25
BFR40	25
BFR79	25
BFR80	25
BFX18*	54
BFX29*	28
BFX38*	38
BFX63*	40
BFX65*	40
BFX64*	38
BFX81*	141
BFX84*	24
BFX85*	28
BFX86*	28
BFX87*	23
BFX88*	26
BFY50*	17
BFY51*	17
BFY52*	17
BFY65*	25
BSY26*	40
BSY29*	85
BSY78	25
BSX20*	20
BSY95A	18
BU105*	168
BU208*	295
E5567	48
MD800I*	158
MJ400*	90
MJ491*	160
MJ2955*	120
MJE340*	45
MJE370*	68
MJE371*	80
MJE520*	65
MJE521*	74
MJE2955*	98
MJE3055*	82
MPF102	36
MPF103	36
MPF104	36
MPF105	36
MPF106	50
MPF107	50
MPSA05	32
MPSA06	32
MPSA55	30
MPSA56	30
MPSA70	26
MPSU02	60
MPSU05	64
MPSU06	32
MPSU52	70
MPSU55	79
MPSU56	82
MPU131*	39
OC25*	65
OC26*	95
OC28*	70
OC29*	70
OC35*	70
OC36*	53
OC41*	17
OC42*	17
OC44*	25
OC45*	17
OC46*	35
OC70*	25
OC71*	23
OC72*	27
OC77*	56
OC79*	53
OC81*	24
OC81D*	28
OC82*	25
OC82D*	35
OC83*	28
OC84*	44
OC84N*	44
OC123*	115
OC139*	140
OC140*	125
OC141*	157
OC170*	40
OC171*	42
OC201*	125
OC202*	135
OC203	150
OC204*	150
TIP29	43
TIP29A	45
TIP29C	68
TIP30	52
TIP30A	56
TIP30B	64
TIP30C	74
TIP31*	52
TIP31A*	54
TIP31B*	58
TIP31C*	68
TIP32*	60
TIP32A*	63
TIP32B*	80
TIP32C*	83
TIP33*	95
TIP33B*	112
TIP33C*	120
TIP34*	110
TIP34A*	115
TIP34B*	140
TIP35*	219
TIP35A	225
TIP35C*	270
TIP36A*	346
TIP41A*	66
TIP41B*	73
TIP42A*	78
TIP42B*	82
TIP2955*	69
TIP3055*	56
TIS43	27
TIS44	27
TIS46	40
TIS50	47
TIS74	47
TIS91	24
ZTX107	12
ZTX108	10
ZTX109	15
ZTX300	14
ZTX301	14
ZTX302	19
ZTX303	22
ZTX304	24
ZTX311	15
ZTX314	24
ZTX341	20
ZTX500	17
ZTX501	15
ZTX502	19
ZTX503	19
ZTX504	51
ZTX531	28
ZTX550	18
2N526*	40
2N696*	15
2N697*	21
2N698*	39
2N699*	45
2N706*	17
2N706A*	19
2N707*	50
2N708*	19
2N914*	18
2N916*	27
2N918*	34
2N920*	51
2N930*	18
2N961*	61
2N1131*	21
2N1132*	23
2N1302*	25
2N1303*	27
2N1304*	45
2N1305*	45
2N1306*	45
2N1307*	45
2N1308*	48
2N1613	20
2N1671*	150
2N1718	190
2N1893*	27
2N2160*	85
2N2217*	40
2N2218A*	25
2N2219A*	24
2N2220A*	26
2N2221A*	21
2N2222*	21
2N2303*	250
2N2369*	14
2N2483*	30
2N2484*	30
2N2614	54
2N2646*	41
2N2904A*	24
2N2905A*	25
2N2906*	18
2N2907*	20
2N2907A*	22
2N2926G	10
2N2926O	8
2N2926R	8
2N2926Y	8
2N2011*	30
2N3053*	17
2N3054*	45
2N3055*	49
2N3525*	96
2N3614*	169
2N3615*	135
2N3663	32
2N3702	11
2N3703	12
2N3704	11
2N3705	12
2N370b	10
2N3707	11
2N3708	12
2N3709	12
2N3710	12
2N3711	12
2N3715*	245
2N3771*	164
2N3772*	175
2N3773*	275
2N3819	22
2N3820	44
2N3823*	44
2N3824*	39
2N3866*	90
2N3903	15
2N3904	18
2N3905	18
2N3906	18
2N4037*	39
2N4058	15
2N4061	13
2N4062*	255
2N4191*	66
2N4236	47
2N4289	24
2N4870	35
2N4871	34
2N5135	12
2N5136	12
2N5138	12
2N5179	60
2N5180	60
2N5191	65
2N5305	40
2N5457	35
2N5458	36
2N5459	36
2N5485	42
2N6027	35
40311*	38
40313*	93
40316*	60
40317*	38
40326*	40
40327	48
40347*	65
40348*	73
40360*	43
40361*	43
40362*	43
40411*	295
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THYRISTORS

600ma TO 18 Case

Volts No.	Price
10 THY600/10	£0.13
20 THY600/20	£0.13
30 THY600/30	£0.19
50 THY600/50	£0.22
100 THY600/100	£0.25
200 THY600/200	£0.38
400 THY600/400	£0.45

7 Amp TO 48 Case

Volts No.	Price
50 THY7A/50	£0.48
100 THY7A/100	£0.51
200 THY7A/200	£0.57
400 THY7A/400	£0.62
600 THY7A/600	£0.78
800 THY7A/800	£0.92

1 amp TO 5 Case

Volts No.	Price
50 THY1A/50	£0.26
100 THY1A/200	£0.27
200 THY1A/200	£0.28
400 THY1A/400	£0.36
600 THY1A/600	£0.45
800 THY1A/800	£0.58

10 Amp TO 48 Case

Volts No.	Price
50 THY10A/50	£0.51
100 THY10A/100	£0.57
200 THY10A/200	£0.62
400 THY10A/400	£0.71
600 THY10A/600	£0.99
800 THY10A/800	£1.22

3 amp TO 66 Case

Volts No.	Price
50 THY3A/50	£0.25
100 THY3A/100	£0.27
200 THY3A/200	£0.33
400 THY3A/400	£0.42
600 THY3A/600	£0.50
800 THY3A/800	£0.65

16 Amp TO 48 Case

Volts No.	Price
50 THY16A/50	£0.54
100 THY16A/100	£0.58
200 THY16A/200	£0.62
400 THY16A/400	£0.77
600 THY16A/600	£0.90
800 THY16A/800	£1.39

5 Amp TO 66 Case

Volts No.	Price
50 THY5A/50	£0.36
100 THY5A/100	£0.48
200 THY5A/200	£0.50
400 THY5A/400	£0.57
600 THY5A/600	£0.69
800 THY5A/800	£0.81

30 Amp TO 94 Case

Volts No.	Price
50 THY30A/50	£1.18
100 THY30A/100	£1.43
200 THY30A/200	£1.63
400 THY30A/400	£1.79
600 THY30A/600	£3.50

5 Amp TO 220 Case

Volts No.	Price
400 THY5A/400P	£0.57
600 THY5A/600P	£0.69
800 THY5A/800P	£0.81

No.	Price
BT101/500R	£0.80
BT102/500R	£0.80
BT106	£1.25
BT107	£0.93
BT108	£0.98
2N3228	£0.70
2N3535	£0.70
BTX30/50L	£0.33
BTX30/400L	£0.46
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Please word your orders exactly as printed, not forgetting to include our part number.

V.A.T.

Add 12½% to prices marked * Add 8% to others excepting those marked †. These are zero.

BI-PAK

P.O. BOX 6, WARE, HERTS

SHOP AT 18 BALDOCK ST., WARE, HERTS.
OPEN 9 to 5.30 MON./SAT.

BI-PAK

High quality modules for stereo, mono and other audio equipment.

PUSH-BUTTON

STEREO FM TUNER

OUR PRICE ONLY

£20.45

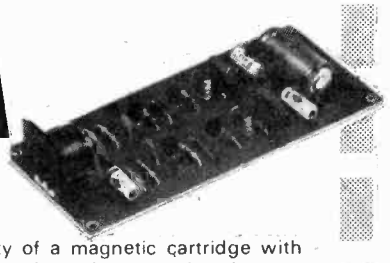
Fitted with Phase Lock-loop Decoder

The 450 Tuner provides instant program selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, by simply changing the settings of the pre-set controls.
Used with your existing audio equipment or with the BI-KITS **STEREO 30** or the **MK60** Kit etc. Alternatively the **PS12** can be used if no suitable supply is available, together with the Transformer **T538.**
The S450 is supplied fully built, tested and aligned. The unit is easily installed using the simple instructions supplied.

- ★ FET Input Stage
- ★ VARI-CAP diode tuning
- ★ Switched AFC
- ★ Multi turn pre-sets
- ★ LED Stereo Indicator

Typical Specification:
Sensitivity 3μ volts
Stereo separation 30db
Supply required 20-30v at 90 Ma max.

MPA 30



Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the new M.P.A. 30, a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.
It is provided with a standard DIN input socket for ease of connection. Full instructions supplied.

£2.85

VAT ADD 12½%

POSTAGE & PACKING

Postage & Packing add 25p unless otherwise shown. Add extra for airmail. Min. £1.00

STEREO PRE-AMPLIFIER

PA100

OUR PRICE £13.75

A top quality stereo pre-amplifier and tone control unit. The six push-button selector switch provides a choice of inputs together with two really effective filters for high and low frequencies, plus tape output.

MK. 60 AUDIO KIT: Comprising 2 x AL60's. 1 x SPM80. 1 x BTM80. 1 x PA100. 1 front panel and knobs. 1 Kit of parts to include on/off switch, neon indicator, stereo headphone sockets plus instruction booklet. **COMPLETE PRICE £29.55** plus 85p postage.

TEAK 60 AUDIO KIT:
Comprising: Teak veneered cabinet size 16¾"x11½"x3¾", other parts include aluminium chassis, heatsink and front panel bracket plus back panel and appropriate sockets etc. **KIT PRICE £10.70** plus 85p postage.

Frequency Response + 1dB 20Hz 20KHz. Sensitivity of inputs
1. Tape Input 100mV into 100K ohms
2. Radio Tuner 100mV into 100K ohms
3. Magnetic P.U. 3mV into 50K ohms

P.U. Input equalises to R1AA curve with 1dB from 20Hz to 20KHz.
Supply — 20-35V at 20mA.

Dimensions 299mm x 89mm x 35mm.

NEW AL30A

10w R.M.S. AUDIO AMPLIFIER MODULE

The AL30A is a high quality audio amplifier module replacing our AL20 & 30. The versatility of its design makes it ideal for record players, tape recorders, stereo amps, cassette and cartridge players. A power supply is available comprising a PS12 together with a transformer T538, also for stereo, the pre-amp PA12.

SPECIFICATION:

- Output Power 10w. R.M.S.
- Supply 22 to 32 volts.
- Load Impedance 8 to 6ohms.
- Input Impedance 50K.
- Sensitivity 90mv for full output.
- Total Harmonic Distortion Less than .5% (Typically .3%).
- Frequency Response 60Hz to 25KHz ± 2db.
- Max. Heat Sink Temp 80° c.
- Dimensions 90 x 64 x 27mm

ONLY £3.60

STEREO 30

COMPLETE AUDIO

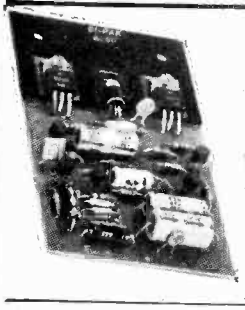
7+7 WATTS R.M.S.

P & P 45p

£16.25

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel knobs, main switch, fuse and fuse holder and universal mounting brackets enabling it to be installed in a record plinth, cabinets of your own construction or the cabinet available. Ideal for the beginner or the advanced constructor who requires Hi-Fi performance with a minimum of installation difficulty (can be installed in 30 mins).

TRANSFORMER £2.45 plus 62p p &p
TEAK CASE £5.25 plus 62p p & p.



AL60

25 Watts (RMS)

★ Max Heat Sink temp 90C. ★ Frequency response 20Hz to 100KHz ★ Distortion better than 0.1 at 1KHz ★ Supply voltage 15-50v ★ Thermal Feedback ★ Latest Design Improvements ★ Load — 3,4,8, or 16 ohms ★ Signal to noise ratio 80db ★ Overall size 63mm. 105mm. 13mm.

Especially designed to a strict specification. Only the finest components have been used and the latest solid-state circuitry incorporated in this powerful little amplifier which should satisfy the most critical A.F. enthusiast.

£4.35

NEW PA12

NEW PA12 Stereo Pre-Amplifier completely redesigned for use with AL30A Amplifier Modules. Features include on/off volume. Balance, Bass and Treble controls. Complete with tape output.

Frequency Response 20Hz-20KHz (—3dB). Bass and Treble range, 12dB. Input Impedence 1 meg ohm. Input Sensitivity 300mV. Supply requirements 24V .5mA. Size 152mm x 84mm x 33mm.

£6.70

PS12

Power supply for **AL30A, PA12, SA450,** etc.

Input voltage 15-20v A.C. Output voltage 22-30v D.C. Output current 800 mA Max. Size 60mm x 43mm x 26mm.
Transformer T538 £2.30

OUR PRICE £1.30

Stabilised Power Supply Type SPM80

SPM80 is especially designed to power 2 of the AL60 Amplifiers, up to 15 watts (R.M.S.) per channel simultaneously. With the addition of the Mains Transformer **BMT80,** the unit will provide outputs of up to 1.5A at 35V. Size: 63mm. 105mm. 30mm. Incorporating short circuit protection.
Transformer BMT80
£2.60 + 62p postage

£3.75

BI-PAK P.O. BOX 6, WARE, HERTS.

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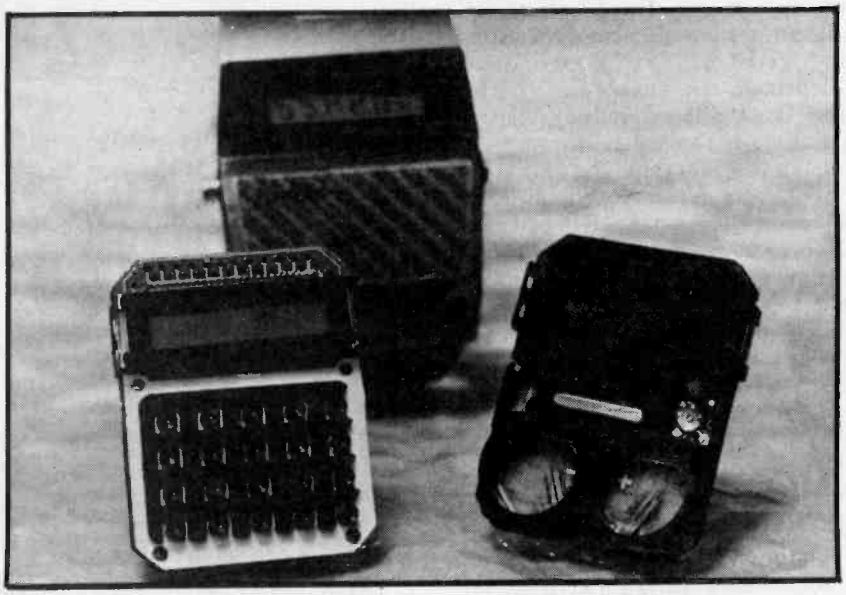
news digest

WATCH THIS CALCULATOR

National Semiconductor have launched a new Scientific calculator watch module. The watch/calculator is based on two new chips, the MM58101 and MM58102 and probably represents the most powerful such combination on the market.

The Watch/Calculator (the name is longer than the module) uses a liquid crystal display to provide a continuous indication of hours - minutes - seconds, as well as a month/date calendar and AM indicator on demand.

In the calculator mode, it employs algebraic logic, has full scientific notation, trig. and log. functions, store and recall memory, pi, powers of numbers, register exchange and reciprocals.



The dual function keyboard, which has thirty six possible switch functions, is activated by a pen, pencil, or other small pointed object.

Unlike conventional digital watches there is no complicated procedure for setting time or date, since the keyboard may be used instead. For example, seconds can be added or subtracted from the display by pushing the plus or minus key followed by the desired number of seconds.

Another useful feature of this Calculator/ Watch module is its ability to store numeric information. A telephone number may, for example, be entered into memory where it will remain until altered by the user or the modules battery runs flat.

Other versions of the Watch/Calculator are also possible, such as financial, statistical or other scientic notations, all by simply re-programming the chip's ROM.

WOW — WHAT A METER

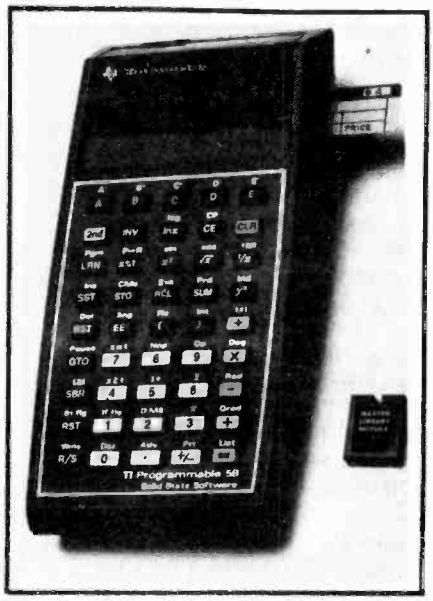
Pictured above is the new Wow and Flutter meter from Pye Unicam Ltd. The PM6307 is designed to allow service technicians to check and align audio and video cassette records and record decks to performance limits which could previously only be measured with laboratory equipment.

The meter consists of a high stability crystal controlled oscillator at 3k Hz or 3.15k Hz, a measurement section and two analogue meters showing DRIFT and FLUTTER to 3% each in three ranges.

The PM6307 should appeal to service technicians as it can differentiate between electrical and mechanical problems. Thus while excessive Wow and Flutter reading are indicative of mechanical wear, Drift is often associated with faulty electronic circuity. The technician can therefore by interpretation of the DRIFT and FLUTTER readings, locate the area of the fault.

A standard DIN input/output socket located on the front panel makes the unit easy to connect to most domestic tape recorders and record players which would be the majority of applications for the unit.

TEXAS STEP AHEAD (5,000 TIMES)



News concerning a new range of calculators has reached us from Fort Bedford.

The range includes two new programmable calculators which offer a significant advance in the provision of memory capability and programming flexibility when compared to the present generation of programmables.

These models, TI Prog. 58 and TI Prog. 59, differ in two respects. First in that the 58 is a key programmable machine whereas the 59 is a card programmable and secondly in their memory capacity. The 58 offers 480 program steps or 60 memory registers while the 59 offers 960 steps or up to 100 memory registers.

The flexibility offered by the capibility to partition memory between program steps and data store is a valuable feature. For every increase or decrease by 10 data memories 80 program steps can be added or taken away.

These calculators also feature plug in solid state software modules. These modules are prerecorded program libraries containing up to 5000 program steps. These program steps can be addressed from the calculator's keyboard or inserted as subroutines in programs developed by the user. They cannot be altered by the user.

Each calculator is supplied with a master library solid state software module containing 25 prewritten programs in the engineering, mathematics, statistics and financial fields. A number of other solid state software modules are available concerning specialist fields such as navigation and engineering.

Both models may be used with Texas' PC-100A print unit to provide program and data lisitings. The printer provides the capability to print 64 characters on 6.35 cm wide thermal paper.

The price for these calculators are expected to be £ 249 for the TI 59, £ 99.95 for the TI58 with the PC-100A at £ 209.00.

INJECTING INTEREST

Alcon Instruments have launched their Chinaglia USIJET Universal Signal Injector. The device incorporates a

blocking oscillator as the main signal generator,giving a baic 500kHz which is modulated at 1kHz for identification and demodulation check purposes. The waveform contains harmonics up to 500MHz and is thus uselul in many servicing applications.

Power consumption from the unit 1.5V battery is 25 mA and the output at the probe tip is 20V peak-to-peak.

In use the fly-lead is connected to the earth line of the equipment under test and the probe tip touched to the point at which the signal is required.

The price complete with earthing lead and instructions, is £ 11.55 inc VAT.

Further details from Alcon Instruments Ltd., 19 Mulberry Walk, London SW3.

LSI DPM OK

The panel meter pictured is based on single chip LSI technology and offers major savings in size, cost and power consumption over earlier digital panel meters.

The units feature a 1999 count, autopolarity, auto ranging and an accuracy of 0.05%. Power may be derived from a wide range of voltages, including AC mains. Power consumption is about 500mW and meters covering ranges from 200mV to 200V are available from stock.

At a price of £ 26.00 each (1 off), these meters represent a practical alternative to analogue panel meters.

For further information contact OMB Electronics, Riverside, Eynsford, Kent, DA4 OAE.

GI NOSE AHEAD

General Instruments have developed a single-chip LSI package containing a FET input, detector, voltage comparator, oscillator, trigger and C/MOS output. It just so happens that this is about all you need for a 'sensitive nose' to detect combastion or, more technically, an ionization smoke alarm.

The MEM 4962 can replace more than 30 discrete components now being used in alarms of this type, to provide a small, rugged and reliable smoke detector.

news digest

WATCH THOSE TEXANS

Texas Instruments recently announced that they are to move into the LCD watch market. They are to introduce a range of models in a wide variety of slim line case styles.

The watches will be powered by a single silver oxide battery which will provide an average of 18 months use.

Prices are expected to start at £18 with top of the range models selling for about £30.

While moving into LCD production, Texas will continue their commitment to the LED market where the emphasis will be on the low cost 'impulse' market.

BALLY VIDEO GAMES

The Bally Manufacturing Corp. of America are to produce a programmable video game based on the powerful Z80 MPU.

The programmable video games unit, which includes a calculator as well as video games, is expected to sell for about £150.

Additional plug-in units, each carrying up to three video games, will also be available. These units will extend the range of the basic unit and are expected to retail at about £10.

THREE NEW EAGLES

Eagle have added three microphones to their range of audio products. The New models, PRO M70, PRO M80, and PRO M90, are rugged designs for use in stage and recording work.

The M90 is a dynamic cardioid mike with a frequency response from 40Hz - 16kHz and a 600 R impedence. The M70 is a capacitor mike while the M80 is dynamic, both are in the same body as the M90.

Prices are £43.90 for the M90, £37.60 for the M80 and £34.20 for the M70. All are backed by the usual two year guarantee.

TIME FOR THE FAX

The BBC has added a further time checking service to the many it already operates. The time is broadcast over the Corporation's CEEFAX service.

CEEFAX is the news and information service which is broadcast in the field blanking period of a television frame and can be displayed on a converted set (see page 17).

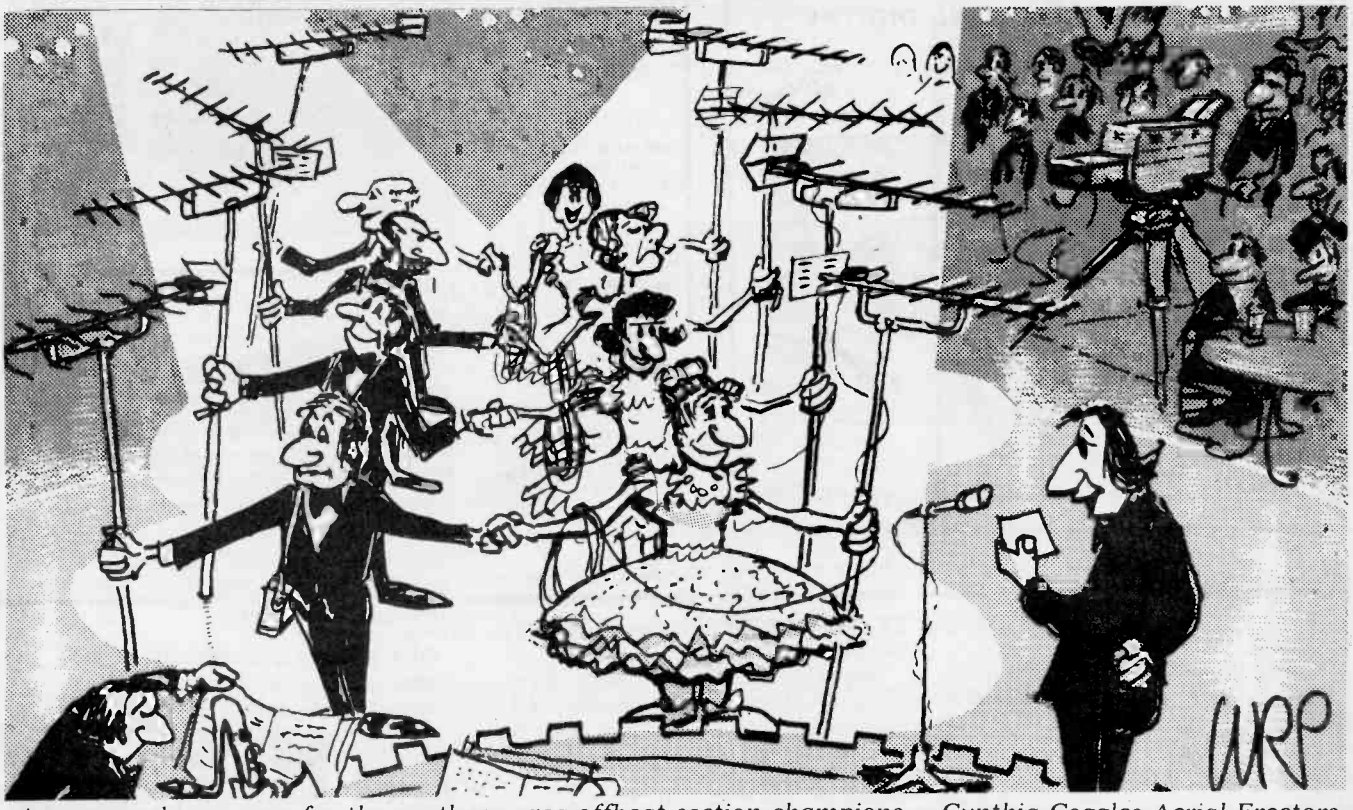
Although the BBC has transmitted day and date information since 1974 the service now offers a time display of seconds. The time is derived from the MSF Rugby signal, which is in turn checked against an atomic clock at the National Physical Laboratory.

Because it takes up to a quarter of a second to write a CEEFAX page, the system is limited in accuracy to this figure.

CORRECTIONS

Digital Frequency Meter, June 1977:-

Foil pattern of board B is not shown full size. A full size foil side PCB pattern can be obtained by sending us a S.A.E.

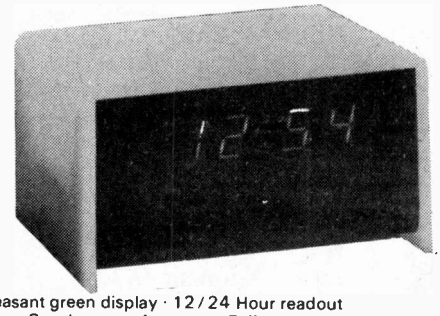


A warm welcome now for the southern area offbeat section champions – Cynthia Coggles Aerial Erectors Precision Formation Team!!

Metac SUMMER BARGAINS

THE METAC DIGITAL CLOCKS

★ COMPLETE KIT ★



- Pleasant green display · 12/24 Hour readout
- Silent Synchronous Accuracy · Fully electronic
- Pulsating colon · Push-button setting
- Building time 1 Hr. · Attractive acrylic case
- Easy-to-follow instructions · Size 10.5 x 5.7 x 8 cm
- Ready drilled PCB to accept components

A professional product for the home constructor. It has been designed by engineers using the most modern techniques and components. It will appeal both to the confirmed hobbyist and to the man who simply wants to 'have a go'. The kit contains everything except a mains lead. The only tools required are a small soldering iron, solder, screwdriver and wire cutters.

KIT PRICE £9.60
+ 76p VAT P&P inc.

ALSO IN STOCK

SUPERB METAL CASED ALARM CLOCK

Green digits, Repeater Alarm
A Top Quality Lounge Clock

£20.32 + £1.63 VAT

CAR CLOCK (Automobile Assoc. Approved)

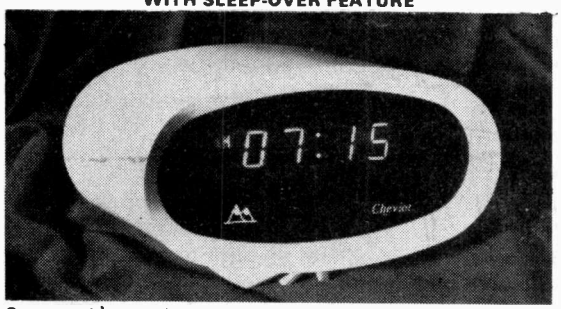
Quartz Crystal Controlled. Red LED Digits

£19.40 + £1.55 VAT

BRITAIN'S TOP SELLING DIGITAL ALARM CLOCK

2-YEAR GUARANTEE — THOUSANDS SOLD

★ Fully Built, Tested and Guaranteed ★
WITH SLEEP-OVER FEATURE



- Bright Orange 12 Hour Display or
- Soft Green 24 Hour Display
- 24 Hour Alarm
- 10 Minute Repetition
- Alarm Set Indicator
- Accurate Silent Timekeeping
- British Designed and Built
- 5 in. across, 3½ ins. deep

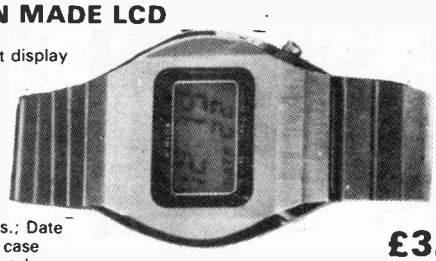
Please state choice

COMPLETE CLOCK
£13.43
+ £1.07 VAT

THE 'METAC' DIGITAL WATCHES

THE GRUEN EXECUTIVE AMERICAN MADE LCD

Continuous 6 digit display with backlight

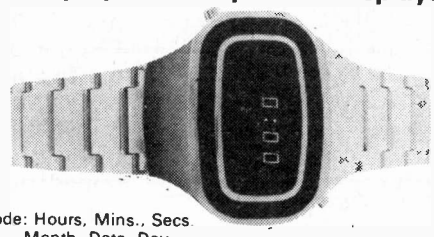


Hours; Mins.; Secs.; Date
Solid heavy metal case
A superb man's watch

Fully Guaranteed

£32.41
+ £2.59 VAT

11 FUNCTION LED CHRONOGRAPH
6 Time Displays : 5 Stopwatch Displays



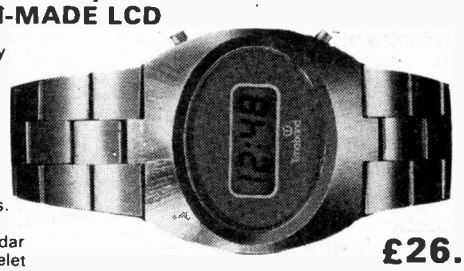
A Truly Remarkable Watch

£30.92
+ £2.47 VAT

Time mode: Hours, Mins., Secs.
Month, Date, Day
Stopwatch mode: Elapsed Time, Secs., Tenths, Hundredths
Elapsed Hours, Mins.
NOTE: Stopwatch mode does not interfere with Time mode.

THE TIMEBAND by FAIRCHILD AMERICAN-MADE LCD

Continuous display with backlight



Hours; Mins.; Secs.
Month; Date
Auto. 4-year calendar
Superb metal bracelet

Fully Guaranteed

£26.95
+ £2.15 VAT

4 FUNCTION LCD WATCH
with Microma Module from USA

CONTINUOUS DISPLAY
WITH BACKLIGHT

£17.59
+ £1.40 VAT

Hours, Mins., Secs., Date
Quality Metal Bracelet. Fully Guaranteed

SAME DAY DISPATCH orders received before 2 pm are posted same day

Cash, Cheque or Postal Order or if you wish to use Barclaycard or Access, simply quote name, address and card number

Metac-Electronics and Time Centre

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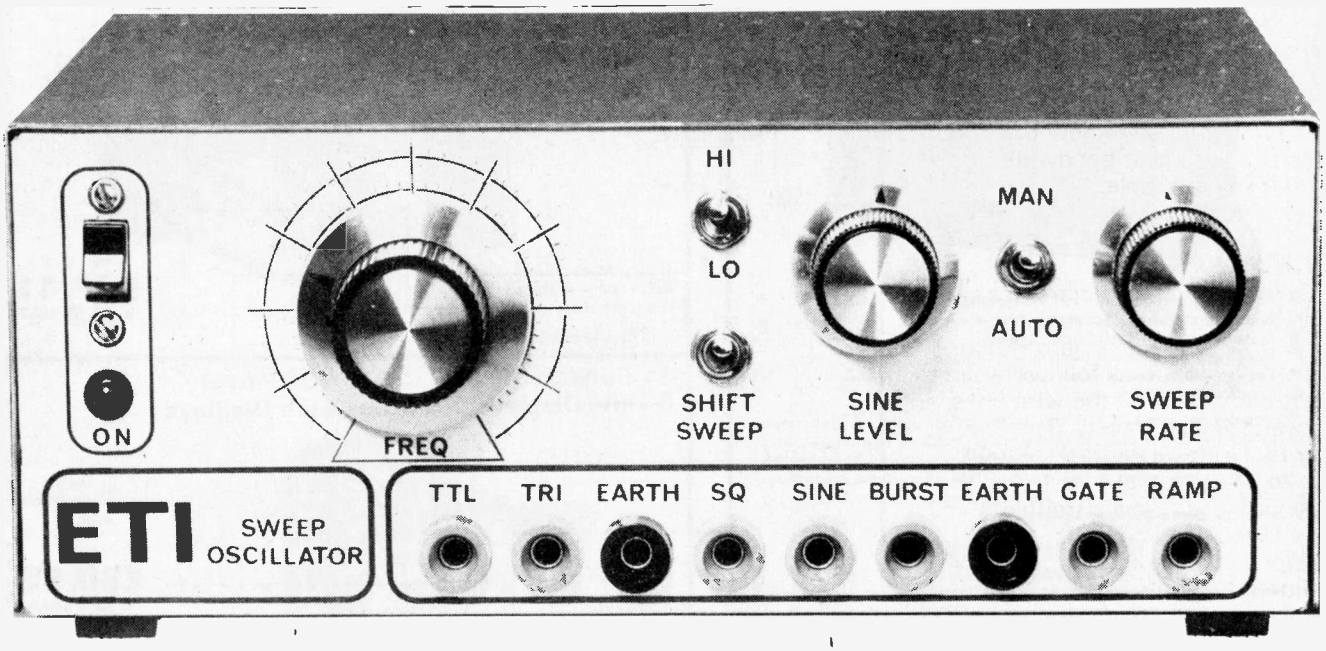
ETI PROJECT

SWEEP OSCILLATOR



Invaluable test unit at less than one fifth of the commercial cost!

By Tim Orr and P. Wielk

SWEEP OSCILLATORS are generally considered to be a rather fancy piece of test equipment and usually attract a fancy price. Units similar to the one to be described sell for around £200 to £300. It produces square and triangle waveforms from a voltage controllable oscillator, which can be internally swept by the machine's own ramp generator, (which is itself controllable), or it can be connected to an external control voltage source. Thus various frequency modulations can be performed, the most useful one being a wide range logarithmic sweep for resolving the frequency response of various networks and filters. To do this, a swept sinusoidal waveform must be synthesised. The triangle waveform is bent, by passing it through a diode function generator, until is closely resembles a sinewave.

Another waveform provided by the function generator is a tone burst output. This gates the sinewave signal on and off and thus generates a burst of sinewaves followed by a period of silence. Tone bursts are very useful for analysing the dynamic responses, (as opposed to the steady state responses), of networks such as filters, compressors, expanders, loudspeakers, etc. The last waveform provided is a square wave suitable for driving TTL circuits. This output uses a current sinking transistor, so that up to about 30 TTL unit loads can be driven by it.

Selecting IC's

The function generator needs fast op-amps to buffer the signals to the external world. These op-amps should also remain stable when connected to various reactive loads. Several devices were tried. The 741S, a fast version of the 741 made by Motorola; the 748, an uncompensated version of the 741; the CA3130 and the CA3140 made by RCA, both of which are fast CMOS devices. Also the LM318, a fast (50v/µS) slew rate op-amp made by National Semiconductors; and the NE531v, another fast device made by Signetics. Not all of these proved successful, particularly when driving reactive loads. Also some of them require external frequency compensation and so the PCB was designed to accept various capacitors. You can use any of the op-amps, but I feel that the best will be obtained by using the suggested devices. In fact you can use the ordinary 741, but this will result in degraded waveforms. Recommended ICs are show on page 12

Using The Machine

Generally try to keep the load impedances presented to the machine as high as possible. The current driving capabilities of all the outputs are limited, particularly at high frequencies and so you may find that outputs become degraded as the frequency increases.

If you want to investigate the frequency response of a filter design, to get a non flickering display, you may have to use a fast sweep rate, say 20 times a second. This could result in a 'time-smeared' display due to the ringing time of the filter. The display will be a cross between the filters dynamic and steady state

response. To overcome this problem, there are two possible solutions. One, use a slow sweep speed, if you have a storage scope then this will be OK. Two, frequency scale the filter up in frequency, so that say, a 100Hz bandpass filter becomes a 1kHz filter. You can then increase the sweep speed by a factor of times 10. However this is generally only possible when you are designing a filter and when you know that there is a sufficient bandwidth margin still available.

Construction

Even though this is electronically a complex project, construction is reasonably straightforward! Main points to note are as follows — first insert and solder all the wire links, followed by the presets. The link near RV1 is insulated. It's a good idea to use terminal pins for all the off board leads, saves trouble if you have to move a wire. Next the resistors, capacitors and diodes can be fitted. C3 only needs to be fitted if you can't get C2 on the board. Q7 needs its base lead bending underneath to fit the board. The only IC that really needs a socket is IC15, but sockets can save hours if used for all ICs — if a fault develops.

All off board connections should be soldered before inserting IC15 anyway. Screened wire should be used to the controls — but only the socket end should be earthed, otherwise nasty hum loops can develop. The external voltage control socket was mounted on the rear panel. The transformer specified has twin windings which are used in parallel. IC1 does not need any heat sink, as very little of its capacity is used. Last and by no means least,
R16 and R34 are both mounted off the main board — good luck!

Setting Up And Alignment

Having built and tested the generator it now only remains for you to align the six presets. **RV1, frequency bias.** Set switch SW2 to manual and switch SW4 to the high frequency range. By turning the frequency control knob, the output of the machine should range from approximately 20Hz to 20kHz. However the transistors in the transistor array IC3 are only matched to within + or — 5mV

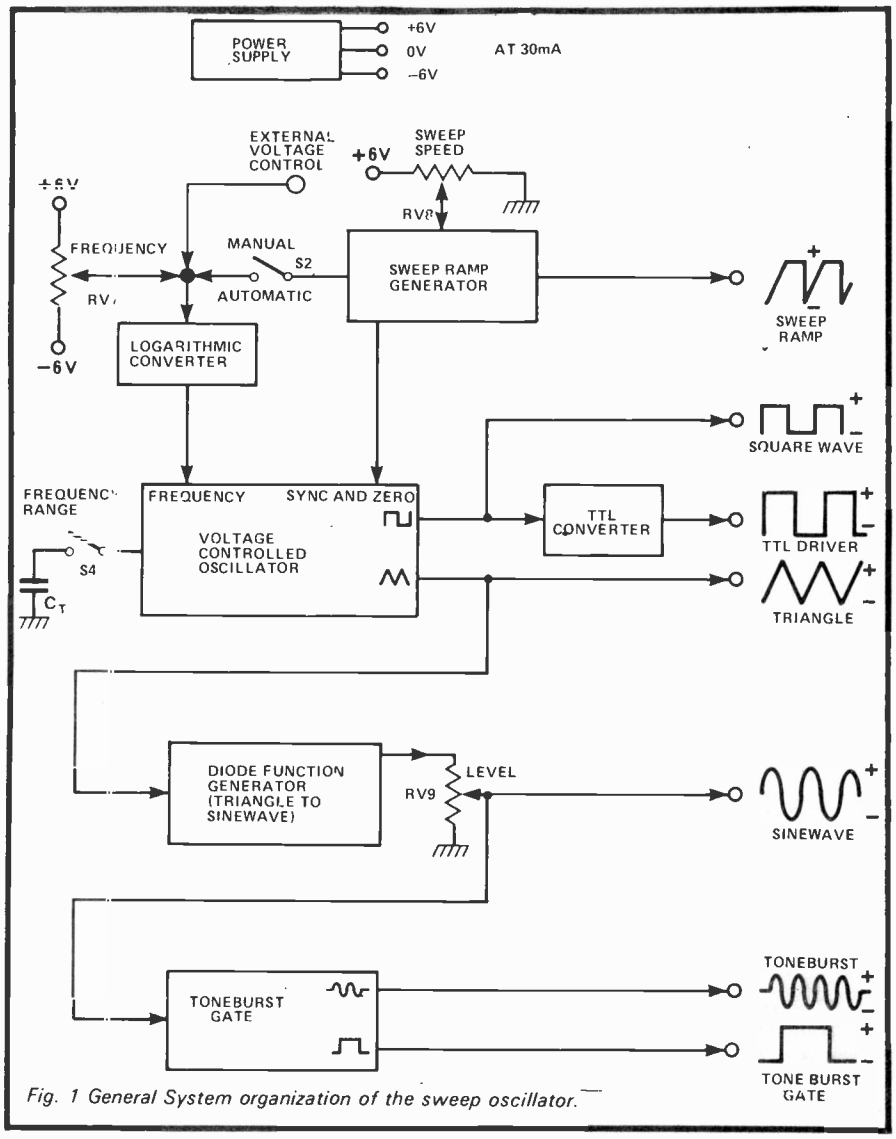


Fig. 1 General System organization of the sweep oscillator.

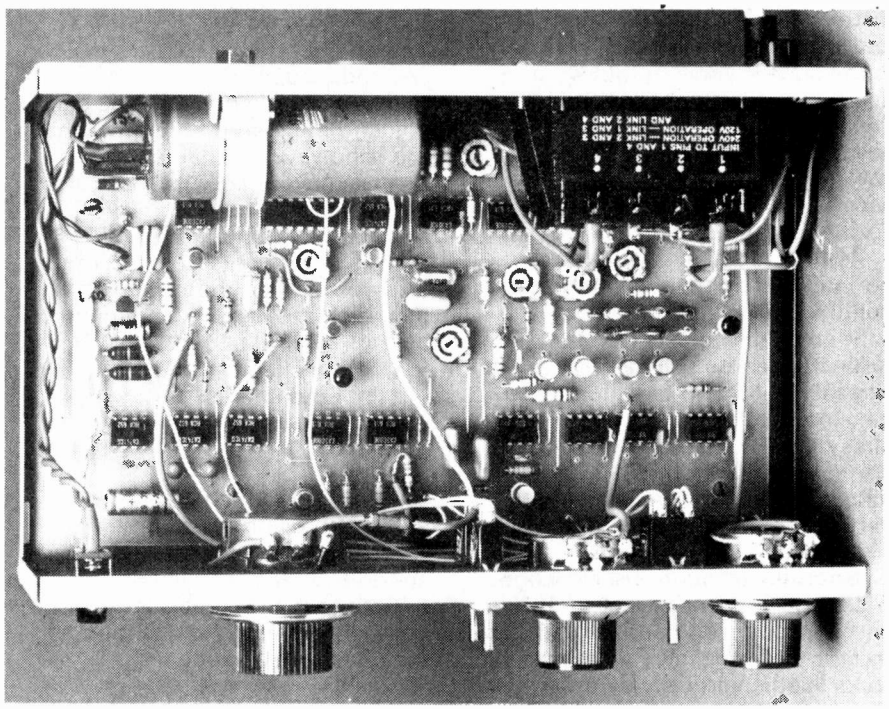


Fig. 2 Internal view of the completed unit.

and this can shift the generator's operating range. So to counteract this mismatch adjust RV1 until the manual operating range is as near to 20Hz to 20kHz as possible.

RV2, triangle time symmetry. The time symmetry of the triangle wave form may not be exactly 1 to 1, and if it is not then the sinewave will have a large THD. The root cause of any time symmetry is IC5, which is a CA3080. If the time symmetry varies significantly when the frequency is changed then IC5 will have to be changed until a suitable output is obtained. To align RV2, set the operating frequency to 1kHz, look at the triangle waveform and rotate RV2 until the best symmetry is obtained. This preset should be readjusted later on when the THD alignment is being performed. Move the frequency throughout its range and check that the symmetry is well maintained.

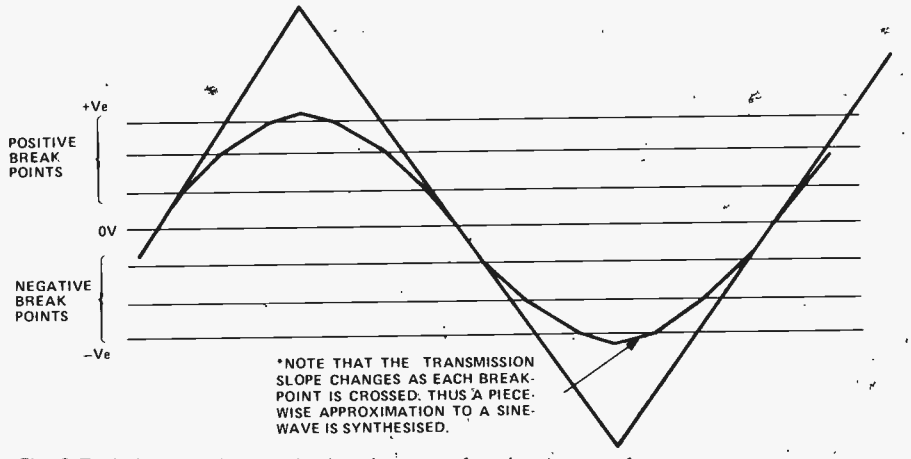


Fig. 3 Technique used to synthesise sine wave for triangle wave form.

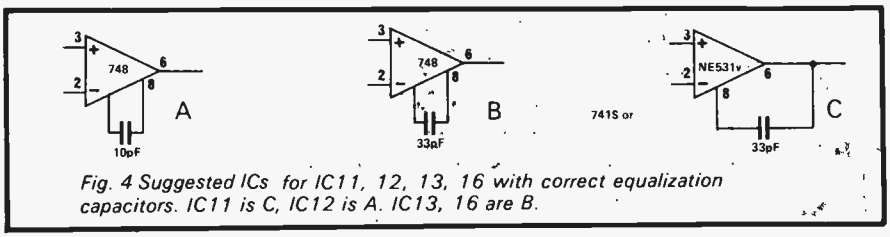


Fig. 4 Suggested ICs for IC11, 12, 13, 16 with correct equalization capacitors. IC11 is C, IC12 is A. IC13, 16 are B.

Ears and Things

THD minimisation RV3, 4, 5, 6. As it was not practical to use high tolerance components and matched diodes in this design, it is necessary to perform several alignments to produce the best possible sinewave. The way in which you align this generator depends on the equipment at your disposal. Here are four methods.

First, by ear. Your hearing apparatus is surprisingly accute to matters of frequency and harmonic structure. For instance if you listen to the square wave output on a good pair of headphones (high impedance preferably), then you can adjust the time symmetry (RV2) by ear with far more accuracy than you can with a direct visual display on an oscilloscope.

As RV2 is adjusted and the symmetry changes there comes a null point where all the even harmonics disappear, which can be distinctly heard. You can also try to align RV3, 4, 5, 6 by listening to the sinewave output at a frequency of say 400Hz. As you adjust each preset you should be able to minimise the harmonics and generally converge upon settings that give the purest tone.

Second, using an oscilloscope. Look at the sinewave (set to 1kHz) on the oscilloscope and adjust RV6 so that the waveform, whatever it looks like, is vertically symmetrical. RV6 merely compensates for any loss of DC offset that has occurred in the production of the triangle. Presets RV3, 4,5, can now be used to adjust the breakpoint slopes. By careful adjustment of them it is possible to converge upon a waveform that looks very nearly sinusoidal.

Third, using a distortion meter. This device is merely a tuneable notch filter. The sinewave is connected to this device and the fundamental is notched out leaving only the harmonics, which you can see and measure. The procedure is to set the frequency to 1kHz and adjust the distortion meter so that the 'sinewave' fundamental has been removed: Look at the residue with an oscilloscope and/or millivoltmeter and adjust RV3, 4, 5 until this residue is at a minimum.

If you don't happen to own a distortion meter you can construct a notch filter at about 1kHz, (see ETI, 'Active filters' and notch out the fundamental by altering the function generator's frequency.

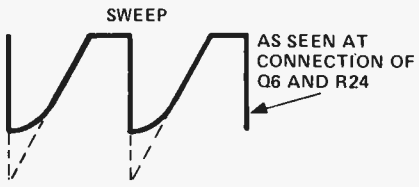
Lastly, using a real time spectrum analyser. These devices are quite cheap, usually about £7000 each. The analyser will display all the harmonics, and so the effect of adjusting RV2, 3, 4, 5, 6 will be instantaneously displayed.

Problems likely to be Encountered

The power supply can be a problem source. The 12V regulator can be responsible for many deviations from the predicted performance, due to the ±5% spread in output voltage. This could cause the sweep range to be larger or smaller, or it can effect the distortion of the sinewave. Here is a list of some common problems and their solutions.

Reduced frequency range. If the manual or swept frequency range is less than expected then increase R12 from 1k to 1k1. This will provide approximately an increase of one octave. If the range is too large then reduce R12 to 910 ohms

Clipped Triangle. This could be caused by a low power supply rail or a large Vp in Q3. Either change Q3 for a low Vp FET or reduce R17 to 470 ohms. Similarly, if the sweep output waveform (output 19) is bent on its negative end, change Q6 for a low Vp device or reduce R24 to 4k7.



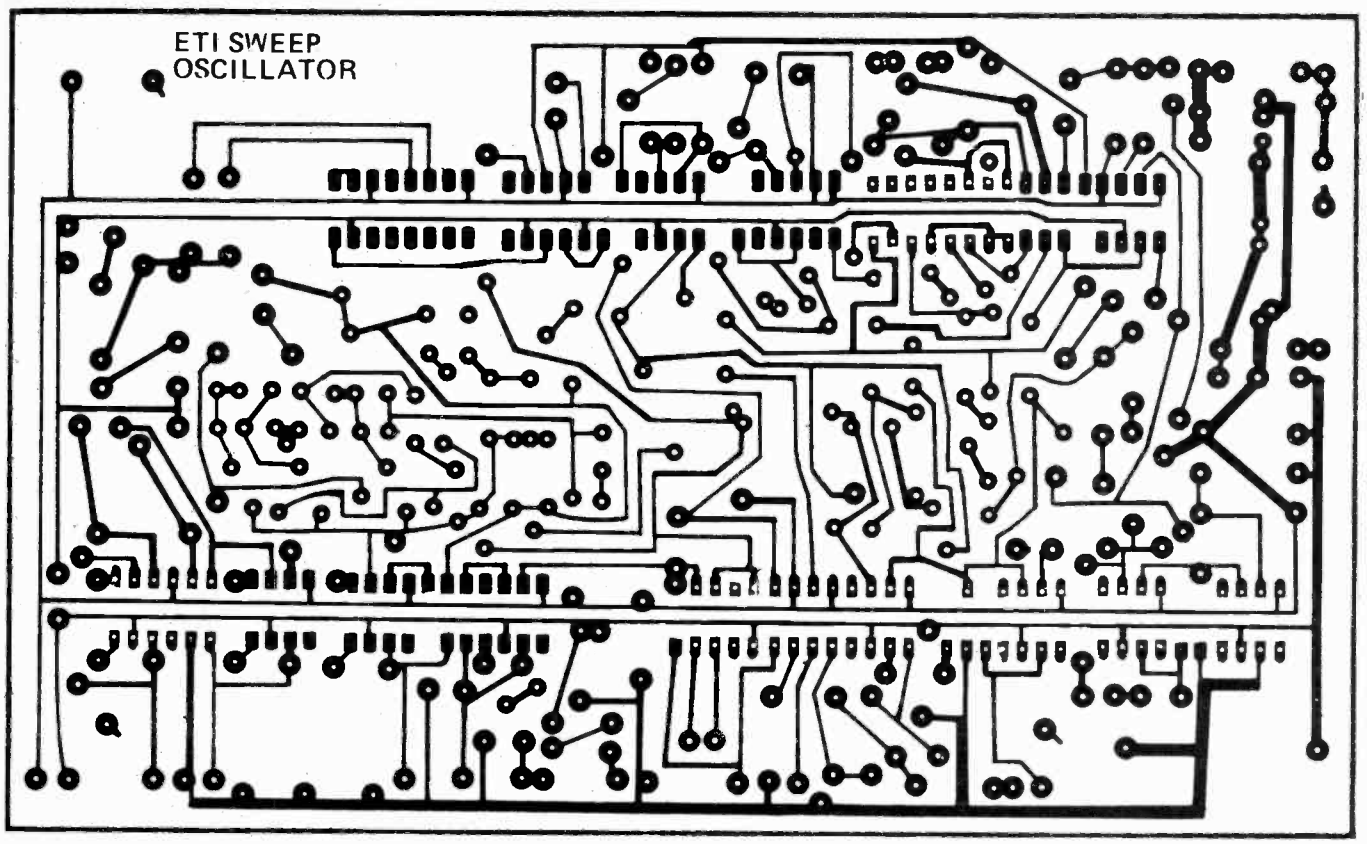
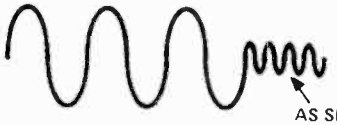
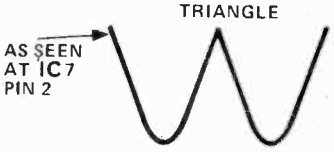


Fig. 5 Full size pattern for the PCB.

Tone burst does not shut off. This is because Q12 will not switch off. Change Q12 for a low Vp device.



Sine wave has a high THD. If the THD cannot be trimmed to about 1% then it is likely that the diode function generator has the wrong gain. If the sinewave looks more like a triangle(a), then increase R42 to 20k. If it has flattened ends(b), then decrease R42 to 16k. Note, very small changes in R42 have a large effect on the THD figure.



SINE WAVE (Variable 0-4V)	**THD < 1.5%**	**TONEBURST GATE**	**12V Fixed**
TONE BURST (Variable 0-4V)	**16Hz on 48Hz off**	**X SWEEP RAMP**	**1V9 Fixed**
TRIANGLE (3V5 Fixed)	**Summetry ±2% (better than)**	**CONTROL INPUT**	**+1V/Octave +3V3/Decade**
SQUAREWAVE (3V5 Fixed)	**Markspace 1:1 ±2% (better than)**	**SWEEP RANGE (Logarithmic)**	**1000:1**
TTL (5V, pulldown to zero)	**Markspace 1:1 ±2% (better than)**	**RAMP RANGE (30Hz to 0.06Hz)**	**500:1**
		HIGH RANGE	**20Hz to 20kHz**
		LOW RANGE	**0.2Hz to 200Hz**
		(Manual or Automatic Sweep)	

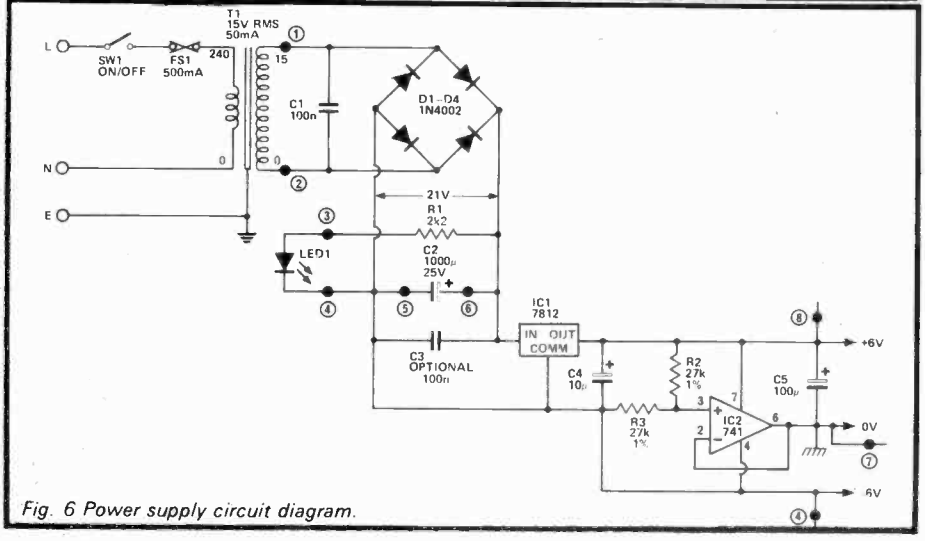


Fig. 6 Power supply circuit diagram.

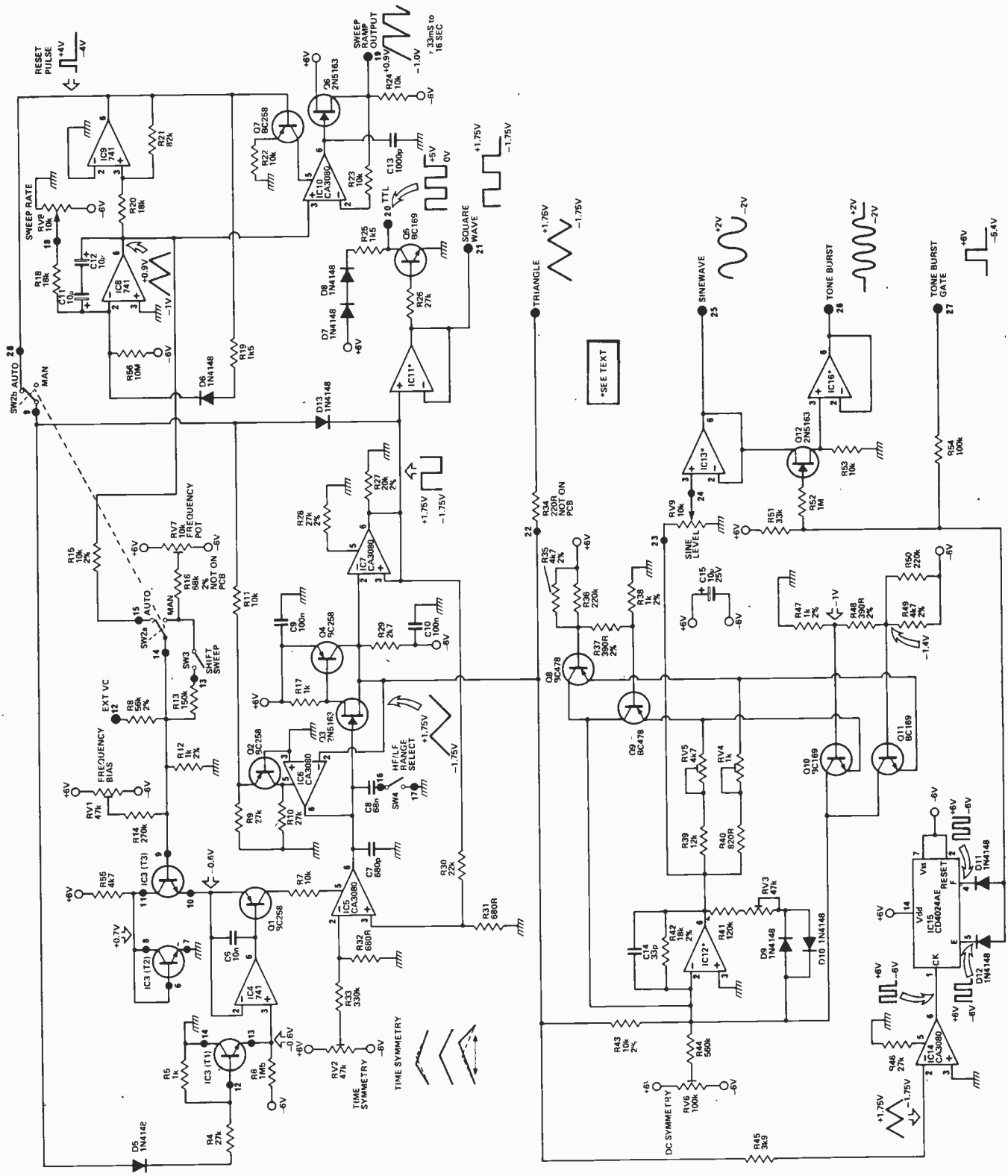


Fig. 7 Main circuit diagram, see page 12 for details of IC11, 12, 13, 16 and compensation capacitors.

HOW IT WORKS

The general system diagram is shown in Fig 1. The heart of the generator is the voltage controlled oscillator shown in more detail in Fig 3 and in the circuit diagram, fig 7. This is the well known triangle square wave oscillator made from an integrator and a schmitt trigger. A control current, (this determines the oscillating frequency), is fed into a current steering device IC5. When a positive voltage is applied to the non-inverting terminal, this control current comes out of IC5 and charges up the timing capacitors C7 and C8. When C8 is switched so that it is in parallel with C7, this selects the low frequency range of operation, (0.2Hz-200Hz). If the applied voltage is negative, then a current equal to the control current is 'sunk' into IC5 and the timing capacitors are discharged. Thus IC5 can either charge or discharge the capacitors, this being determined by the steering voltage.

The speed at which the capacitors charge or discharge is determined by the magnitude of the control current. If this current is constant then the capacitor voltage will increase or decrease linearly. The voltage on the timing capacitor is buffered by a high impedance buffer, Q3,Q4. The FETQ3, has such a high impedance that it hardly takes any current from the timing capacitor, so that it does not affect the charging or discharging operation. Q4 is arranged to drive Q3 at constant current, and the pair, (Q3, Q4), form a high input impedance voltage follower, with a DC shift caused by the FET characteristics. In fact it would be advisable to use low pinch off voltage FET's throughout so as to minimise the effects of these offset voltages.

The way in which oscillation occurs is as follows. Control current is injected into IC5 and the voltage on the timing capacitor rises. This voltage is buffered and presented to the schmitt trigger IC7. When this voltage reaches the upper hysterysis level, the schmitt flips over to its low state and thus the steering voltage becomes reversed. The timing capacitor voltage then ramps down until the lower hysterysis level is reached and then the schmitt flips back to its original state. Thus the timing capacitor voltage ramps up and down between these two hysterysis levels, the speed at which this occurs being determined by the control current. Switching in another capacitor C8, will reduce the ramp rate and hence the frequency of operation. This circuit produces triangles and square waves with a 1 to 1 time symmetry and symmetry about OV.

IC6 and Q2 are used to 'zero' the triangle output for the start of sweep. IC6 adjusts the voltage on the timing capacitor so that the triangle output is at OV. It does this only when Q2 supplies it with current.

The triangle output has a 220ohm resistor connected in series to prevent any damage caused by possible short circuits. The square wave output is buffered by A11 which has a fast slew rate. Q5 is the TTL driver stage. When switched on, it will pull down almost any load to a voltage near to OV. If a faster pull up is required the 1K5 resistor can be reduced.

Next the logarithmic converter. This device converts the sum of all the control voltages into a current, (the control current), to which it is logarithmically related. That means that for every IV increase of external control voltage the control current and hence the operating frequency will double. This logarithmic relationship is very useful for audio work, because when using a swept output, (displayed on an oscilloscope), the X axis is in octaves and decades rather than being linear. The circuit that does the conversion is known as an exponentiator and works in the following manner (see IC3, (T1,2,3.) IC4 and Q1).

IC3 is a CA3046 which is a transistor array providing us with a set of well matched devices at a low cost. Transistor IC3, (T1), has a current of 3.5μA passing through it and this produces a reference voltage of about −600mV at its emitter. IC4 and Q1 adjust themselves so that the emitter of IC3 (T3), is also held at this reference voltage. There are three control voltages, from the frequency pot wiper, the external control voltage terminal and the internal sweep ramp. These are resistively summed together and presented to the base of IC3, (T3). This transistor converts the control voltage into a current which flows out through the emitter, completely through Q1 and then to IC5. This is the control current. The voltage at the base of IC3, (T3) is logarithmically related to its emitter current. A voltage increase of about 18mV will double this current. However, this process is very sensitive to temperature changes which would result in drift in the function generators operating frequency, and so the arrangement of IC3 (T1) and IC3 (T3) has been used to provide temperature compensation. Also to keep self-heating effects to a minimum, IC3 (T2) is used to clamp the collector voltage of IC3 (T3) to +0.7v and thus reduce the power dissipated in the transistor array.

The next section to be discussed is the internal sweep ramp generator, (IC8,9,10,Q6,Q7). IC8, 9 form another triangle/square wave oscillator, having a controllable rise time and a fast reset time. IC8 is the integrator, IC9 the schmitt trigger. The output of IC8 ramps up at a rate largely determined by the sweep rate pot setting. When the upper hysterysis level is reached, IC9 output goes high, D6 becomes forward biased and the integrator ramps down very rapidly, reaches the lower hysterysis level, the schmitt trigger flips over and the process repeats itself. The ramp output is then used to drive the base of IC3 (T3), eventually sweeping the oscillator over a frequency range of 1000:1. This is approximately 10 octaves which requires a change in Vbe IC3 (T3) of about 180mV.

The ramp waveform can be used to drive the X axis on an oscilloscope but it needs some slight modifications to make it suitable. It needs to have a very fast reset of the order of a few microseconds to make the fly back invisible. This is achieved with the track and hold circuit Q6, 7, IC10. During the sweep the output of this circuit follows the input. However, during the reset period, IC10 is 'held' by virtue of the fact that no current is supplied to it. When the reset period is over, current returns to IC10 but its input has the 'start' ramp waveform presented to it, but its output has the stored value of the 'finish' ramp waveform. The output jumps as fast as it can, (within a few microseconds) to the input voltage and proceeds to track it. The process repeats itself. The reset voltage is used (in the sweep mode only), to perform three other tasks. **One,** it sets the schmitt trigger IC7 into a high state so that it always starts a new sweep with the same phase, (via the D13 route). This stops jitter on the display.

Two, the reset is used to activate the zeroing switch mechanisms Q2 and IC6. **Three,** the control current is reduced during reset, due to the connection of D5. This helps the zeroing process. When switch SW2 (this is a double pole switch) is in the automatic position, both the sweep wave form and the reset pulse are routed to their respective sections of the circuit, and a logarithmically swept output is generated. The manual frequency control knob has no effect on the process, except when switch SW3 (the shift sweep), is closed.

This enables the sweep to be manually displaced up or down the frequency axis by a factor of about 5 times. That is if the sweep were between 20Hz to 20kHz it could be shifted up to 100Hz to 100kHz or down to 4Hz to 4kHz, thus enabling the useful range of the generator to be greatly extended. When switch SW2 is in the manual position, the sweep and reset signals are disconnected and so the generators output frequency is entirely determined by the manual control knob, plus any external control voltages and of course the position of the range switch SW4.

Next the diode function generator IC12, Q8, 9, 10, 11 and D9, 10. This circuit converts the triangle waveform into one that approximates a sinewave, see fig. 3. It is called a diode function generator, although four of these supposed diodes are transistors, Q8,9,10,11). The triangle is applied to an op-amp with several feedback routes, the purpose of which are to change the gain of the section, depending upon the instantaneous signal level. As the triangle waveform (which is symetrical about OV) goes positive, the output of IC12 goes negative. When it exceeds —0.6V, diode D9 begins to turn on and in doing so, the overall feedback resistance is reduced and so therefore the transmission slope is also reduced. This is known as the first break point. Transistors Q10,11 have their bases biased to voltages of −1.0v and −1.4v respectively. These transistors will provide further feed back routes when the output of IC12 exceeds −1.6v and 2.0v, and this extra feedback will decrease even more the transmission slope. Thus, the triangle waveform is gradually bent to resemble a sinewave in the negative excursion of IC12.

However there is also a complementary set of feedback routes for positive excursions via D10,Q9 and Q8 and so a complete sinewave is synthesised. This process is far from perfect and the best THD figure that can be obtained by careful adjustment of RV3, 4, 5, 6 is about 1.0% at 1kHz. This compares with a figure of about 0.2 to 0.5% THD for moderately expensive commercial function generators. These lower figures can only be obtained by having a precision regulated power supply, good tolerance resistors (0.5%) and a more elaborate set of MATCHED diodes. Also, some high quality equipment will be needed to make the final adjustments to the sinewave.

The sinewave from IC12 is passed through a manual level control and is buffered by the voltage follower IC13 to the output terminal. The sinewave also goes to the **toneburst section.** IC14, 15, 16 and Q12 FET Q12 is used as an analogue switch between the sinewave and the voltage follower/buffer IC16. This switch is turned on for 16 cycles of the sine wave and off for 48 cycles. The switching occurs synchronously as the waveform passes through OV. The control for the FET switch is generated by IC14 and 15. IC14 is used as a voltage comparator which determines whether the triangle waveform is positive or negative. It generates a square wave of + and —6V state as the triangle waveform passes through OV. This square wave is used to clock a seven stage CMOS counter, IC15. The divide by 32 and 64 outputs are AND'd together to generate the voltage control for the FET switch. This voltage is high (FET switch on) for 16 cycles and low (FET switch off) for 48 cycles and is used as an output (toneburst gate) to trigger, say, an oscilloscope.

The last piece of circuitry to be described is the power supply, IC1, 2. This delivers + and —6V at about 30mA. The transformer delivers 15V RMS which produces about 21V of unregulated supply. A 12VRMS transformer would be rather low and you might experience problems of the supply dropping out.

SWEEP OSCILLATOR

PARTS LIST

RESISTORS	(all ¼ W 5% unless otherwise stated)
R1	2 k 2
R2,3	27 k 1%
R4,9,10,26,46	27 k
R5,17	1 k
R6	1 M 5
R7,11,22,23,24,53	10 k
R8	56 k 2%
R12,38,47	1 k 2%
R13	150 k
R14	270 k
R15,43	10 k 2%
R16	68 k 2%
R18,20	18 k
R19,25	1 k 5
R21	82 k
R27	20 k 2%
R28	27 k 2%
R29	2 k 7
R30	22 k
R31,32	680 R
R33	330 k
R34	220 R
R35,49	4 k 7 2%
R36,50	220 k
R37,48	390 R 2%
R39	12 k
R40	820 R
R41	120 k
R42	18 k 2%
R44	560 k
R45	3 k 9
R51	33 k
R52	1 M
R54	100 k
R55	4 k 7
R56	10 M

CAPACITORS	
C1,3,9,10	100 n polyester
C2	1000 u 25 V tant.
C4,11,12,15	10 u 25 V tant.
C5	100 u 25 V tant.
C6	10 n polyester
C7	680 p polystyrene
C8	68 n polyester
C13	1 n polystyrene
C14	33 p ceramic

TRANSFORMER	
T1	240 V, 0-15 + 0-15 V (3 VA per winding) (Doram 207-217)

CASE	
Samos S7	(Doram 984-497)

MISCELLANEOUS
500 mA fuse, holder, single screened wire, stranded flex, pcb as per pattern, 3-core mains wire, 8 off 4 mm. red sockets, 2 off 4 mm. black sockets, pcb mountings, etc, instrument knobs.

POTENTIOMETERS	
RV1,2,3	47 k Hor. min. trim
RV4	1 k " " "
RV5	4 k 7 " " "
RV6	100 k " " "
RV7	10 k lin. moulded track pot.
RV8,9	10 k log. carbon pot.

SWITCHES	
SW1	off-on rocker etc. 3 A 250 V
SW2	D.P.D.T. toggle
SW3,4	S.P.S.T. Toggle

SEMICONDUCTORS	
Q1,2,4,7,8,9	BC 258 or similar (BC 477,8,9)
Q3,6,12	2N 5163 or 2N 3819 (N type FET)
Q5,10,11	BC 169
D1-4	1N 4002
D5-13	1N 4148
LED1	.2" type
IC1	7812
IC2,4,8,9	741
IC3	CA 3046 or CA 3146
IC5,6,7,10,14	CA 3080
IC11,12,13,16	see text
IC15	CD4024AE

BUYLINES

Most of the components are easily available, if they are in stock! **Marshalls** are preparing various packs for this project to make construction easier. All resistors for **£1.50**, capacitors for **£1.60**, switches **£2.70** and a complete semiconductor pack (preferred ICs for IC11, 12, 13, 16) for **£16.75.** All prices include VAT but add **30p** per order for postage etc.

Total cost for the whole project should be under **£35.00.**

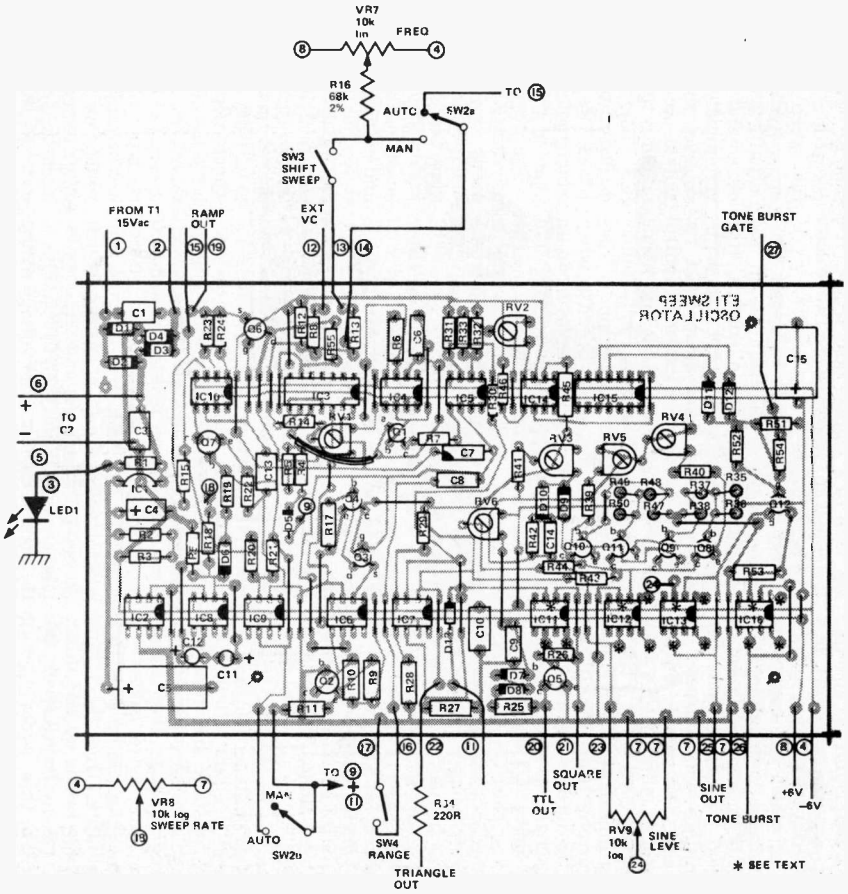


Fig. 8 Overlay and interconnection pattern.

Halvor Moorshead takes a look at Videocraft's

Teletext Kit

The Texas Instruments TIFAX module is now available to the amateur and a kit is available comprising everything you need to convert your colour TV (if it is a suitable model) for reception of Teletext.

IN THE JULY 1975 issue of ETI, we carried a main feature entitled 'Teletext Takes Off'. History has shown that our title was a mite premature!

This feature, and the forecast, was based on the announcement by Texas Instruments that they were going to produce a dedicated module which would bring down the cost of a Teletext capable TV set to the level of the mass-market.

Now most readers will know what Teletext is, but due to the lack of publicity over the past year or so, some of you may be unfamiliar with this system.

What is Teletext?

In late 1972 the BBC announced a system called CEEFAX: this would be a series of 'pages' of written information which could be displayed on a suitably modified or designed TV set. The 'pages' would be broadcast during the frame blanking. The transmitted signals were (and are) a series of digital pulses which did not form a picture in themselves but programmed a character generator at the receiver to write the page.

The 'pages' are transmitted sequentially and to hold the display on the TV screen, memory was also necessary.

Not long after the BBC announced this system, the IBA announced ORACLE, technically a very similar system.

Sense prevailed and a committee of all interested parties got together and drew up a technical specification using the best of both CEEFAX and ORACLE. This new system is generally known as TELETEXT, though the BBC (who did invent the thing after all) seem reluctant to differentiate between the system and the service, both of which they call CEEFAX.

Progress report

In September 1974, the BBC started a full experimental service and although some of the information now broadcast is experimental in nature, it is fully operational.

Both BBC networks put out 100 pages on all 625-line transmitters and the information provided is real and properly updated.

The IBA until recently were transmitting ORACLE only from London and from programmes networked from the capital but at the time that we're putting this issue to bed, ORACLE is due to be transmitted over the country, irrespective of the programme origin.

It is to the eternal credit of both the BBC and the IBA that they are operating very full systems - there is nothing amateurish or slip-shod - the information is mostly up - to - date and there is enough of it to be useful.

Both services are also operated with a sense of fun and are not yet plagued with considerations of 'balance'. The receipes on ORACLE are accompanied by a delightful graphic of one of the 'Homepride' men; retail outlets who are displaying Teletext can still get their names mentioned on a page and birthday greetings for Teletext users are put out.

Now the problem, if that's not too strong a way of putting it, is that very, very few people can receive it. No one knows for sure how many TV sets are equipped but it's probably under 2,000 so we've got a fabulous system, fully operational put out over the entire country, but with only a handful of viewers.

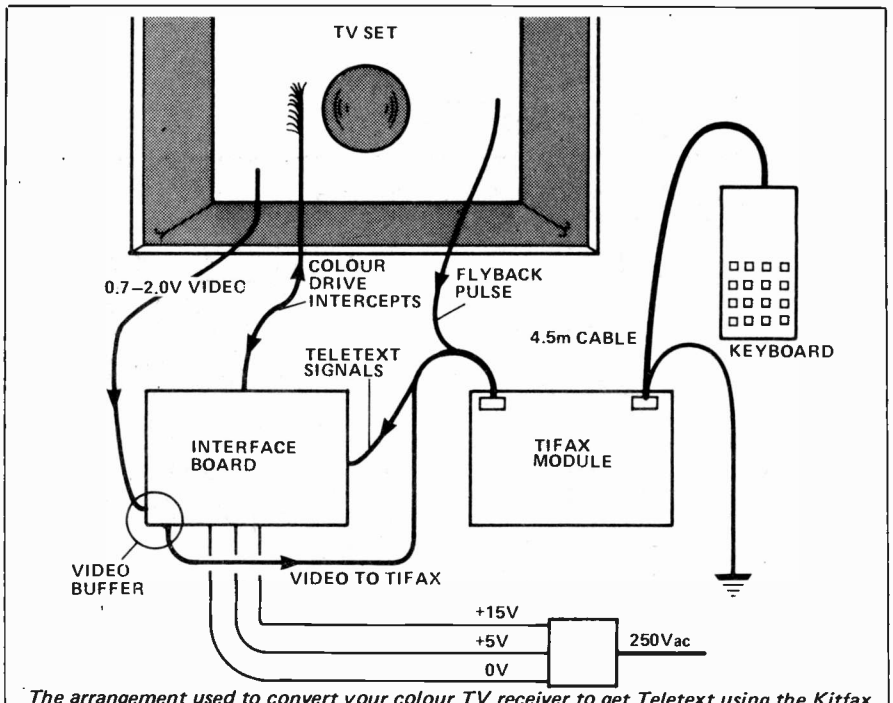
Perhaps the publicity given to it was a bit premature but now is the time to give the flag another wave because you can now buy a converted set or, if you're technical, you can modify your own set.

Kitfax

The long awaited TIFAX module is now available and one company, Videocraft of London, is supplying a conversion kit to the likes of us.

When we first heard about this we were very excited and arranged to try out a kit and convert one of our own TV's. In fact things didn't work out as we expected but we learned a lot about the kit and Teletext in general.

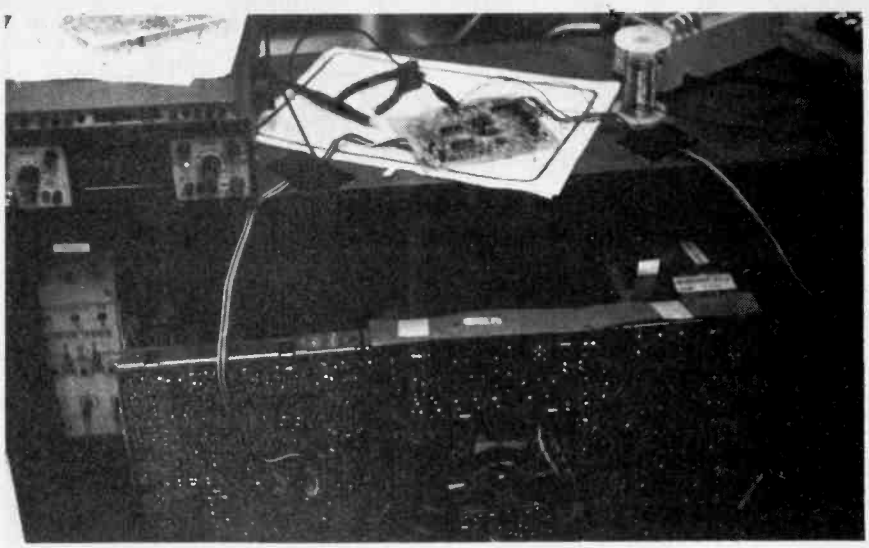
The kit comprises four main items: 1. Power supply, 2. Tifax module 3. Keyboard (very like a pocket calculator on a string) and 4. The Interface board.



The arrangement used to convert your colour TV receiver to get Teletext using the Kitfax from Videocraft. Connections to the Tifax module are made with Molex connectors. The connections you make to the set depend upon the chassis. The Video and flyback pulse signals are simple taps but the signal intercepts involve cutting the track of the PCB and connecting wires to both sides of the break. The screen of the keyboard cable is earthed in case it is broken and dangerous voltages have found their way in.

The keyboard and Tifax module need nothing doing to them, they're pre-assembled and even the connectors are prewired. The power supply needs building; all the components are supplied but there's no PCB or tag strip. The Interface board has to be built but this contains few enough components to be made up quickly in any one of two patterns to suit the particular TV to be converted. We'd rushed Videocraft a bit so we only got draft instructions which delayed matters a bit but we sorted out the problems O.K. Construction took about 3 hours and sorting out the connections to the TV and wiring it in took another 1½ hours. In theory the latter could take far, far less but you want to be careful.

The set we converted was an ITT 26in



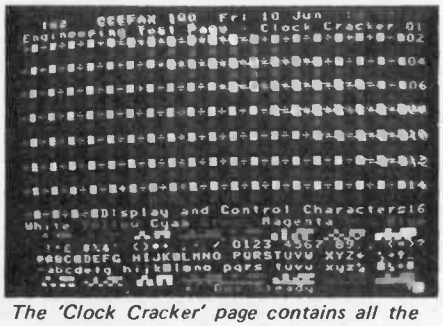
Photograph taken during the installation of the kit to the ITT CVC8 chassis.

Principle index page of ORACLE. There is now so much put out that the complete index will not fit onto one page.

We were experimenting at the time of the Jubilee as you can see. BBC-2 contains many such graphics.

Newsflashes are one of the main features of Teletext and are a fully operational part of the system. The IBA update theirs until 23.00Hrs.

Part of the fun aspect that pervades both CEEFAX and ORACLE at the moment is demonstrated here.



The 'Clock Cracker' page contains all the possible characters that can be displayed.

The weather map is just one example of a rolling page. Although always page 115, this page alternates between two displays, this is page B (may just be seen top right).

CVC8 chassis about three years old. Our problems arose because we found out after a heck of a time that this is not a suitable chassis for conversion! The other colour set we had for conversion uses the BRC 9000 chassis which is also a tricky one (we didn't try it, Videocraft told us in advance).

We feel that this was just bad luck. (We did get Teletext in brilliant colours and were able to operate it O.K. but had unbeatable troubles due to page rolling and hum). At Videocraft's workshops, which are really buzzing, they've modified a large number of sets which we've seen working so we know most sets work O.K.

This is not a beginner's kit by any stretch of the imagination - but it's not claimed to be. There is no casing as all the sections fit inside the TV - where there's always plenty of room - except for the keyboard and its wire to select TV, Teletext or the other facilities. You have to use some initiative but unless you've got some - and a measure of common sense - you shouldn't be dabbling inside the back of a TV set!

If you've got a TV which can be converted, it'll cost you £180 plus VAT and postage - well under half the price of any other method of converting.

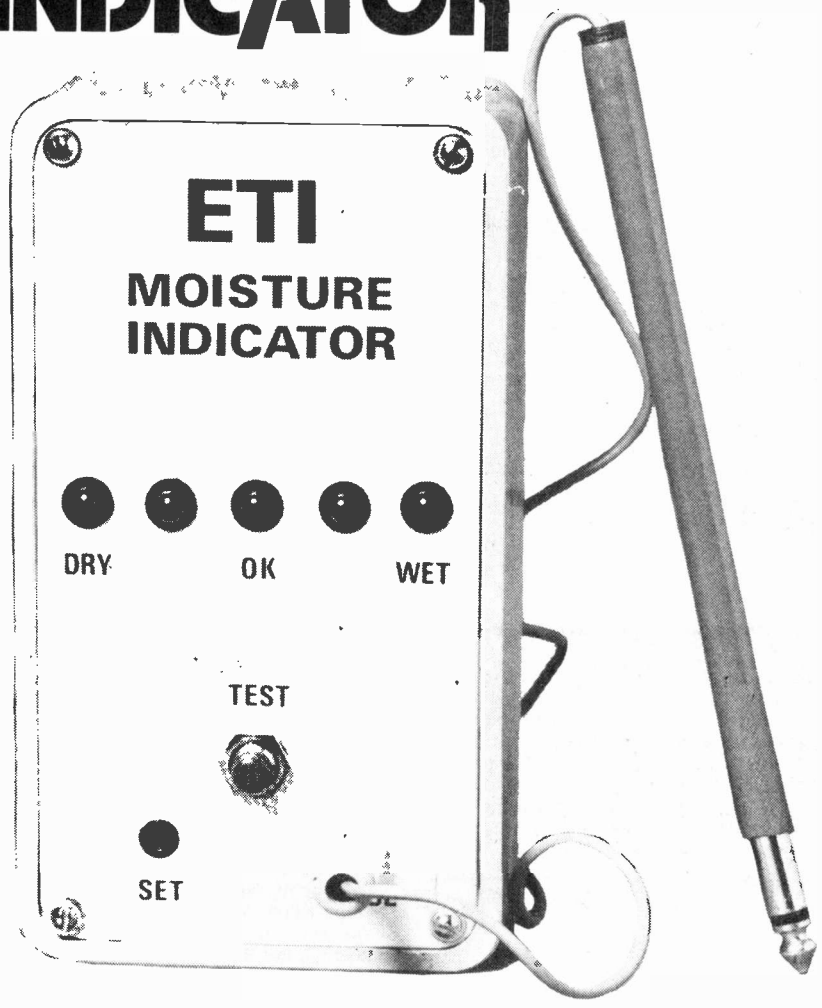
Some readers may well ask why the kit isn't arranged as a 'plug-in'. In fact, this makes a colour display impractical and would increase the cost considerably. Colour on Teletext may sound like a luxury but anyone who'se seen it in mono and colour wouldn't ask.

Teletext is here to stay and if you want to be a genuine pioneer and can indulge your enthusiasm to the tune of £196.90 , Videocraft's Kitfax could be what your'e looking for *if* you've got a set suitable for conversion.

Just think of inviting around the neighbours - you'll have something working that they've probably never heard of, let alone got and the punch line is, of course, "Oh, I did it myself in a few hours, the rental companies will be offering suitable sets soon". Then go out and change your name to Jones!

SHORT CIRCUITS

SOIL MOISTURE INDICATOR



TO A GREENHOUSE OWNER, or indeed to many indoor and outdoor gardeners the degree of moisture within a plant pot's soil or compost is important but relatively unknown. When pots were made of fired clay an expert could rap the pot with his knuckles and the 'ring' or 'thud' would show the need for watering! Nowadays however, the use of polythene sleeves and plastic containers gives too variable a sound for adequate guidance.

This circuit was developed to give an easy and accurate indication of the need for water or - just as important, very often - of a state of excess that tends to drown the roots of a plant.

Development

Ohmmeter measurements between probes in various soils and composts showed a surprising range of resistances, from about 3 kΩ to about 30 kΩ and further enquiry proved (as might have been expected) that soil acidity and probe dimensions also varied the readings; in particular the use of dissimilar metals for the probe tips gave enormous variations. Indeed some soil-probe combinations seemed to be trying to produce a reverse resistance reading when used in one way and then nearly full-scale - zero resistance - when the probe connections were reversed. The probe electrodes *must* be of the same metal, preferably solid and not plated.

Initial circuitry suggested that a fairly sensitive micro-ammeter would be needed, or at least an amplifier to drive a less sensitive instrument. A gardener could easily drop the completed apparatus and this could be an expensive accident; also, a pointer-type instrument led to queries about the 'needle is 2 mm further than last time', and 'not the same reading as last week' when (potted?) field trials were carried out in greenhouses. An LED display was therefore chosen as being cheaper, very robust and giving sufficiently repeatable results.

Construction

All the components with the exception of the LEDs, PB1, and SK1, which are mounted onto the front panel, are carried by the PCB. RV1, the sensitivity adjustment potentiometer, is made accessible via a hole drilled in the case.

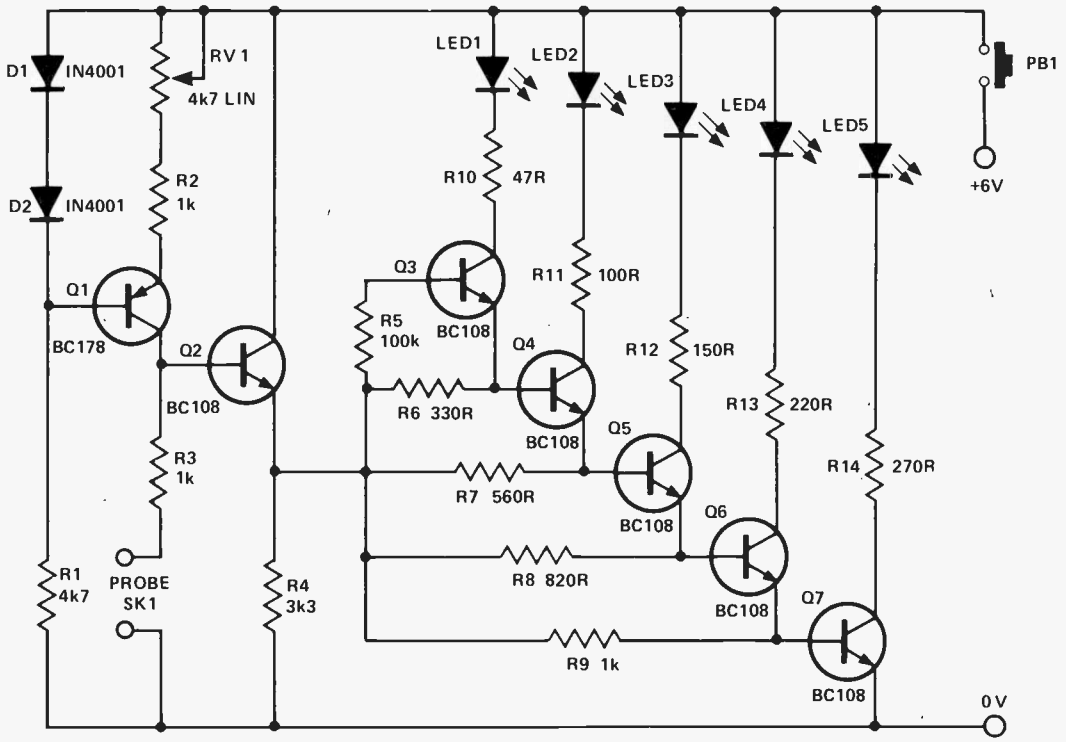
The most taxing part of constructing the device is the actual 'building up' of the probe. Ours was fabricated from a Japanese ¼" mono jack plug. Remove the cap, and upon inspecting the contents within, you will see that the tip contact is held in place by what appears to be a splayed rivet.

Take a file to this until the contact comes away freely. You can now remove the tip contact, earth contact and a spacing washer. However, we've not done yet. Hold the knurled 'body' of the plug in a vice or strong pliers, and physically pull the barrel out of it! (It may be necessary to make a small saw cut across the thread in order to achieve this.)

The barrel and tip portion is all you need for this job. A plastic sleeve is now visible over the central rod, and this too can be pulled out. Solder the probe lead to this as shown below, fixing the rod in a central position with some Araldite or similar adhesive.

Mounting the probe assembly is largely up to you, but we found that a 'Biro Minor' ballpoint, which is a cheap and universally available device, accepted the barrel like it was made for it.

Wiring from the probe to the box should be strong but as flexible as possible, so that continued use does not take its toll and incorrectly monitored moisture drowns both your plant and reputation as a genius!



Circuit of the moisture indicator

HOW IT WORKS

Fig.1 is the basic diagram of the system. A constant current (preset to suit local soil conditions) through the probe tips, and the moist soil, produces a volt drop that is proportional to the resistance of the soil. This voltage then turns on an LED, which typically requires some 2 V at 15 mA for adequate brightness. A soil

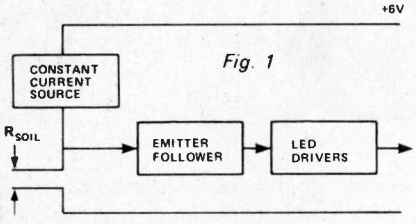


Fig. 1

resistance that is higher or lower than that given by the correct moisture content should also be indicated, so five LEDs are incorporated to cover the range of 'too wet' to 'too dry'.

Using silicon transistors, an emitter-base voltage of about 0.6 V is sufficient to turn on the emitter-collector current of Q7 and further increase in voltage (or base current) then results in additional emitter-collector current flow if the load allows. By connecting Q6 emitter to Q7 base, Q6 base needs to be 0.6 V more positive than Q7 case, hence at about 1.2 V (at the base) Q6 as well as Q7 is conducting. Similarly Q5, 4, 3 will conduct at base voltages of 1.8, 2.4, and 3.0 V respectively.

The current through an LED is limited to 15-20 mA by an additional series resistor (R10-14); the transistors Q3-7 are bottomed at this present collector current, a collector voltage then being only slightly more positive than its emitter when an LED is at full brilliance.

Resistors R5-9 are included to prevent the various base-emitter diodes from clamping the output of Q2 to a low value. The inclusion of these resistors and the required currents through them taken taken by the various bases means that the 0.6 V steps of voltage that should turn on Q3-7 are modified slightly. When the LEDs are illuminated the total base current drive for Q3-7 is in the order of 10-20 mA and this is supplied by Q2, an emitter follower.

A quick revision of theory reminds us that the collector characteristics of a transistor, Fig.2, shows a nearly constant-

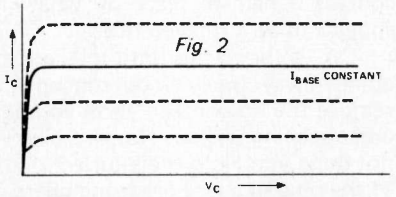


Fig. 2

current curve when the base is supplied with a steady value of current and voltage, this voltage being about 0.6 V. In Fig.3 the base voltage is clamped or set by a zener diode to a particular value, say Vz, and the emitter voltage is therefore about (Vz – 0.6) V. The emitter current (and, for all practical purposes,

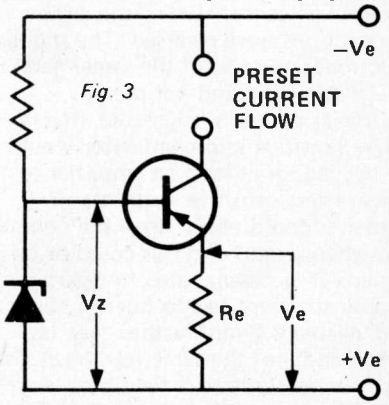


Fig. 3

the collector current too) is thus defined as Ie = VeRe and by selection of Re the value of Ie (or Ic) is determined. As long as there is about one volt between emitter and collector the collector current remains constant at this chosen value - or at least until a resistor or load of too large a voltage and so robs the collector of its working voltage.

With only a 6 V supply Vz must be as small as possible and once again the fact that a forward biased silicon diode drops about 0.6 V is used. The two series-connected diodes D1-2 maintain Q1 base at about –1.2 V and the voltage drop across R2-RV1 is about 0.6 V.

PARTS LIST

RESISTORS (all ¼ W 5%)

R1	4 k 7
R2,3,9	1 k
R4	3 k 3
R5,11	100 R
R6	330 R
R7	560 R
R8	820 R
R10	47 R
R12	150 R
R13	220 R
R14	270 R

POTENTIOMETER

RV1	4 k 7 hor. min. type

SEMICONDUCTORS

Q1	BC 178
Q2-7	BC 108
D1, 2	IN 4001
LED1-5	.2" type

SWITCH

P.B.1	Push to test type

SOCKET

SK1	3.5 mm panel jack socket

PROBE

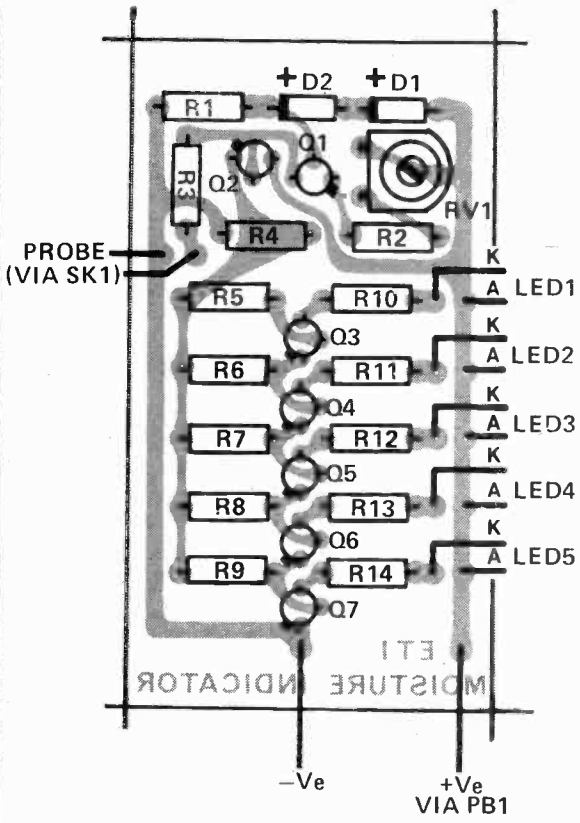
See text	(¼" mono jap. type jack plug, Biro 'Minor' ball point pen)

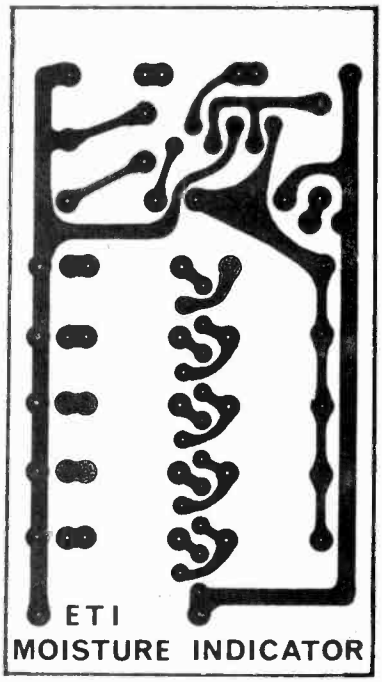
CASE

5¼" x 2⅛" x 1½" / 134 x 73 x 38 mm

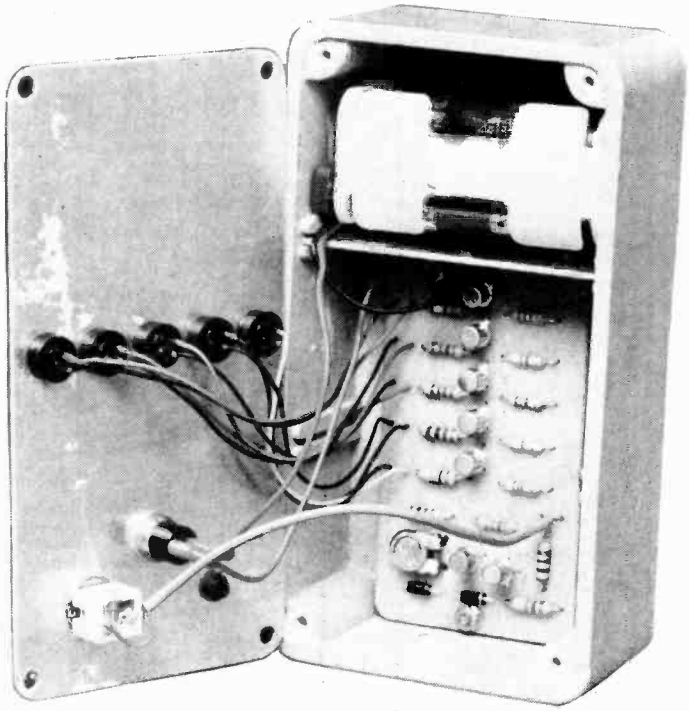
MISCELLANEOUS

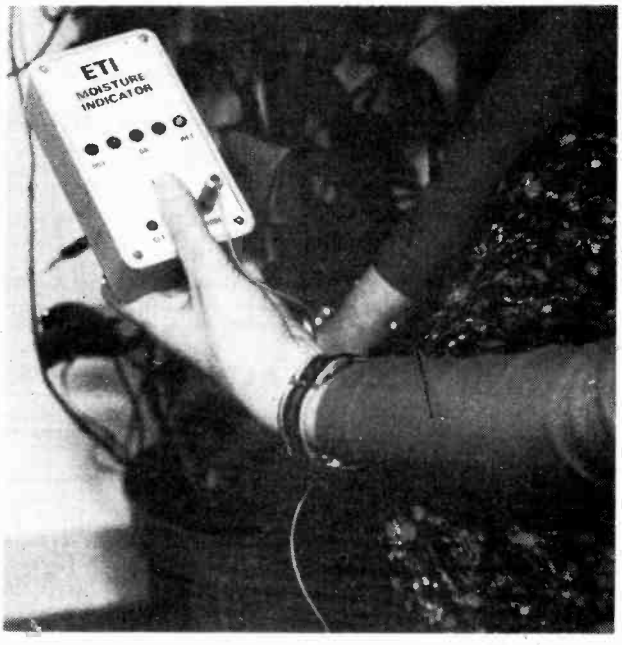
Battery holder (4 x HP7), battery clip, screened wire, wire, Araldite, 3.5 mm jack plug, pcb as pattern.





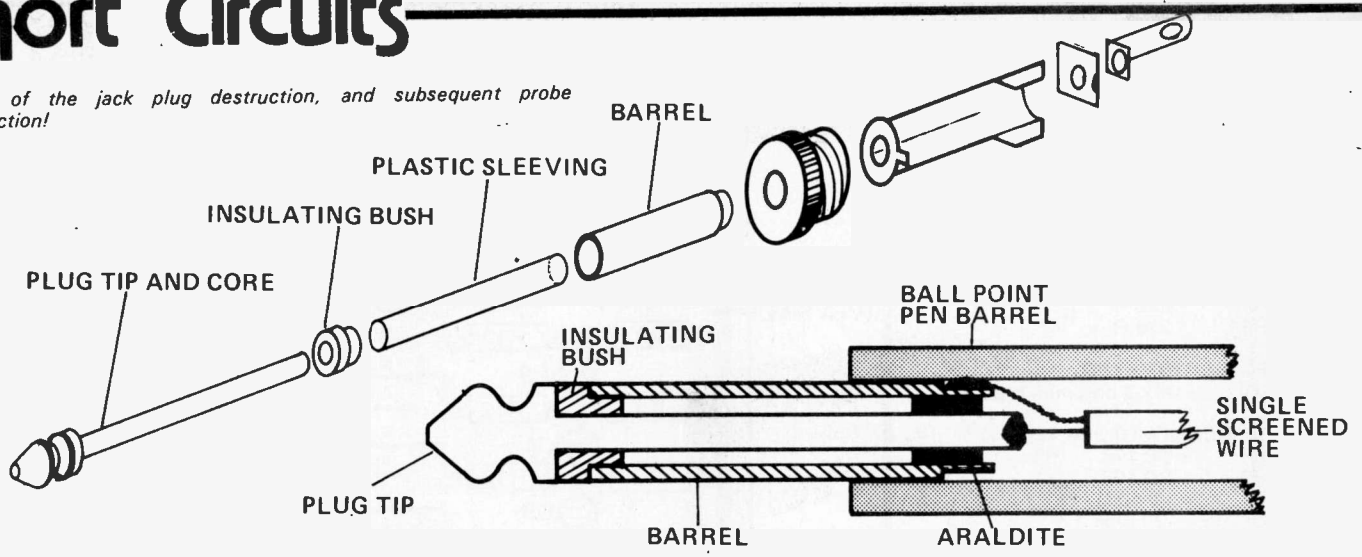
Above left: Component overlay for our Soil Moisture Indicator. The only thing to be careful of here is the orientation of the semiconductors.
Above right: Full size foil pattern for the PCB. This will be available from all the usual suppliers (see Mini-Ads) by the time you read this.
Below: Just to prove it works! A shot of the unit actually in use at the ETI Rubber Plant Department, being deftly weilded by our resident doddering old bearded gardener!





Short Circuits

Details of the jack plug destruction, and subsequent probe construction!



Testing and Using

Before connecting the supply to the board, check carefully there are no 'bridges' present lest they lead you to troubled waters.

With the probe 'dry' all the LEDs should come on. With a short-circuit across it (i.e. VERY wet!) not one should be lit. Check the range of current in the probe, by short-circuiting with a milliammeter, to be about 0.1 mA to 0.6 mA approx.

Push the probe into soil of what you consider correct moisture, and adjust RV1 to light three LEDs. More moisture than this then lights *fewer* LEDs, whilst a drier soil lights more.

Perhaps one usage for this would be if you trotted off on holiday, leaving some willing person to take care of the plant-life while you sample the night-life. Once set the indicator could ensure that your instructions are carried out faithfully, and you don't return to see your favorite rubber plant impersonating a water-lily.

BUYLINES

The probe for this project was constructed from a ¼" Japanese mono jack plug, and a 'Biro-Minor' ballpoint pen available from most stationers. The case is a Norman F.B.1 fibre glass type available from H.L.Smith, 287 Edgware Road, London, W.2. at approximately £1.20 inc. VAT and p&p. All other components should be easily obtainable.

The approximate cost of construction, including box, is £6.50 inc. VAT.

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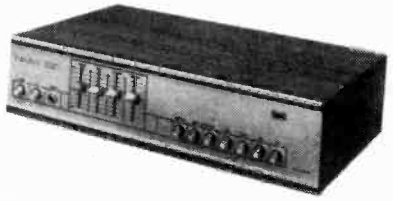

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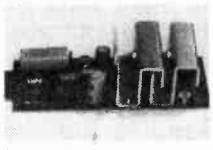

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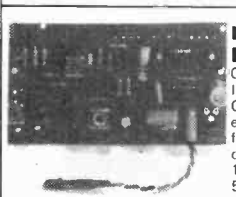

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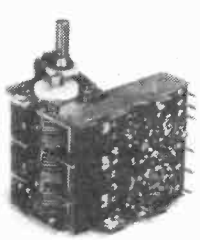

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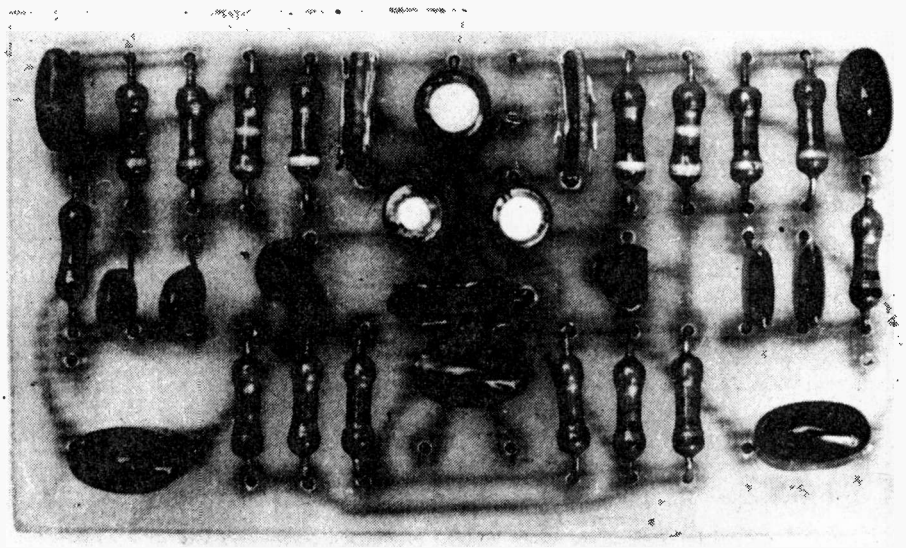
SHORT CIRCUITS

ELECTRONIC BONGOS!

MANY musical instruments can be simulated with sometimes astonishing accuracy by electronic circuitry. Complex circuits in the form of electronics synthesizers, can reproduce virtually any sounds that one can imagine.

Regrettably though at the present state of technology even a basic music synthesizer is an expensive and complex undertaking, and is beyond the scope of a series such as this. Nevertheless providing one attempts only to simulate a limited range of sounds some extremely realistic effects can be obtained without too much complication.

This article shows how to build up a circuit which simulates the sound of bongo drums. The finished unit is played in basically the same manner by tapping one's fingers on a pair of plates — one for each 'drum'.



Construction

The touch plates may be made of any electrically conductive material — copper, brass, stainless steel, aluminium, etc. Size and shape is not critical — they need to be at least 50 mm across but they may be much larger than this if desired — and round, square, triangular or whatever you will!

The finished unit may be housed as you wish in a box — built into another instrument — or even made up as a full-size or miniature replica of a bongo drum. But if you use a metal case you must have the touch plates insulated from the case and spaced away from any metal surface by at least 25 mm.

Potentiometers RV1 and RV3 are used only in the initial setting up procedure — easy access is not essential. Potentiometer RV2 controls the level of sound output and is required if the unit is to drive an amplifier which has no built-in volume control. If desired this potentiometer may be omitted from the board and replaced by a larger rotary potentiometer located away from the circuit itself. If you do this you'll need a 50k half watt rotary device (logarithmic curve). Connect it as if you were using the original potentiometer — except that now you're doing it via three bits of wire.

When the unit is assembled check out all connections and check all tracks to ensure there are no solder 'bridges'.

Setting up

Connect the unit to a suitable amplifier and loudspeaker. Connect the battery and then switch on the amplifier — keeping the volume control at a low setting.

Rotate RV1 to minimum setting and RV2 to about mid-way. Transistor Q1 should now be oscillating and you should head a sound from the loudspeaker. Now turn RV1 until the oscillation just stops and touch the associated touch plate momentarily. This should cause the circuit to produce a 'bong' sound which then decays away. Continue to adjust RV1 until a realistic bongo sound is reproduced.

Now repeat the operation for the second oscillator by adjusting RV3. Turn the amplifier up loud and play away!

Extending the circuit

The components specified will result in frequencies of about 290 Hz and 400 Hz. These frequencies are determined by C1, C2 and C4 (for the left hand part of the circuit) and the corresponding C9, C10 and C11. The frequency produced is inversely proportional to the values of these capacitors. Thus doubling their value will halve the 'bong' frequency. If you change the frequency maintain the same approximate ratios between capacitor values.

If you are ingenious and/or have some knowledge of electronics it is quite possible to extend this circuit so that you have a whole series of oscillators of different frequencies. The circuit is totally symmetrical except for the capacitor values mentioned above, so all you do to build up 'half circuits' — all connected to the common battery — and with their outputs connected to the point on the circuit which is the junction of R8, R9 and R6.

It is also possible to build the circuit using a range of switched capacitors to provide the tonal range you require.

HOW IT WORKS

The circuit consists of two twin-T type sine-wave oscillators. Each is virtually identical - there is one per touch plate.

Each oscillator has a filter in the feedback loop. If the loop gain is greater than unity the circuit will oscillate. In this application the gain is adjusted to be just less than unity. Touching 'touch plate' force starts the oscillator but the moment one's finger is removed from the touch plate oscillations will die away. The rate of decay is of course a function of circuit gain and this is controlled by RV1 (and RV3).

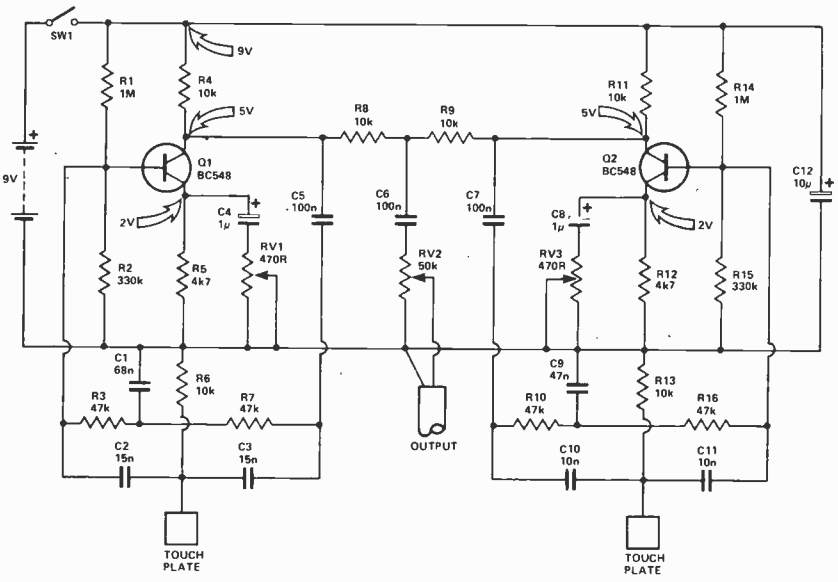
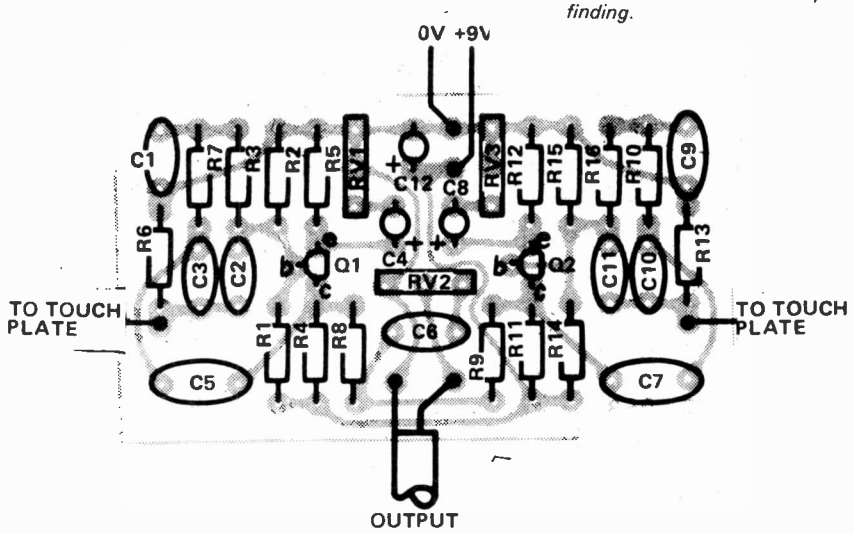
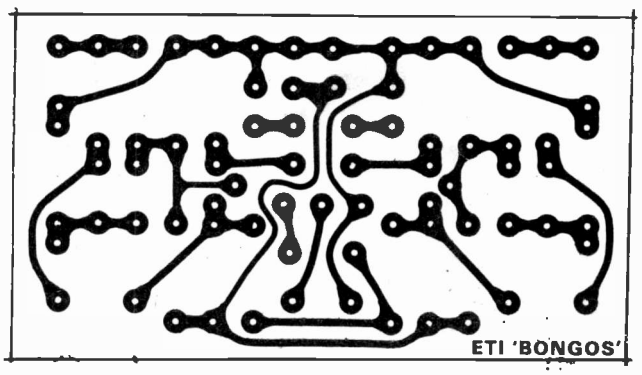


Fig. 1. Circuit diagram for the bongo circuit. Note that the voltages given around the circuit are all with respect to ground, and are intended as an aid to fault finding.



Above: The component overlay for the design. The board is symmetrical which may or may not make it easier to get working as there is a good chance one half will work first time! No case details are shown as the board will probably be built into something else.
Below: The foil pattern, shown full size.



PARTS LIST

RESISTORS (all ¼ W 5%)

R1,14	1 M
R2,15	330 k
R3,7,10,16	47 k
R4,6,8,9,11,13	10 k
R5,12	4 k 7

CAPACITORS

C1	68 n polyester
C2,3	15 n polyester
C4,8	1 u 16 V electrolytic
C5,6,7	100 n polyester
C9	47 n polyester
C10,11	10 n polyester
C12	10 u 16 V electrolytic

SEMICONDUCTORS

Q1,2	BC 548 or BC 108

POTENTIOMETERS

RV1,3	470 R vert. trim type
RV2	50 k vert. trim type

SWITCH

SW1	off-on rocker or toggle

MISCELLANEOUS
pcb as pattern, PP3 battery and clip, screened wire, metal for touch plates.

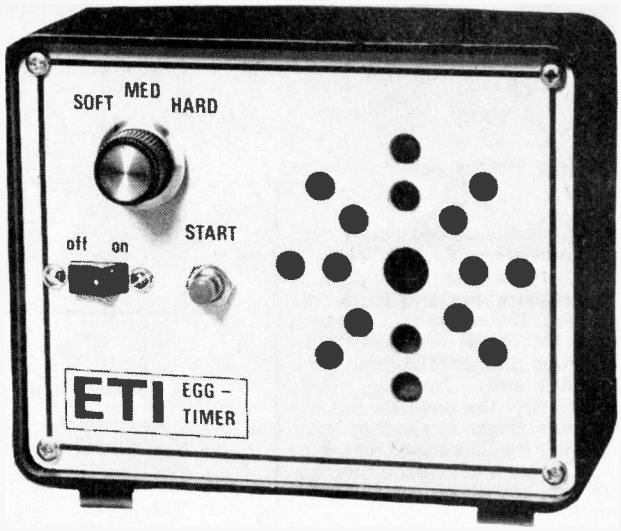
BUYLINES

All the components used here should be readily available; if the BC 548 cannot be purchased then the BC 108 will be o.k.

The total cost of the project, excluding a box should be about £3.00 inc. VAT.

Get to work on our

EGG TIMER



This design uses two integrated circuit chips to provide a versatile and accurate timer for your kitchen

THE ANALOGUE MINERAL egg timer that has been used in the kitchen until now has a number of serious drawbacks. The main one being that when it has finished "doing its thing" it does nothing to draw attention to the fact. Instead it sits quietly on your shelf while your attention is elsewhere and your egg is becoming decidedly hardboiled.

Our egg timer gets over this problem by giving you a shout when it feels that your breakfast is ready.

Getting it together

Construction is made easier if our PCB layout is used, pay particular attention to the orientation of the integrated circuits and electrolytic capacitors during assembly. When the board is finished, make a quick check of the soldered joints, also check that there are no solder bridges.

Our pictures show how we mounted the PCB board and the layout of our front panel.

As you like it

The preset resistors, RV1, 2, 3, can be adjusted to provide the following range of times depending on the position of SW2:

Soft	2½	—	3 mins
Medium	3½	—	4 mins
Hard	4	—	5 mins

To use the timer, switch on SW1 and press PB1. The timer will operate after the period selected by SW2 has elapsed.

The unit uses very little current in its timing mode but a lot more when it is producing the tone. So, for long battery life, do not leave the unit switched on and producing a noise for too long.

BUY LINES

The project was based on readily available components obtainable from most stockists. SW2 was a 2 pole 3 way type using only one half. LS1 is the Eagle TP26G (80 R) and the case came from Doram.

The cost of construction, including VAT, should be approximately £6.00.

HOW IT WORKS

The timer is based on the 741 op amp, IC1. R1 and R2 hold the inverting input at half supply voltage. Pin 3, the non-inverting input, is connected to the junction of C1, PB1 and SW2.

SW2 selects one of three resistor and potentiometer combinations, the value of this combination determines the timing period.

Upon operating PB1, to discharge C1, the voltage on C1 will increase towards the supply rail at a rate determined by the resistors selected by SW2.

When the voltage on C1 reaches half supply voltage the output of the 741 will swing from nearly 0 V to near to positive supply rail.

The time taken for the 741 to change O/P state is approximately 0.7 CR seconds where C is in Farads and R in Ohms.

The second IC is a 555 connected as an astable oscillator which a frequency of about 800 Hz.

When the O/P of the 741 is near 0 V the transistor Q1 is biased off and the 555 has no power applied to it. When the 741 changes state, Q1 turns on, allowing the 555 to oscillate and the tone is produced.

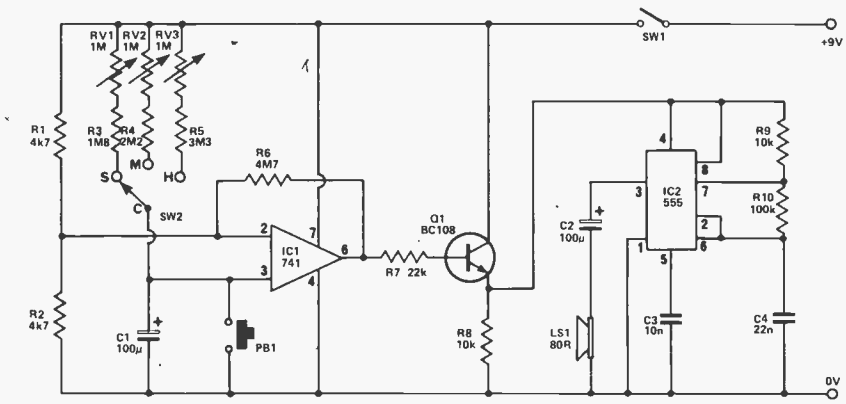


Fig. 1. Circuit diagram of egg timer.

Short Circuits

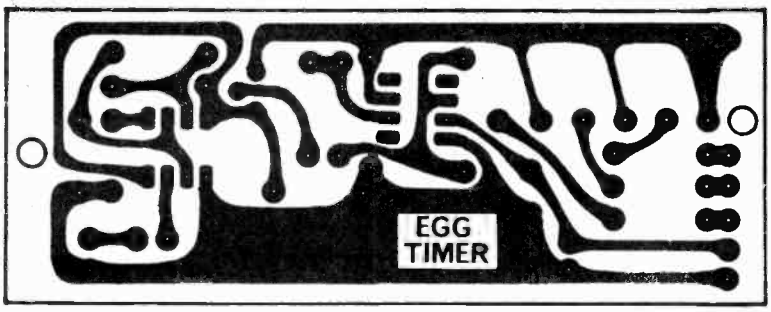


Fig. 2. Foil pattern of egg timer shown full size (100mm x 40mm).

PARTS LIST

RESISTORS (¼ W 5%)
R1,2 4 k 7
R3 1 M 8
R4 2 M 2
R5 3 M 3
R6 4 M 7
R7 22 k
R8,9 10 k
R10 100 k

CAPACITORS
C1 100 u 10 V tantalum electrolytic
C2 100 u 16 V electrolytic
C3 10 n polyester
C4 22 n polyester

POTENTIOMETERS
RV1-3 1 M min. hor. trim type

SEMICONDUCTORS
Q1 BC 108
IC1 741
IC2 555

SWITCHES
PB 1 push to test type
SW1 off-on rocker or slide
SW2 1 pole 3 way rotary

LOUDSPEAKER
LS1 80 R type (Eagle TP 26 G)

CASE
DORAM type M3 (984-526)

MISCELLANEOUS
pcb as pattern, PP6 battery and clip, knob, rubber feet, wire, etc.

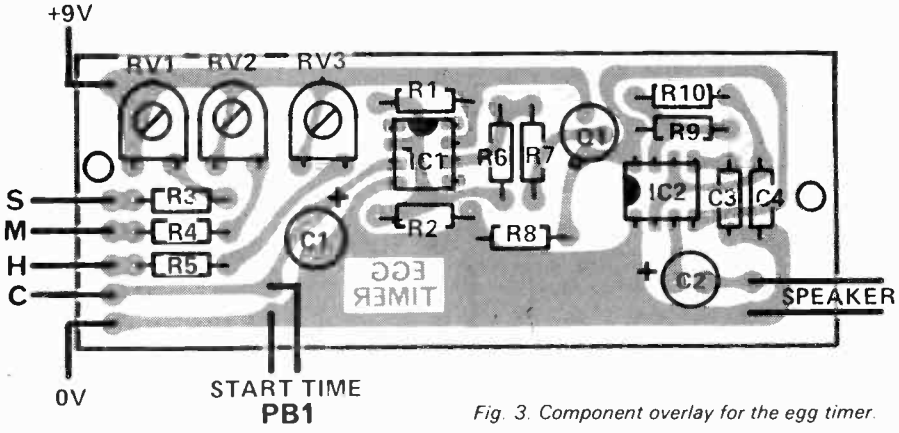


Fig. 3. Component overlay for the egg timer.

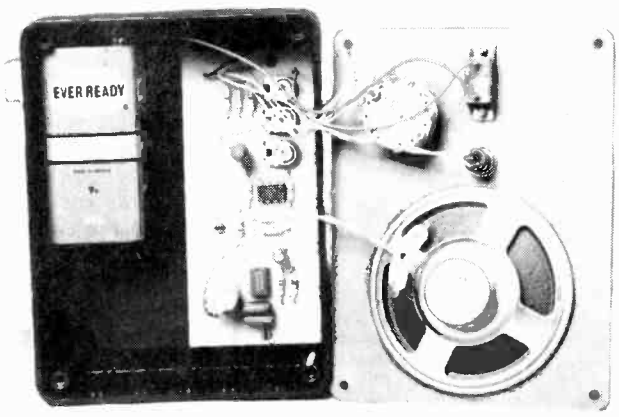
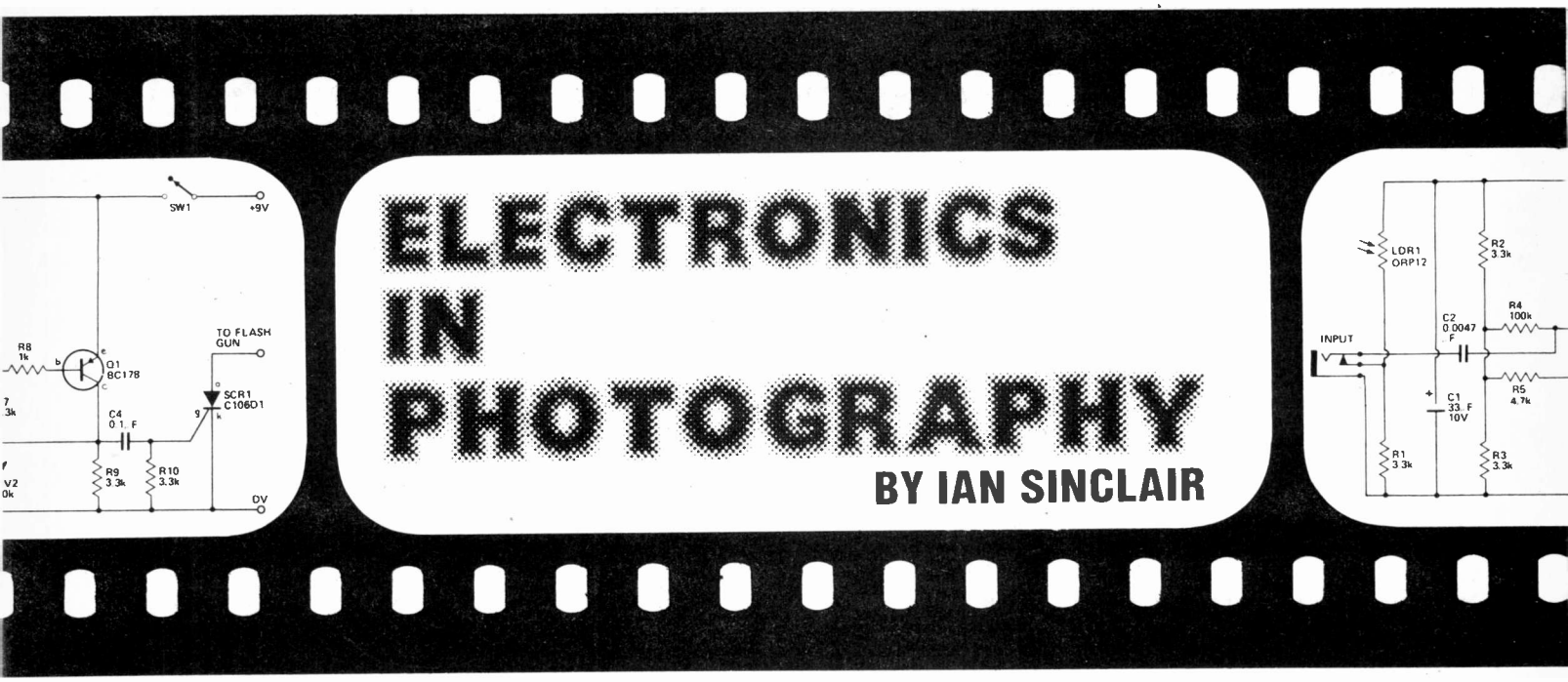


Fig. 4. View of the interior of the egg timer showing the location of the major components.



ELECTRONICS IN PHOTOGRAPHY

BY IAN SINCLAIR

FOR SOME CONSIDERABLE time now, there have been close links between electronics and photography. Glancing through past issues of ETI, for example, we find a fair number of projects of particular interest to keen photographers, and a look through past copies of "Amateur Photographer" shows the appreciation of the role of electronics shown by our photographic kindred. This article sets out to describe how electronics is involved in photography today, as it affects the keen amateur and the professional.

Electronics circuits, ranging from the very elementary to the extremely complex, become involved with photography at almost every step in the photographic process; at the camera itself, in the darkroom, and in slide and cine projection. Some of the electronic circuits that are used will be familiar, others less so, and we assume that the readers of this magazine are much more familiar with the electronic circuits than with the photographic processes.

Exposure Control

One of the earliest applications of simple electronics to the camera was exposure metering and, later, control. The amount of darkening of a given photographic film is decided both by the intensity of the light that reaches the film, and the duration for which the film is exposed. The intensity of light (luminous flux) reaching the film is regulated by the iris of the camera, a variable opening placed close to the lens, or built into the lens by placing it between the elements (separate glass pieces making up the lens). The timing is decided by the open time of another aperture, the shutter, which opens when the shutter release is pressed, and closes a preset time later. From fairly early days, shutter timings were obtained by using clockwork mechanisms that were reliable and robust. Today with smaller cameras in use, and more objects of interest moving, the range of shutter speeds has had to be increased to cope, and the regulation of the light level by an iris is used to a greater extent; the shutter speed is set to a value capable of "freezing" movement (of object or photographer) and the iris is used to set the light level for the correct exposure. This is why camera electronics are so devoted to controlling the iris, leaving shutter control in a lesser rôle.

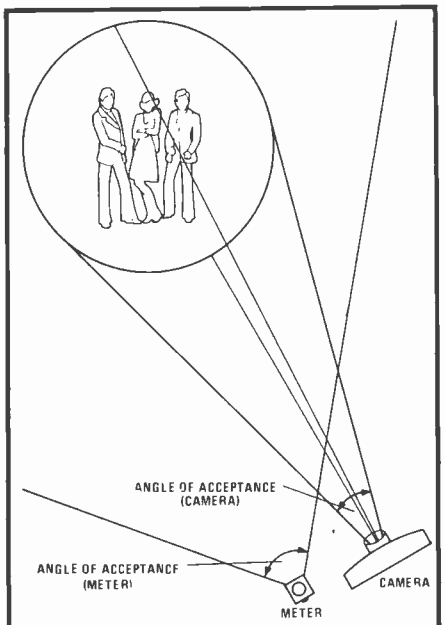


Fig. 1. Acceptance angles. The amount of light passing through a camera lens is not usually the same as the amount passing through the window of a separate exposure meter. This problem is more apparent when a telephoto lens is in use.

The first efforts concerned metering rather than control; consisting of exposure meters, using selenium cells driving moving-coil meters. The problem of these meters, which can produce excellent results if used properly, is that the light reaching the meter may not be proportional to the light reaching the lens (Fig. 1). The problem becomes more apparent when telephoto lenses are used, since there will be little relationship between the light entering the lens and the light entering the meter. One partial solution, still used, is the "incident light" reading, in which the meter, fitted with a diffusing cone, is pointed at the light source and the resulting reading used in setting the camera aperture.

The combination of colour slide film, which needs fairly exact exposure, with interchangeable lenses, and the single-lens reflex system, called for some improvements in light metering systems. Single lens reflex cameras use a mirror at 45 to the light path to divert the light path to

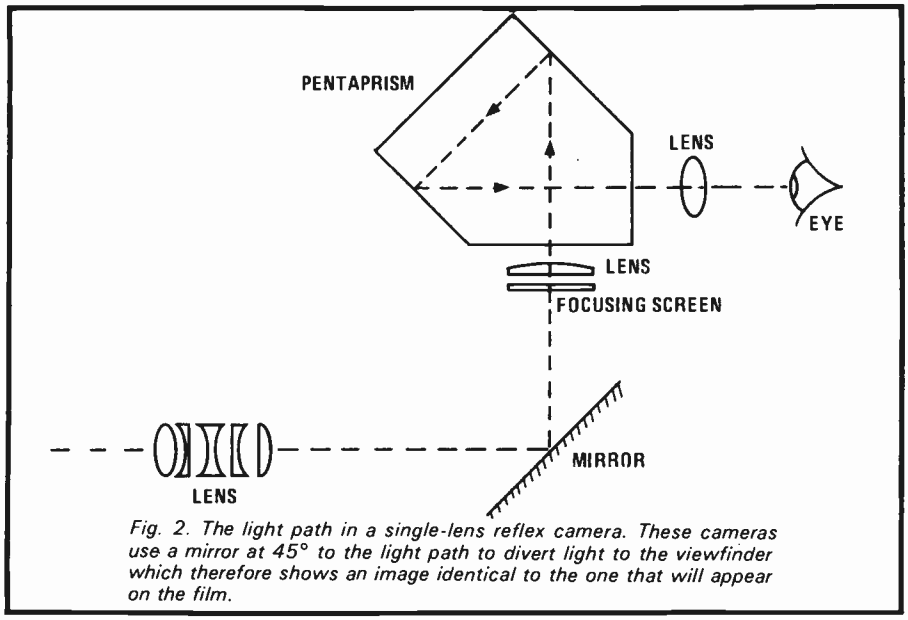


Fig. 2. The light path in a single-lens reflex camera. These cameras use a mirror at 45° to the light path to divert light to the viewfinder which therefore shows an image identical to the one that will appear on the film.

the viewfinder (Fig. 2), which therefore shows an image identical to the one that will appear on the film. Since the viewing is done through the lens, there is no parallax problem caused when close-ups are taken, as there would be if a separate viewfinder were used and specialised work such as photomicrography becomes possible.

TTL Metering

The next logical step is to place the exposure meter somewhere in this reflex viewing system, so that the light coming through the lens also operates the exposure meter. Right away we come up against a problem that still divides good quality cameras into two groups — shall this light reading be taken at one point in the image (a **spot** reading) or should the photocell be affected by the total amount of light entering the lens (an **average** reading). If the reading is a spot one, we must be certain that the spot is located on a piece of the picture we most need to be correctly exposed, so that we can take this reading. If the reading is an average one, we must be sure that the exposure will not be faulty because of a misleading average.

The use of TTL (**T**hrough **T**he **L**ens) metering, whether spot or average, demands the use of cells much more sensitive than the old selenium type. Cadmium sulphide cells have been used for some time; since they are photoresistive, not photovoltaic, they need a battery. They are also much more sensitive to red and infra-red than the eye or the usual run of films so that some light filtering must be used to correct the balance of the light reaching them.

Indication

The first types of TTL cameras used the cells to indicate correct exposure, which had then to be set by the user after taking the meter reading. Very soon, this developed to a system still used today in which the setting can be done while the image is viewed in the finder. The needle of the exposure meter appears in the viewfinder along with a marker coupled to the iris control. Aligning the marker and the needle by opening or closing the iris control sets the iris to the opening called for by the metering, but the photographer can, from experience of the type of subject and lighting, modify the setting as needed. A more "electronic" modification of this method, pioneered by Yashica, uses two LED displays (Fig. 3 c,d,e), one shaped as a U, the other as a ∩. A U displayed means that the iris is set for underexposure, an ∩ indicates overexposure, and a complete oval indicates correct exposure, for average light reading. Once again, the experienced user can modify the setting.

These systems, though simple, still demand considerable design expertise. The exposure indication is controlled by four quantities: film speed, shutter speed, iris setting and subject illumination, so that variation of any of these quantities will affect the readings. Since the resistance of the cell is determined by the amount of light reaching it, the compensation for film speed and shutter speed must be made by altering other parts of the system, either electrically by potentiometers in the current path, or optical, by neutral density filters in the light path.

With film speed set according to the type of film in use and the shutter speed set for coping with the motion of the subject or camera, the object is viewed and the meter needle position matched by the marker ganged to the iris opening. This scheme has the disadvantage that the image in the viewfinder might be very difficult to see if the iris is at a small aperture

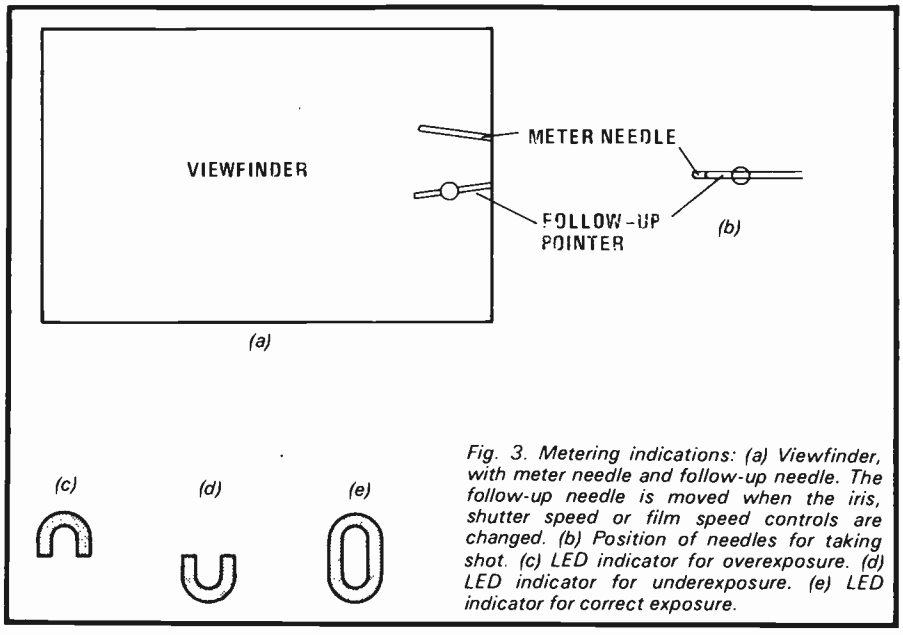


Fig. 3. Metering indications: (a) Viewfinder, with meter needle and follow-up needle. The follow-up needle is moved when the iris, shutter speed or film speed controls are changed. (b) Position of needles for taking shot. (c) LED indicator for overexposure. (d) LED indicator for underexposure. (e) LED indicator for correct exposure.

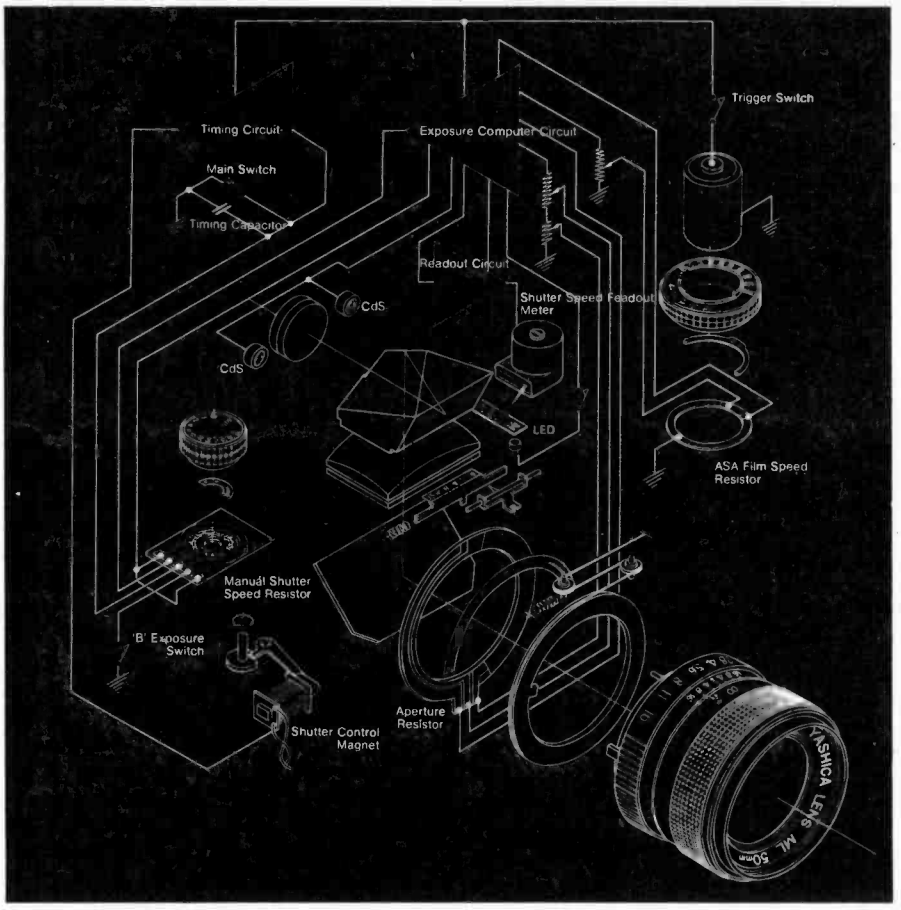


Fig. 4. Yashica FXI open aperture control system.

(stopped down) so that the next design step was full-aperture finding. This comes in two types, full aperture viewing or full-aperture metering. In each case, the iris can be fully open until the shutter release is pressed; the aperture is then changed to a preset value just before the shutter opens. In full aperture metering, the iris control ring affects the meter sensitivity and presets the iris control without changing the setting of the iris, which remains at full aperture, hence the name, for a bright display in the viewfinder. When the release is pressed, the iris is set, and the shutter operates. In simpler types of camera, viewing for focusing is done at full aperture (and cannot easily be done at reduced aperture) but the iris is stopped down when the metering system is switched in. With this system, the metering can be switched in momentarily to set the iris; if left in place, the system can reset after the release has been pressed.

Automatic Camera Systems

The final step in this progression is to use the photocell(s) to control the iris directly, with an over-ride to enable the photographer to adjust the exposure if he wants to. A block diagram of the system used in the Yashica FX1 is shown in Fig. 5. The IC in this system has been developed for Yashica, and comprises a set of comparators into which information on film speed, shutter speed, and iris setting is fed, along with the input from the cells. Since d.c. amplification is easily carried out using ICs, cadmium sulphide cells have now given way to silicon cells which, though less sensitive, can be made much smaller and have a colour response that matches the films (whether colour or black and white) much better.

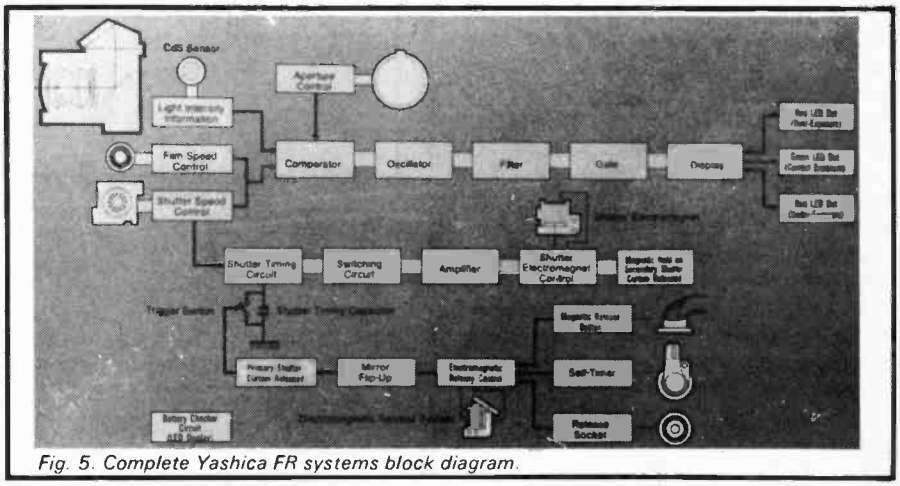


Fig. 5. Complete Yashica FR systems block diagram.

Time Control

For many years, the Compur shutter was the ultimate in timing. Pressing the shutter release opened a set of interlocking shutter blades situated between the lens elements and started a clockwork timer that closed the blades again after the preset time. With additional spring assistance, times of 3 ms or less were obtainable. The demand for interchangeable lenses and faster times led to the development of the focal plane shutter, the first types of which resembled a miniature roller blind with a slit of the same width as the film. This roller blind is set parallel to the film, and when the shutter release is operated, the slit is drawn rapidly across, exposing the film.

The modern focal plane shutter consists of two blades operated electromagnetically rather than by clockwork. This makes the release action smoother, and enables the camera to be operated by remote electrical contacts. The principle used is that pressing the shutter release button activates a solenoid that pulls the blades of the shutter apart, and also starts charging a capacitor through a resistor. At a set level of voltage on the capacitor, the current through the solenoid is switched off, and the blades are closed by a spring or by another solenoid. The timing here is achieved by capacitor charging, a familiar electronic principle, rather than by mechanical gearing, so that the speed is infinitely variable as compared to the set speeds obtainable with mechanical action. To conserve battery charge,

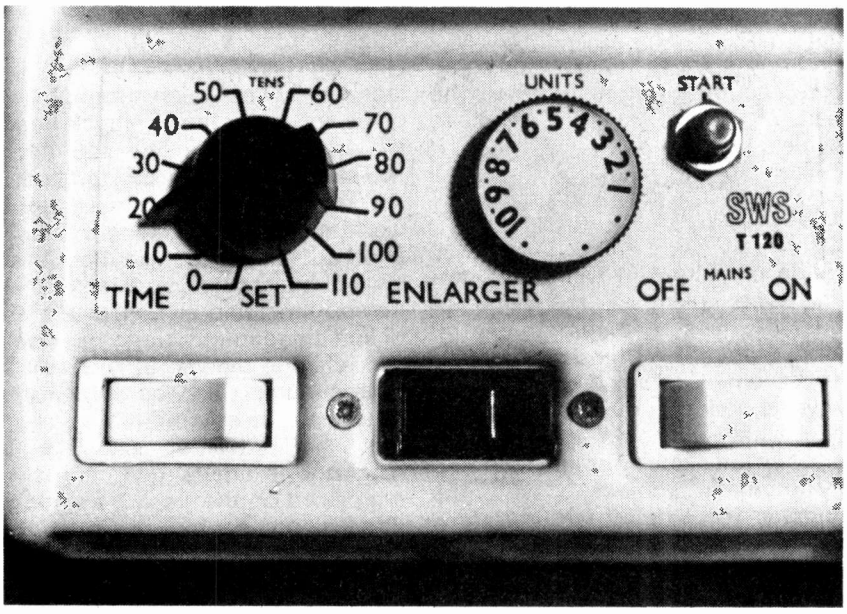


Fig. 6. Photograph of author's enlarger timer

however, the slower speeds are usually of set values obtained by mechanical operation, electrically triggered; this also avoids the problems of very long time constants, which would call for large capacitance and resistance values.

Darkroom Electronics — light readings

The design and construction of electronic devices for the darkroom is simpler than the corresponding work on cameras, because there are practically no restrictions on size or power supply. Whereas camera electronics must be fitted into the space available on a camera, and operate at the low voltage and current obtainable from small long-life cells such as the manganese alkali or silver oxide types, darkroom electronics equipment can be of any reasonable size and shape and can also be mains operated. The darkroom operations of interest to us are measurements of enlarger light values and the timing of enlargement, possibly along with electronic control of the temperature of chemical baths, and voltage stabilisation of enlarger lamps. The requirements for colour printing are much more stringent than those for black/white printing, so that electronic aids, though very useful for B/W work, are of more use when a large amount of colour printing is done.

With the small format (36 mm x 24 mm) negatives used for so much work nowadays, nearly every print produced is an enlargement.

The enlarger is a high-quality projector arranged vertically so that the photographic enlarging paper (bromide paper) can be laid flat on a base-board and the negative, held in a carrier, used to project an enlarged image on to the paper. The amount of enlargement may be fairly small, such as to the "enprint" size, or very large. In each case, however, the amount of exposure time for the combination of negative and paper size must be determined.

The use of electronic exposure meters simplifies problems of exposure and colour correction considerably. For B/W work, the use of an enlarger exposure meter is most

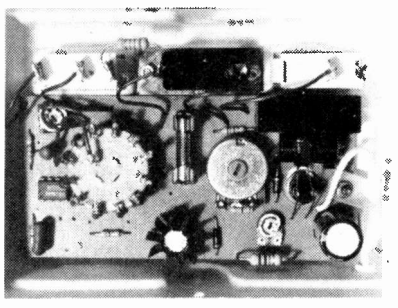


Fig. 7. Interior of unit shown above.

valuable when technical phtography (such as photographing circuits for ETI!) is carried out, since the density of negatives, the contrast range, and the amount of enlargement may vary much more than those of the family snaps. The simplest types of B/W enlarger exposure meters use ORP12 cadmium sulphide photoresistive cells operating moving coil meters or other indicators. The setting of the speed of the paper, which must be done using a test-strip, since manufacturers do not quote paper speeds for most materials.

For colour adjustment, much more elaborate meters are needed, preferably using silicon cells with amplification. The problem now is not simply that of exposure, but of adjusting the colour of the light in terms of three primary colours (red, green, blue) or their complementary colours, cyan, magenta, yellow. This requires three light readings, one for each colour, and the outputs should be in the form of colour correcting factors that can be supplied in the form of filters. In the simpler types of enlarger, a "filter drawer" is used between the condenser lens (used to make the light from the lamp converge into the projecting lens) and the main lens, and the readings on the colour meter are used to help select the correct filters. On the more expensive enlargers, the correcting filters are built in the form of a "colour head," controlled by three dials on the lamphousing. These are set to correspond with the meter readings, so carrying out the colour correction. Another reading taken from all three sensing cells is then used to determine the exposure time needed.

For the occasional colour print (and the cost in money and work will ensure that the prints will be occasional) the high cost of a colour analyser is quite prohibitive, matching the price of a good oscilloscope, but for regular colour work, particularly when very expensive materials are used, such as in the Cibachrome process, the cost is comparable with the price of the type of enlarger that will have to be used anyway, and can be justified if really excellent results must be attained.

Before leaving the darkroom, we should note that for colour processing, the temperatures of several of the solutions, notably the first developer and colour developer, are critical, needing control to within 0.25 C. This can be done by keeping

all the bottles, along with the developing tank or drum, in a water bath, and the maintenance of the bath temperature is much easier if thermostatic control can be used. Conventional bimetalic thermostats have much too great a difference between switch-on and switch-off temperatures (differential), but an electronic type using a thermistor to sense temperature and a triac to control heating current can easily provide the amount of control that is needed.

Other Applications

Outside the darkroom, the applications of electronics mainly concern projectors, flashguns, and cine equipment. The capacitor-discharge flash gun, using a transistor inverter circuit to provide a few hundred volts to charge the capacitor, is well established. With the flash gun connected to the camera shutter contacts, the capacitor is discharged through a thyristor when the shutter is wide open, and the current flows through a tube containing Argon and Xenon gases at low pressure. The time of the flash is short, about 100 µs or less, which is very short compared to the shutter speed, and the usual arrangement is to have a fixed delay built into the camera, so that the shutter speed must be set to 1/60s, or to a part of the shutter speed dial marked with the letter X. The timing of the exposure is then entirely due to the flash, though complications can arise if the long exposure time allows some exposure in conditions of partial darkness.

A recent development is the triggered shut-off flash (or "computer" flash, as the advertisements dub it). In this system, a silicon cell detects the light reflected back from the subject in the first micro-second or so of the flash, and this cell then charges a second capacitor feeding a comparator. At a fixed value of voltage, the comparator fires a second thyristor that short-circuits the main capacitor, stopping the flash very rapidly. In this way, the camera can be left at a fixed setting and flash photos taken without the usual need to pace out distances and set the aperture of the camera each time. Other flash developments more familiar to the electronics constructor are light-triggered flash used to synchronise one flash gun to the flash of another, so filling in shadows, and sound-triggered flash, used for some "frozen-action" shots where the speed of sound can be used to provide a variable delay.

Projection

Slide projectors of the semi-automatic type, using a magazine of slides advanced by a remote-control that incorporates motor-driven focus, have become popular within the last few years now that reasonably-priced models have become available. A more recent development is the fully-automatic projector, with the automatic focus (also featured now on some enlargers). This is based on the principle that the light reflected back from a projection screen is greatest in intensity when the image is correctly focused. A photocell mounted at the front of the projector picks up the reflected light, and the output of the photocell is taken through a d.c. amplifier to a servo-system operating the focus screw of the lens. Because the photocell is part of a negative feedback loop, the system will settle with the lens in the position giving maximum reflected light, therefore in focus. The system is disabled during slide changing or in the absence of a slide in the carrier, to avoid having the servo-system hunt about for an impossible focus.

Another application of electronics to slide projectors of the automatic or semi-automatic types is the synchronised tape-slide show. To achieve this, using an ordinary reel-to-reel tape recorder, a synchroniser unit is needed. This consists of an additional tape head over which the tape is led on its way from the playback head to the take-up spool. The sound commentary is recorded on one track of the tape, and synchronising pulses via the additional (sync.) head on another track. On playback, each sync pulse at the sync-head is picked up and amplified to generate a pulse of sufficient amplitude to operate the slide-change switch. In this way, the slide changing can be synchronised exactly to the commentary providing that the order of slides in the magazine is unchanged. The pulses are placed on the track by setting up the equipment for recording, and changing the slides at the appropriate times. The pulse at the projector socket is now used to generate the sync signal, and this is recorded on to the tape at the sync head.

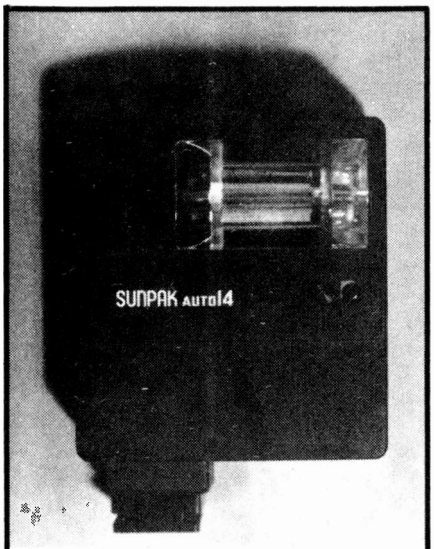


Fig. 8. A modern flash gun, with automatic flash cut off. The small silicon cell that detects the reflected light can be seen in this view.

Finally, the closest marriage between photography and electronics occurs in modern cine sound. This is such a specialised field that even to start on cine sound systems would take up much more space than can be justified here, and we can only note that the use of Dolby noise reduction looks like making the optical sound system, in which the sound is recorded in the form of light-and-dark bands on the film, a very serious rival for the magnetic tape stripe systems that have dominated cine sound for years. The important advantage of optical sound is "lip-sync," meaning that the synchronisation of sound and picture is close enough to permit views of people speaking, without the nonsense mouthing words that are not these being heard.

Looking to the future, it seems that the applications of electronics to photography will surely increase. At the time of writing, new colour printing systems are being announced at almost monthly intervals, new cameras appear with still more advanced electronics systems, and elegant applications of electronics appear in instruments that previously used only optical or mechanical techniques. One outstanding possibility for the future is a more electronic image formation process -- we are still using the silver halide process for images (along with dye coupling for colours) that was being used over 100 years ago. In these days of electrostatic copiers, could we be at last heading for a film that will wean us away from silver?●

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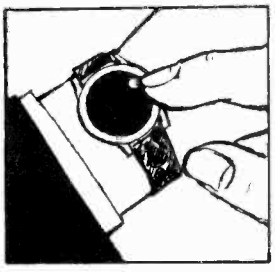

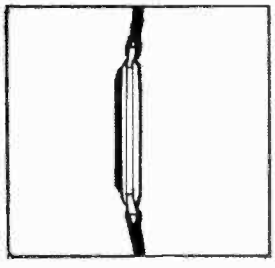

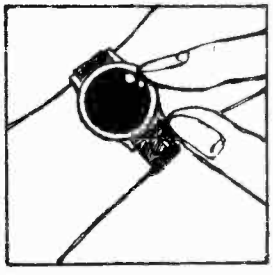

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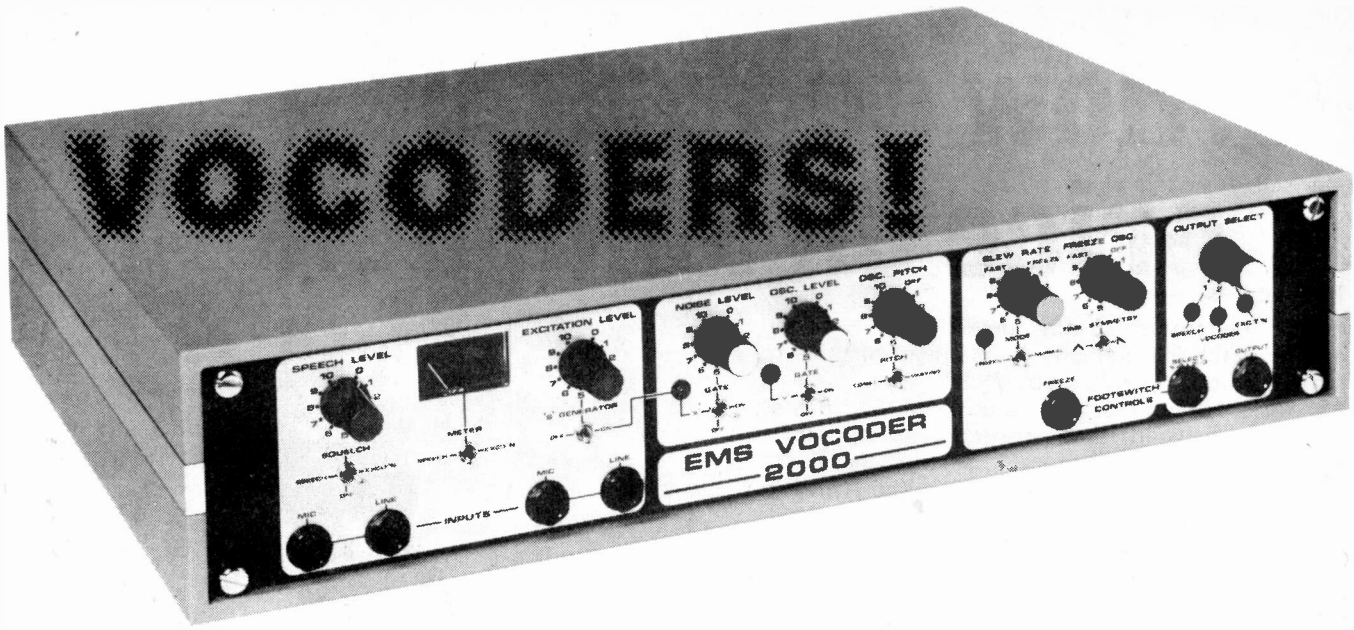

THE EMS VOCODER (VOice CODER) is a machine that can change the age or sex of a talker, compress or expand the speech in time without varying the pitch and make normally inanimate objects speak!

For instance, an electronic organ or guitar could be made to speak or sing! Other tricks include that of freezing a sound in midword, making a single voice sound like a chorus, producing synthetic speech at constant or varying pitch, and many others. Several well-known artists and organisations have used or own Vocoders. These include the BBC Radiophonic Workshop, The Pink Floyd, The Who, Stevie Wonder, Kraftwerk, Tangerine Dream, all of whom have used them to produce dramatic effects on records, radio and television, as well as live on stage.

History

One of the first speaking machines that we know of was designed by a man called Kratzenstein back in 1779. He had a bit of trouble getting hold of ICs and so he designed his machine with bellows, vibrating reeds and acoustic resonators. His machine was capable of generating vowel sounds, but not much else.

In the late 1800s, Alexander Graham Bell had a bash at constructing a speaking machine, which again was mechanical and could only produce very poor quality speech. However he claims to have 'taught' his dog (a Skye terrier) to say "How are you Grandmamma?". This was done by making the dog growl and then manipulating its vocal tract by hand.

Other mechanical speakers were constructed but it wasn't until the advent of electronics that speaking machines became really practical. One type of machine that emerged was the Channel Vocoder, invented by Dudley (1939). This Vocoder was used to compress the band width necessary to send intelligible speech down, say, a telephone line.

Interesting Effects

However, as EMS has proven, the Vocoder can be used to do a whole lot of other interesting things. The Channel Vocoder operation is as follows, (fig. 1), speech is analysed into 22 frequency bands throughout the audio spectrum. The time varying energy levels in each channel is extracted by an envelope follower. This is in fact a real time spectrum analysis of the speech.

Another signal, the excitation, is introduced into the Vocoder. This is the signal that we will make talk. That is, if the excitation signal is a chord from an organ, we will end up with a talking chord. The excitation signal is also analysed into 22 frequency bands throughout the audio spectrum. However, the signal that is presented to each band is multiplied by a control voltage, which is the envelope signal from the speech channels. Thus the time varying spectrum of the speech is imposed upon the excitation signal, that is the excitation is filtered in a way entirely prescribed by the speech signal.

Realism

If realistic synthetic speech is required, the excitation used is a voltage controlled oscillator and a noise source. The oscillator is controlled in pitch by a pitch extractor and is used to synthesise the 'voiced' portions of speech. The 'unvoiced' portions, sounds like 's'

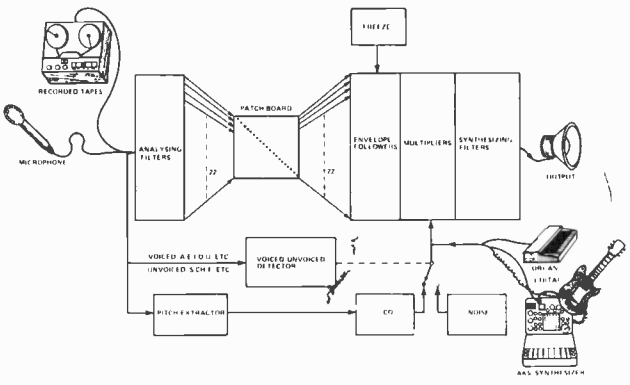

Fig. 1 Block diagram of the big Vocoder model (not illustrated). The model 2000 works in the same way but is simplified for stage (live) useage

'ch', 'f', 'th', are synthesised with the noise source. The synthesised speech can be modified by, say, shifting the pitch of the oscillator and shifting up the interconnection between analysing and synthesising channels. This will change a man's voice into one of a woman or a child. If the original voice and the synthesised voice are then mixed together, a 'double tracking' or 'chorus' effect is heard.

The first EMS Vocoder was designed by Tim Orr for West German Radio (Cologne). Since then he has designed two other types of unit (see photos), the larger one being for studio work, the smaller one, by virtue of its reduced size and portability, for live work.

So, next time you hear something strange on the record, radio or TV, then maybe it's a, it's on the tip of my tongue, it's a V . . . . . !

Two Vocoders are produced by EMS, a big 22 channel one (as in schematic) which is yours for only £10,500 plus VAT. Possibly more within the reach of our readers is the illustrated Vocoder 2000 which is £2,500 plus VAT.

Further details from Electronic Music Studios Ltd, The Priory, Great Milton, Oxford.

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DESIGNING & USING
ACTIVE FILTERS PART 2

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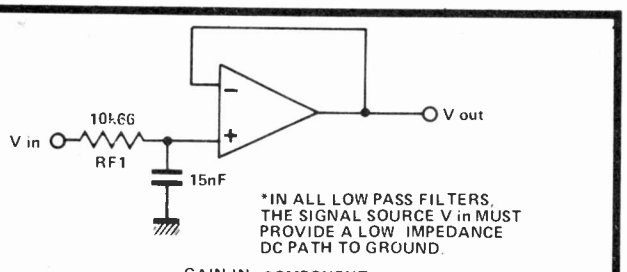
The following section contains all the information needed to be able to build low and high pass filters, of first, second, third and fourth order to Bessel, Butterworth and Chebyshev characteristics.

Low pass

Figure 1 shows a first order low pass filter. In all the examples to follow the filters have been designed for 1kHz operation. Equal component value 'Sallen and



	RF1	GAIN IN dB	COMPONENT TOLERANCES	
BESSEL	10k66	0	10%	ALL THE RESPONSES ARE THE SAME FOR A FIRST ORDER FILTER
BUTTERWORTH	10k66	0	10%	
CHEBYSHEV	10k66	0	10%	

Fig. 1. A general circuit for a first order low pass filter.

Key' filters have been used as the basic building blocks. If operation at a frequency other than 1kHz is required, then the resistor/s Rf should be scaled accordingly, (the Rd resistors are not altered). For example, if operation is required at 250Hz, then the Rf in the chart must be multiplied by

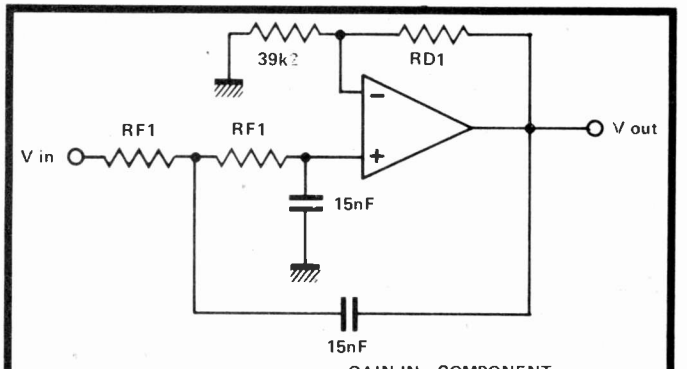
$$\frac{1000}{250}$$

which is

$$\frac{\text{(Normalised 1kHz)}}{\text{Required frequency of operation)}} = 4.$$

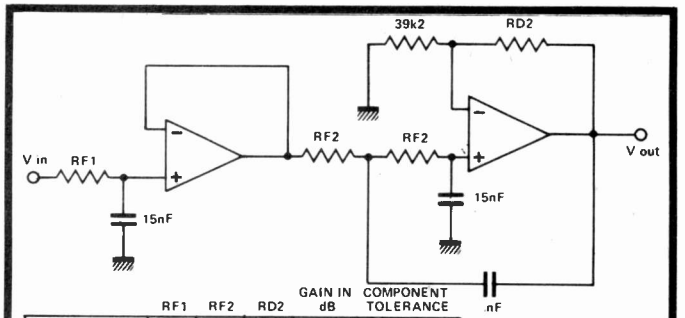
Figure 2 shows second, third and fourth order filters. The design procedure is as follows:—

1. Decide which type of filter is required, high, low, bandpass or notch.
2. In the case of high or low pass, decide which type of response is required, Bessel, Butterworth or Chebyshev.
3. Next, what filter order is needed. This will have led you to a particular order filter with components designed for 1kHz operation.
4. Scale the Rf components so that the filter will operate at the required frequency.
5. Build and test the filter.



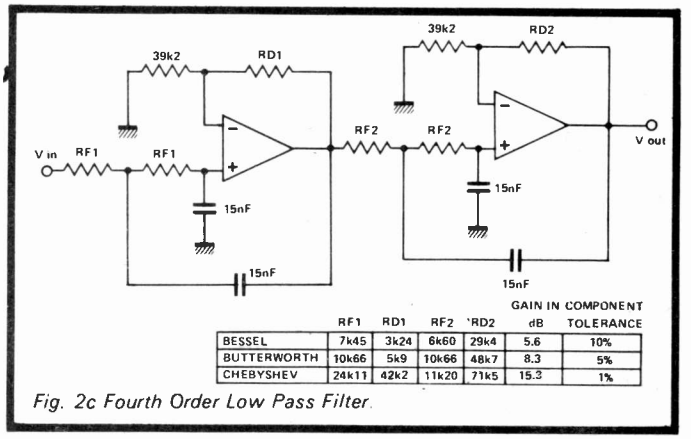
	RF1	RD1	GAIN IN dB	COMPONENT TOLERANCE
BESSEL	8k39	10k5	2.3	10%
BUTTERWORTH	10k66	22k6	4.1	10%
CHEBYSHEV	12k6	48k7	6.8	5%

Fig. 2a Second Order low pass filter design, break frequency = 1kHz.



	RF1	RF2	RD2	GAIN IN dB	COMPONENT TOLERANCE nF
BESSEL	8k	7k26	21k5	4.1	10%
BUTTERWORTH	10k66	10k66	39k2	6.0	10%
CHEBYSHEV	35k41	11k73	66k5	8.6	2%

Fig. 2b Third Order low-pass filter. To alter break frequency (here 1kHz) scale resistors accordingly.



	RF1	RD1	RF2	*RD2	GAIN IN dB	COMPONENT TOLERANCE
BESSEL	7k45	3k24	6k60	29k4	5.6	10%
BUTTERWORTH	10k66	5k9	10k66	48k7	8.3	5%
CHEBYSHEV	24k11	42k2	11k20	71k5	15.3	1%

Fig. 2c Fourth Order Low Pass Filter.

There are of course some problems which may occur. One is that these filters have a voltage gain in their passband. So you might find that although you have got the required frequency response there is an unexpected signal gain.

This may cause some problems with op-amp bandwidth. As a rule of thumb, the op amps should have 10 to 100 times more bandwidth than the product of the filters maximum operating frequency times the individual stage gain of each section. If the op amp runs out of bandwidth or introduces a phase shift then the filter is not going to work properly. For the examples given, if you use a 741 as the op amp then a frequency limit of approximately 10kHz should be imposed. (If an LM318 is used then the limit can go to 200kHz). Another problem is one of range of values of Rf. If Rf is made too small then large currents have to flow from the Op amp and this may effect the performance of the filter. If Rf is too large there may be hum pick-up problems and DC offset voltage problems due to bias currents. Therefore, keep Rf between 1k and 100k. If Rf needs to exceed this range, scale the capacitor as well.

Charting examples

As an example of using the design tables, let us solve the following problem. Design an audio 'scratch' filter, having a break frequency of 7.5kHz and an attenuation at 15kHz of more than 20dB. The first decision to be made is what type of response do we want? A roll off of more than 20dB/octave is quite steep and so the Bessel filter is ruled out. The Chebyshev filter has a poor transient response and at 7.5kHz we would hear it ringing. Therefore a Butterworth response should be used. Next, the filter order. Third order gives us — 18dB/octave which is not sufficient, fourth order gives —24dB/octave. Hence what is needed is a fourth order Butterworth design (fig. 2c).

The break frequency is 7.5kHz and so the resistors Rf1 and Rf2 have to be *divided* by 7.5. This gives Rf1 = 1k42, Rf2 = 1k42, Rd1 = 5k9, Rd2 = 48k7, C=15nF, and the component tolerance is 5%. Now we must fit preferred values to the resistors.

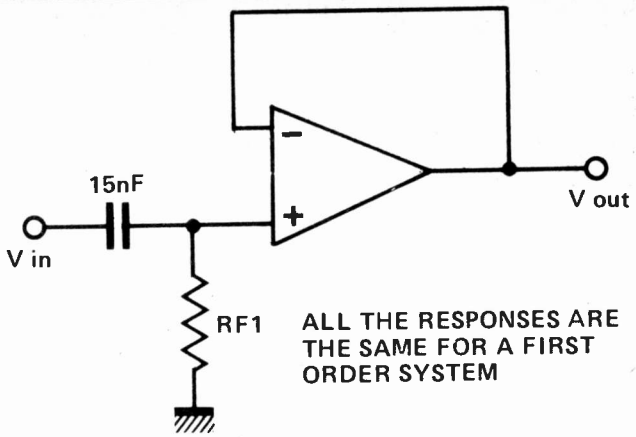
Rd2 becomes 47k, Rd1 becomes 6k2 (this is just over the limit of tolerance) Rf1 and Rf2 are a problem. Even when taken to the nearest E24 value they are outside the component tolerance allowed. There are two solutions; use the nearest E96 1% resistor or use 1k5. This will lower the break frequency by about 6%, but as this is only an audio filter no one will probably be any the wiser!

High Pass

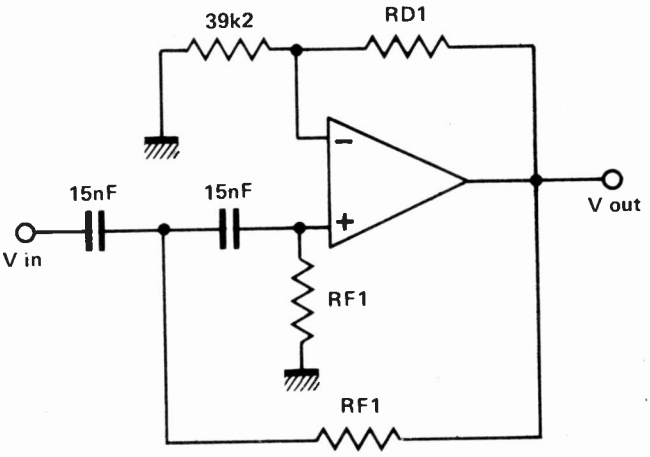
Figure 3 gives the design tables for high pass filters. The design procedure is exactly the same as that for low pass filters.

Band Pass

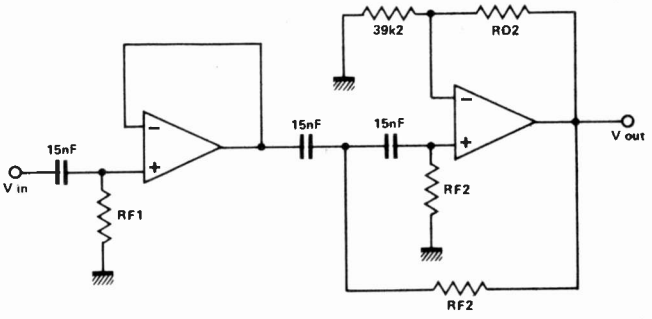
Several second order band pass filters can be cascaded to produce a different response shape which, like those discussed earlier for the low and high pass filters, can be optimised to give maximum roll off, or maximum pass band 'flatness'. However, these tend to get rather difficult to design and so only second order filters will be discussed.



	RF1	GAIN IN dB	COMPONENT TOLERANCE
BESSEL	10k66	0	10%
BUTTERWORTH	10k66	0	10%
CHEBYSHEV	10k66	0	10%



	RF1	RD1	GAIN IN dB	COMPONENT TOLERANCE
BESSEL	13k55	10k5	1.3	10%
BUTTERWORTH	10k66	22k6	1.6	10%
CHEBYSHEV	9k01	48k7	2.2	5%

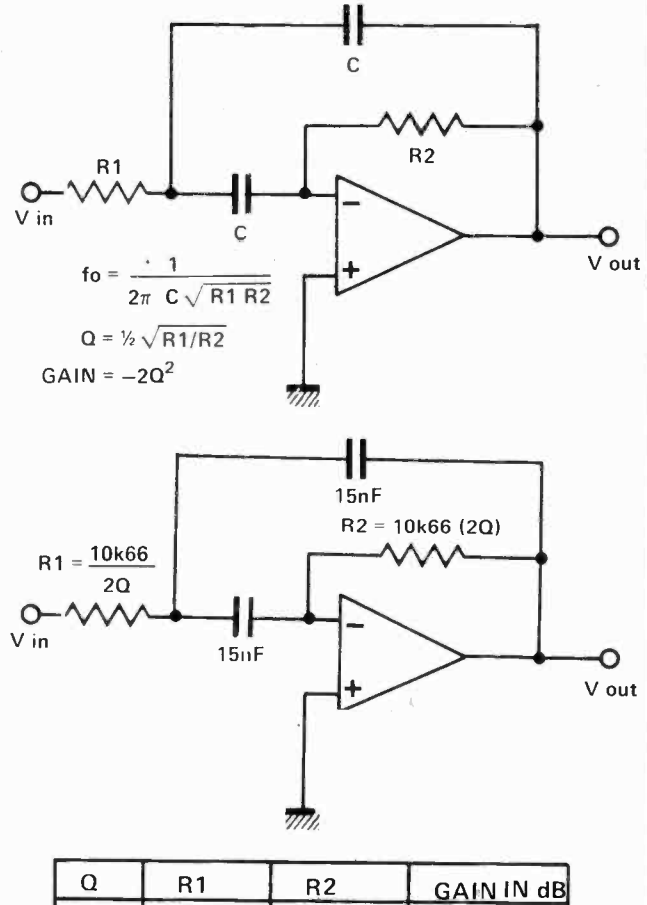


	RF1	RF2	RO2	GAIN IN dB	COMPONENT TOLERANCE
BESSEL	14k19	15k68	21k5	4.1	10%
BUTTERWORTH	10k66	10k66	39k2	6.0	10%
CHEBYSHEV	3k21	9k70	66k5	8.6	2%

Fig. 3. From the top! First, second and third order high pass filters, break point 1kHz. Final roll off is 6, 12 and 18 dB/octave respectively.

ACTIVE FILTERS

Figure 4 shows a simple bandpass filter known as a multiple feedback circuit. This circuit can only provide low values of Q up to about 5. It will probably oscillate if it is designed to give a higher Q. Note that a high Q implies a large gain at the centre frequency. Therefore care must be taken to ensure the op amp has enough bandwidth to cope with the situation. Fig. 4 gives a design chart, normalised for 1kHz operation. First, choose a Q factor and then perform the frequency scaling. For instance, if the centre is 250Hz, then multiply *both* R1 and R2 by a factor of 4. If a high Q is required, then a multiple op amp circuit must be used. The 'state variable' and the 'Bi-Quad' are two such circuits and Q's as high as 500 may be obtained with them.

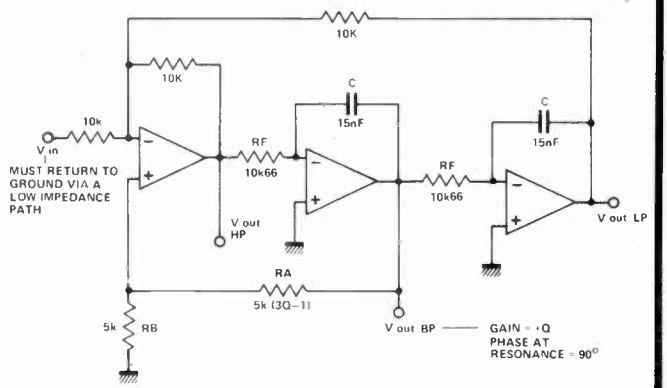


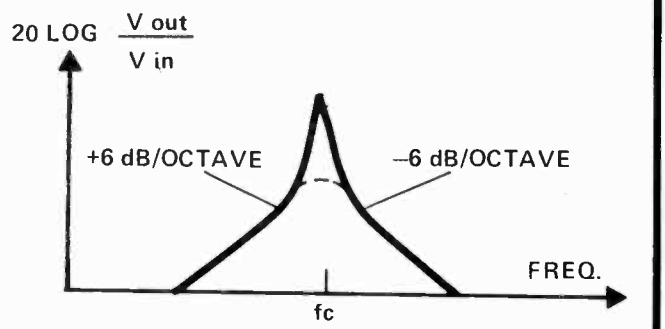
Q	R1	R2	GAIN IN dB
1	5k33	21k32	6 dB
2	2k66	42k66	18.1dB
3	1k77	60k40	25.1 dB
4	1k33	85k33	30.1 dB
5	1k06	106k66	34.0 dB

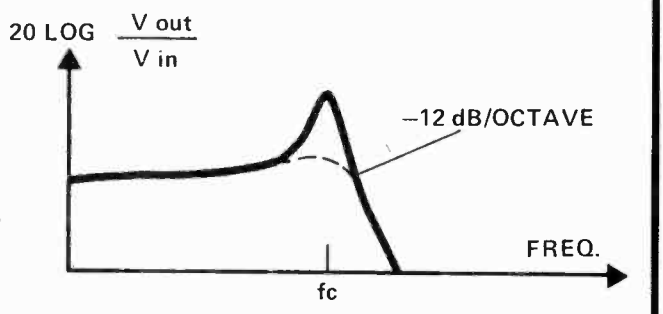
Fig. 4. A multiple feedback bandpass filter. The centre circuit is normalised for 1kHz. The table is the design table for this circuit. To change the centre frequency change R_1 and R_2 by an equal factor.

Figure 5 shows a state variable filter. It has three major features which are

1. It can provide a stable high Q performance.
2. It is easily tuned.
3. It is versatile, providing bandpass, lowpass and highpass outputs simultaneously.







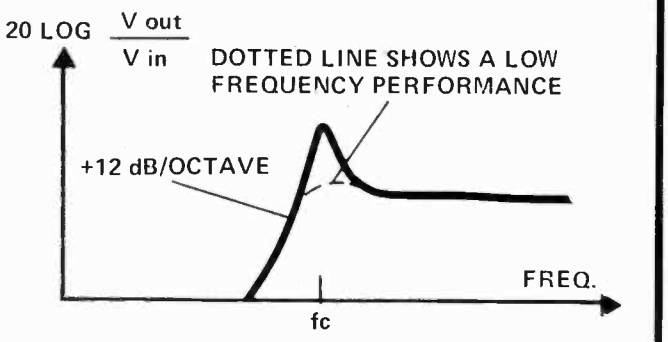


Fig. 5. The state variable filter is called a universal filter because it can give bandpass, low and high pass outputs — as shown above. Note that all these responses are second order in nature.

The Q is determined by the ratio of two resistors, RA and RB, where RA/RB = 3Q – 1). The resonant frequency fc =

$$\frac{1}{2\pi R_1 C}$$

Note that there are two C's and two Rf's in the circuit, and so if the filter is to be tuneable, then both Rf's should change by an equal amount (the Rf's can be a stereo pot).

You will note that Q and fc are independent of each other, and so as the resonant frequency is changed, Q remains constant, and visa versa.

Op amps

The requirements placed upon the op amps in the filter, Fig. 5, are less than that for the multiple feedback circuit. The op amps need only have an open loop gain of 3Q at the resonant frequency. Say we have a Q of 100 and an fc of 10kHz. Therefore the open loop gain is 300, the frequency is 10kHz and so the gain bandwidth product needed is 3MHz. When using a high Q, care must be taken with signal levels. The gain of the filter is +Q at resonance, and so if you are filtering a 1V signal with a Q of 100 then you could expect to get a 100V output signal!

National Semiconductors manufacture an active filter integrated circuit, which is a four amp network that can be used to realise state variable filters with Q's up to 500, and frequencies up to 10kHz. The device is called AF100.

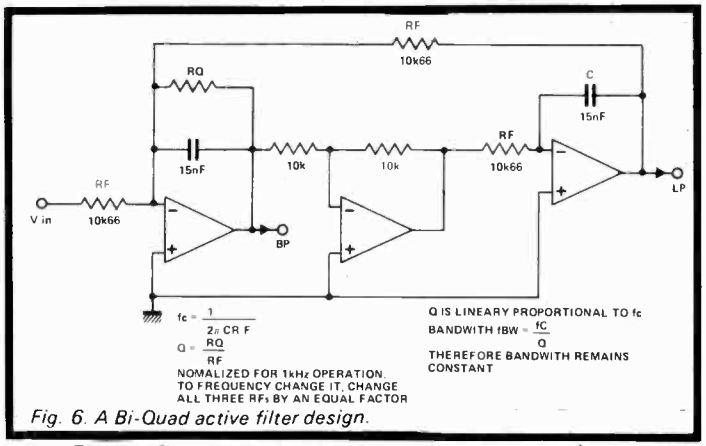


Fig. 6. A Bi-Quad active filter design.

Figure 6 shows a Bi-Quad active filter. It looks very similar to the state variable filter, but the small changes make it behave quite differently. It only has a bandpass and a low pass output. The resonant frequency is given by

$$fc = \frac{1}{2\pi CR_f}$$

Next month: Comb filters, delay lines and some practical circuits to build up.

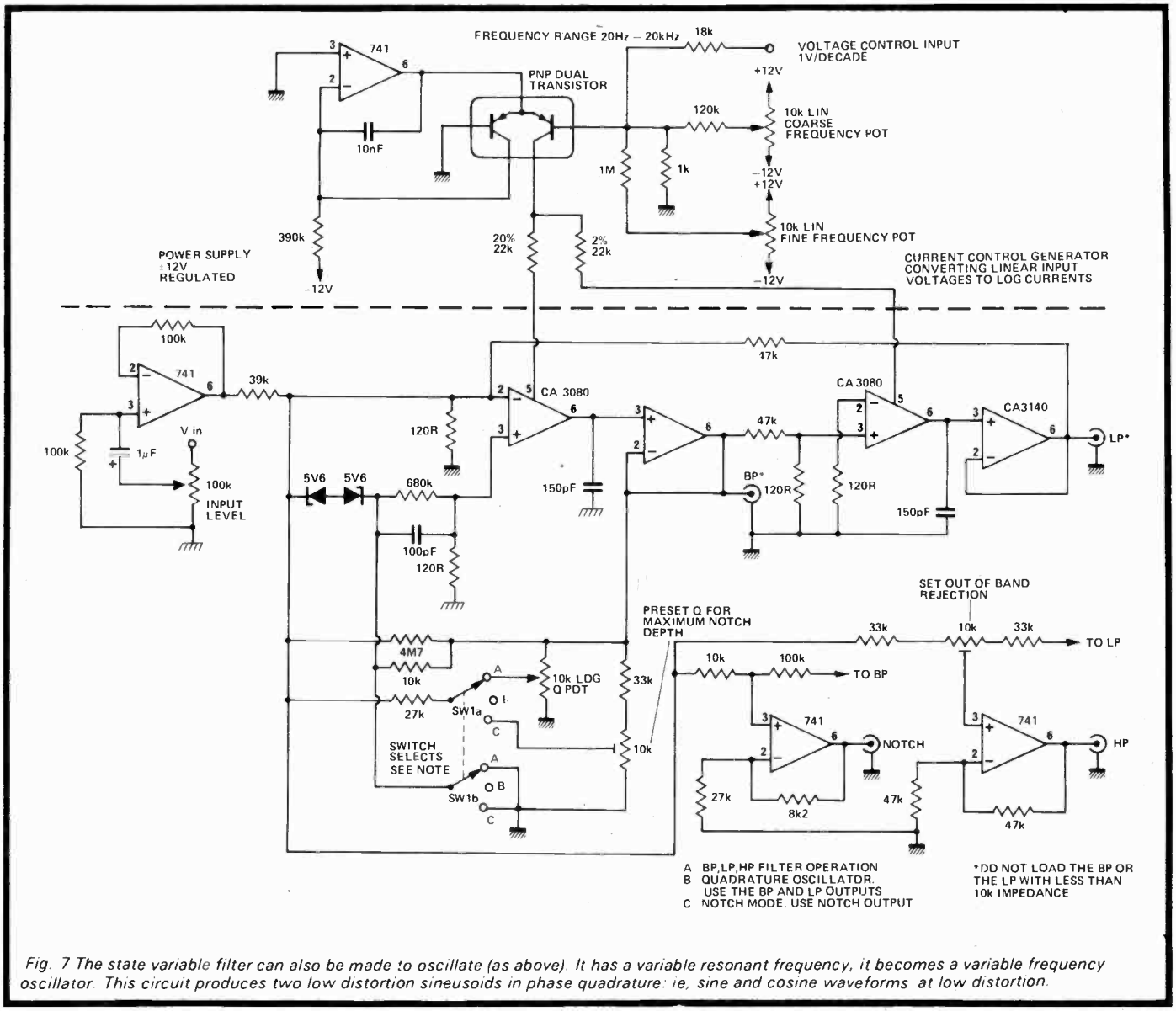


Fig. 7 The state variable filter can also be made to oscillate (as above). It has a variable resonant frequency, it becomes a variable frequency oscillator. This circuit produces two low distortion sineusoids in phase quadrature: ie, sine and cosine waveforms at low distortion.

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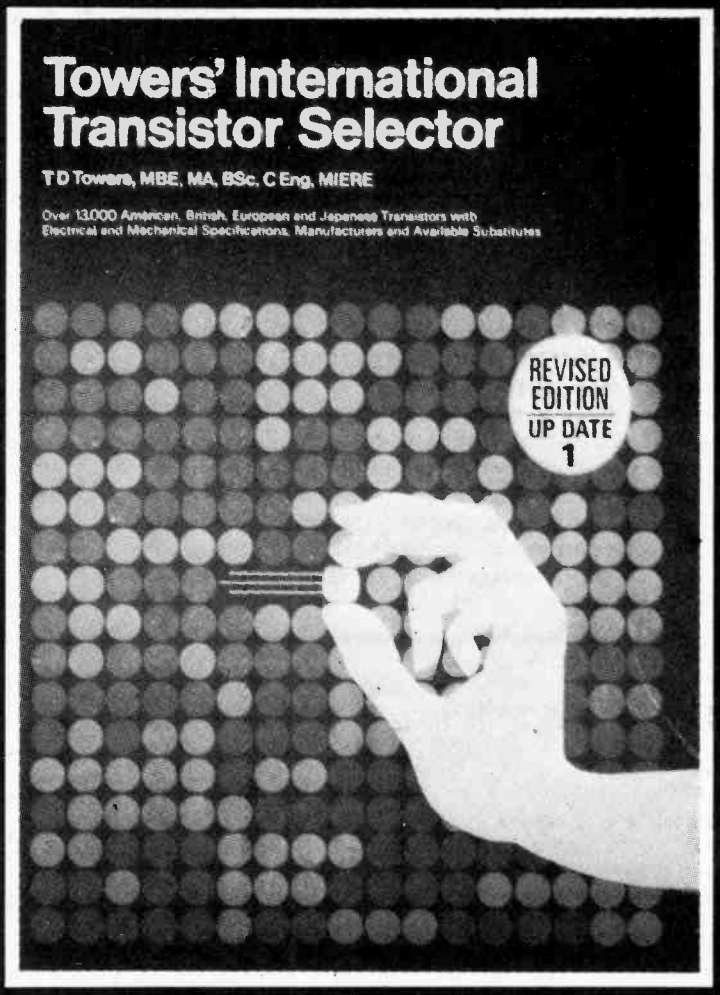

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TECHNICAL BOOKS FROM ETI

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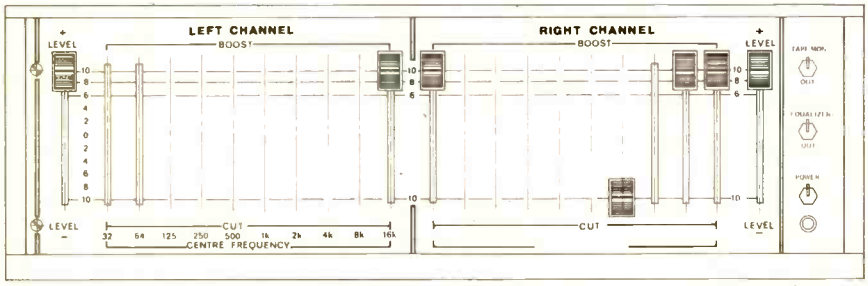
What to look for in the September issue: On Sale August 5th

Graphic Equaliser



THERE ARE OCCASIONS when ordinary tone controls are just not good enough. The room you listen to your hi-fi in will have more effect on the sound pouring forth from the speakers than anything else.

It has been acknowledged for some time that to really 'get through to the music' one must cancel this detrimental effect somehow. Graphic Equalisers are the tool to do the job! Basically an equaliser is a ten/twenty channel tone control system, allowing for greater flexibility in tailoring the overall sound of a system. They can be employed for special effects, like picking the voice out of a 'too-heavy' backing, or bringing out a guitar solo from the boring bass track — but being purists we shan't mention that.

Next month we publish full details of a revolutionary new design for such a device, a 20 channel equaliser with a spec that includes it in the 'super-fi' class, and NO COILS! Our equaliser uses gyrator circuits to replace all the inductors which are usually so messy and so expensive.

With this to add to your hi-fi, some systems will be more equal than others!

LOUDHAILER

NOT a megaphone, but a hand-held amplifier and very efficient horn speaker together with the microphone separated. A 12V supply is used which can be taken from internal batteries or external supply from a car battery.

Two IC's are used enabling a good microphone to be used and giving 2½W. Now this output may sound pathetic to those associating this power with regular, highly inefficient speakers but it's more than adequate when using a good horn speaker.

The separation of the microphone and the speaker greatly reduces howl-round problems as well.

CONTINUITY TESTER

NOT your hackneyed multivib with a break in the supply rail (see old copies of our competitions) but a properly designed unit which will tell you if there's continuity and very little else — no voltages to turn on transistors etc.

TRANSFORMERS

IT is true to say that in most mains powered projects the mains transformer will be the single most costly item, yet often very little attention is given to the selection of this unglamorous component.

We take a close look at the different types of transformers available, and how best to use them.

BUCKET BRIGADE

COMMONLY CALLED 'bucket brigade' by those who are fond of such things, charge coupled devices are roaring onto the market, and seem destined to take a firm hold in several places!

They take the form of ANALOGUE shift registers, and immediately make such things as echo units, phasers and even TV cameras smaller and better. At the most basic they work by shifting a 'packet' of charge along a long, long line of electrodes under the influence of an external clock signal. Since the size of this 'packet' is variable, you have an analogue device — the variable clock means variable delay, too.

STEREO SIMULATOR

ADD LIFE to those dull mono sounds with this circuit. When used between a mono signal source and a stereo amplifier this unit gives an extra something — we're not sure what it is — but we like it.

SYSTEM 68: CPU BOARD

PUT the 68 into System 68 with our CPU board. The board, based on the M6800 MPU provides the various clocks and control signals required by this chip. The board also provides for the mounting of a small amount of ROM, for the system firmware, and some RAM, for a scratchpad memory area.

September is bargain month in ETI

IN AUGUST 1976 we carried a mass of offers — these proved to be so popular with readers and suppliers that we're repeating this type of offer in the September issue. There will be money saving vouchers on a mass of different products and with a wide variety of ETI's advertisers.

JUDGE US BY THE COMPANIES WE KEEP

TO ALL OUR CUSTOMERS

IF YOU HAVE NEVER HAD A MARSHALL'S CATALOGUE BEFORE, YOU'VE PROBABLY ONLY SEEN OUR ADVERTS AND NEVER REALLY APPRECIATED THE VAST RANGE OF PRODUCTS WE CAN OFFER. WELL, HERE'S AN OPPORTUNITY TO CHANGE ALL THAT! IN THIS 32-PAGE CATALOGUE, WE HAVE SET OUT TO MAKE YOUR COMPONENT BUYING EASY. THE CENTRE PAGE IS A TRANSISTOR WALL CHART FOR QUICK REFERENCE AND FOR THOSE OF YOU WHO BUY COMPONENTS IN QUANTITY WE CAN OFFER ATTRACTIVE DISCOUNTS; SOME EXAMPLES OF THESE ARE GIVEN IN OUR "TOPLINERS" ON PAGE 31.

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All credit sales are subject to a minimum invoice value of £10. The post & packing charge is 50 pence.

DESPATCH

All items in stock are despatched the same day as receipt of order and are sent by first class parcel post. Exceptions to our same day turn round service are where matched transistors are required or when we are out of stock of a particular item. In the latter case the balance of your order will be sent as soon as possible.

NON-DELIVERY

All complaints should be made in writing giving exact details of the items ordered, the remittance sent if applicable and the date the order was posted to us.

CARRIAGE & PACKING CHARGES

Minimum 40p, balance will be charged at cost.

ENQUIRIES

Requests for quotations and details of the items offered for sale by this company should be sent separate from any orders, and we would appreciate the enclosure of a stamped addressed envelope to facilitate prompt attention.

ORDERS

These should be worded exactly as per description in our catalogue and confirmation orders must be clearly marked confirmation, otherwise we cannot be held responsible for duplication.

PRICES

All goods will be supplied as per prices quoted in our lastest catalogue, subject to no special quotation having been made, but we do reserve the right to change prices without prior notification and would point out that all prices quoted are exclusive of VAT

As we are distributors for a large number of British, Continental and American semiconductor and component manufacturers, we can offer attractive quantity prices for all devices in this and our other product lists.

Please note that one of the main factors affecting prices is the parity of the £ to other currencies, particularly the $ (U.S.).

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2. Goods which can be proved to be of faulty manufacture or below manufacturer's specification should be returned to us accompanied by a full statement specifying the fault and the application, and will be returned by us to the original supplier for checking. Claims of this kind must be made within 14 days of despatch and returned to us in the original condition and packing material. Please note no claims can be accepted for goods which have been soldered.
3. We must emphasise that we cannot replace components that have been soldered, and recommend the use of sockets, or if in doubt, prior testing.

EXPORT & DOCUMENTATION

For customers requiring details on export procedures with any necessary documentation, please apply to our Sales Department.

CONSEQUENTIAL DAMAGE

We cannot accept responsibility for damage to persons or equipment as a result of failure of product supplied by us.

DATA

All data in this catalogue is believed to be correct but Marshall's cannot accept responsibility if errors or omissions occur.

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When writing out an order to us, we would appreciate a **complete** description of the items being ordered, including the various type numbers where available.

All goods are guaranteed brand new and to makers' specification. Faulty goods will be replaced under guarantee providing they are returned within 14 days from date of purchase, unused and with full information on the fault. Subject only to our technical agreement. Note: We cannot exchange soldered devices.

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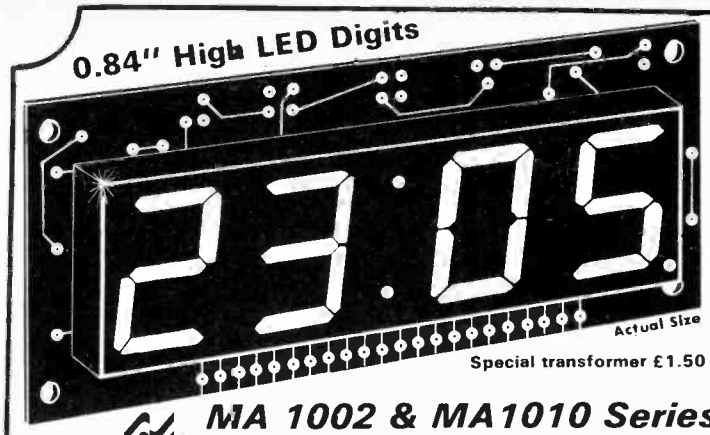


Special transformer £1.50

NEW DIGITAL ALARM CLOCK MODULES

MA1002F 12-hr. **£10.90** MA1010E 12-hr. **£14.50**
MA1002H 24-hr. **£10.90** MA1010G 24-hr. **£14.50**

MA 1002 & MA1010 Series Electronic Clock Modules

The MA1002 & MA1010 Series Electronic Clock Modules are assembled and pretested modules which combine a monolithic MOS-LSI integrated clock circuit, 4-digit LED display, power supply and other associated discrete components on a single printed circuit board to form a complete electronic clock movement. The user need add only a transformer and switches to construct a digital clock for application in clock-radios, alarm or instrument panel clocks. Timekeeping may be from 50 or 60 Hz inputs and 12- or 24-hour display formats may be chosen. Direct LED drive eliminates RF interference. Time setting as made easy through use of "Fast" and "Slow" scanning controls.

For 50Hz operation connect pin 16 & 17 on MA1010

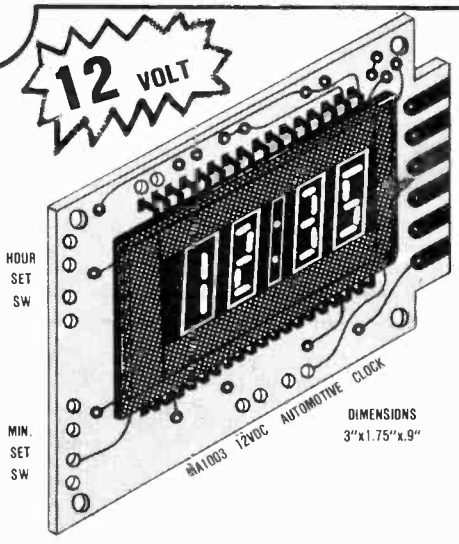
The MA1002F and MA1010E have a 12-hour display with an AM and PM indicator. The MA1002H and MA1010G have a 24-hour display.

Features include alarm "on" and "PM" indicators, "sleep" and "snooze" timers and variable brightness control capability. The modules are extremely compact, the MA1002 measuring 1.375" by 3.05", the MA1010 measuring 1.75" by 3.75". This small size is achieved by bonding the I.C. to the back of the circuit board.

It is highly recommended that the transformer be obtained with the clock module as it is a special dual secondary type not otherwise readily available.

Special transformer £1.50

SPECIALS



NEW DIGITAL CAR CLOCK MODULE

NATIONAL

THE MA1003 ready-built module was specially built and designed for the American market, with the luxury car, aircraft and boat in mind. Unlike conventional quartz clocks, this unit operates from a very high frequency crystal resonating at over 2MHz for extra accuracy and stability. Stringent safety regulations dictate that this module is completely suitable for use in hostile environments and "shake, rattle and roll" conditions. Automatic display blanking is included when ignition is turned off, to consume a miserly 3mA.

THE BRIGHT GREEN DISPLAY, fluorescent, can be filtered from green to blue to give that personalised look. The compact and rugged design enables the module to be mounted anywhere, easily and with the minimum of effort. Works from any 12 volt supply. First time in Europe.

DEVELOPED BY NATIONAL SEMICONDUCTORS. A name known worldwide and respected. RECOMMENDED TO RETAIL AT £29.95+VAT

- INTERNAL CRYSTAL TIMEBASE +.5 SEC/DAY
- COMPLETE, TESTED MODULE. JUST ADD SWITCHES
- BRIGHT 0.3" DISPLAY — GREEN FOR SAFETY
- TRANSIENT PROTECTED, TIMEKEEPING DOWN TO 9V.
- EASILY INSTALLED, COMPACT AND RUGGED DESIGN
- DIMS TO 50% BRIGHTNESS WHEN CAR LIGHTS ON
- LOW POWER CONSUMPTION — FOR PORTABLE USE
- IDEAL FOR CARS, BOATS, AIRCRAFT OR CARAVAN

PRICE £17.50 + VAT

ALSO AVAILABLE

Specially designed case, with cut out centre front, black rexine finish for dash mounting.

Price **£1.20**

SPECIALS

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SIEMENS—MULLARD
THOMSON CSF

ELECTROLYTIC — AXIAL

Miniature electrolytics
By SIEMENS and
MULLARD
Types B41313 B41283
B41010, 015 - 016

UF	Volts	Size mm	Price 1—99	UF	Volts	Size mm	Price 1—99
.47	100	4.5 x 11	£0.13	47	40	8.5 x 15	£0.11
1.0	40	3.2 x 11	£0.13	47	63	8.5 x 20	£0.14
1.0	100	4.5 x 11	£0.13	68	16	6.7 x 18.5	£0.09
1.5	63	6.1 x 12.5	£0.09	100	16	8.5 x 15	£0.12
2.2	25	3.2 x 11	£0.13	100	25	8.5 x 17.5	£0.13
2.2	63	4.5 x 11	£0.13	100	40	10 x 20	£0.15
2.2	100	5.8 x 11	£0.14	100	63	10 x 25	£0.20
3.3	63	6.1 x 12.5	£0.09	100	100	14 x 30	£0.28
4.7	16	3.2 x 11	£0.13	150	16	8.3 x 18.5	£0.12
4.7	40	4.5 x 11	£0.13	150	25	10.3 x 18.5	£0.14
4.7	63	5.8 x 11	£0.14	220	16	8.5 x 20	£0.14
4.7	100	6.5 x 17.5	£0.10	220	25	10 x 20	£0.16
6.8	40	4.8 x 12.5	£0.08	220	40	10 x 25	£0.20
6.8	63	6.1 x 12.5	£0.08	220	63	14 x 30	£0.28
10	25	4.5 x 11	£0.13	220	100	18 x 30	£0.38
10	40	5.8 x 11	£0.14	470	16	10 x 25	£0.18
10	63	6.5 x 17.5	£0.11	470	25	12 x 30	£0.21
10	100	8.5 x 15	£0.12	470	40	14 x 30	£0.26
15	16	4.8 x 12.5	£0.08	470	63	18 x 30	£0.40
15	40	6.1 x 12.5	£0.08	470	100	21 x 40	£0.60
15	63	6.7 x 18.5	£0.08	1000	16	14 x 30	£0.25
22	25	5.8 x 11	£0.14	1000	25	16 x 30	£0.35
22	40	6.5 x 17.5	£0.11	1000	40	18 x 35	£0.43
22	63	8.5 x 15	£0.11	1000	63	21 x 40	£0.60
22	100	8.5 x 20	£0.14	2200	16	18 x 35	£0.42
33	16	6.1 x 12.5	£0.08	2200	25	21 x 40	£0.50
33	40	6.7 x 18.5	£0.09	2200	40	25 x 40	£0.65
47	16	6.5 x 20	£0.11	4700	16	21 x 40	£0.60
47	25	6.5 x 17.5	£0.11	4700	25	25 x 40	£0.82

ELECTROLYTIC—RADIAL

HIGH RIPPLE

UF	Volts DC	Size mm	Price 1—99
1000	40	25 x 35	£0.93
1000	63	25 x 45	£1.05
2200	25	25 x 45	£1.00
2000	40	30 x 45	£1.08
2200	63	30 x 55	£1.30
2200	100	30 x 55	£1.50
4700	25	30 x 45	£1.15
4700	40	35 x 55	£1.36
4700	63	40 x 74	£2.00
10000	25	35 x 55	£1.80

Tol
+50%
−10%

SEIMENS B41070

ELECTROLYTIC—PLUGGABLE

TYPE B41316/7
SIEMENS

UF	Volts DC	Size mm	PRICE 1—99
1.0	63	8.7 x 12.6	£0.12
2.2	63	8.7 x 12.5	£0.12
4.7	63	8.7 x 12.5	£0.12
10	63	8.7 x 12.5	£0.12
22	63	10.7 x 12.5	£0.12
47	63	12.7 x 16.5	£0.15
100	63	15 x 20	£0.19
220	16	12.7 x 16.5	£0.14
470	16	15 x 20	£0.18
1000	16	15 x 30	£0.26

Tol
+100%
−10%

TANTALUM BEAD

UF	Volt DC	Size mm	Price 1—99	UF	Volts	Size mm	Price
0.1	35	9 x 5	£0.15	10	6.3	10 x 5.5	£0.15
0.22	35	9 x 5	£0.15	10	16	11 x 6	£0.19
0.47	35	9 x 5	£0.15	15	15	12 x 7	£0.21
1.0	35	9 x 5	£0.15	15	25	12 x 7.5	£0.23
2.2	16	9 x 5	£0.15	22	6.3	11 x 6	£0.19
2.2	35	10 x 5.5	£0.15	33	10	11 x 6	£0.21
4.7	16	10 x 15	£0.15	47	6.3	12 x 7.5	£0.21
4.7	35	11 x 6	£0.19	100	3	12 x 7.5	£0.21

TYPE B45134 SIEMENS
Radial lead Tol ± 20%
MINIATURE TANTALUM BEAD

CERAMIC DISC 63V

SIEMENS
B37448/9

Flat Ceramic Capacitors from a New Material with Dielectric Constant of 50,000

The development of a new titanate ceramic material represents a step towards reducing capacitor size which is significant for capacitors used for coupling and decoupling in AF circuits.

UF	VDC	Size mm	1-99 Price
.01	63	4 x 2.5 x 4	£0.06
.022	63	4 x 2.5 x 4	£0.06
.033	63	4 x 2.5 x 6	£0.06
.047	63	4 x 2.5 x 8	£0.07
.068	63	4 x 2.5 x 10	£0.08
.1	63	4 x 2.5 x 9	£0.08
.22	63	6 x 2.5 x 18	£0.17

HIGH VOLTAGE CERAMIC DISC

Capacitance VDC	Price	Capacitance VDC	Price
100pf 1kv	£0.07	2,200pf 2kv	£0.09
100pf 2kv	£0.09	2,200pf 4kv	£0.12
100pf 3kv	£0.09	2,200pf 5kv	£0.17
100pf 4kv	£0.09	3,300pf 2kv	£0.11
220pf 6kv	£0.07	3,300pf 4kv	£0.15
470pf 2kv	£0.07	4,700pf 2kv	£0.11
470pf 6kv	£0.10	4,700pf 4kv	£0.18
1,000 2kv	£0.07	10,000pf 2kv	£0.13
1,000pf 4kv	£0.09	10,000pf 3kv	£0.17
1,000pf 6kv	£0.16		

HIGH VOLTAGE

CERAMIC PLATE

MULLARD & THOMSON CSF

ALL 63 VDC WORKING 6p EACH
Values available pF
Quantity Price on request

1pF	10	100	1000
1.2	12	120	1200
1.5	15	150	1500
1.8	18	180	1800
2.2	22	220	2200
2.7	27	270	2700
3.3	33	330	3300
3.9	39	390	3900
4.7	47	470	4700
5.6	56	560	5600
6.8	68	680	6800
8.2	82	820	10000

Tolerance
1-10pF ± 25%
10-330pF ± 2%
390-1000pF ± 5%
1000pF-10kpF ± 10%

VERY NEAT AND
COMPAT .1" PIN
SPACING

pF	Size	Dmns
1.8-22	1	3.5 x 4.5mm
27-47	2	4.5 x 5.5mm
56-68	3	5.5 x 6.5mm
82-100	4	6.5 x 7.5mm
120-150	5	6.5 x 10.5mm
180-220	4	6.5 x 7.5mm
270-330	5	6.5 x 10.5mm

POLYSTYRENE

Close tolerance Polystyrene capacitors from Siemens B31110/B31310

5% Tolerance. 160v working

Price 1—99

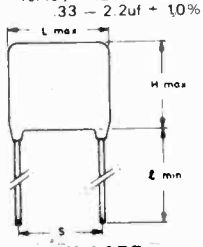
Values available
10pf, 15pf, 22pf, 33pf, 47pf, 68pf, 100pf, 150pf, 220pf, 330pf, 470pf, 680pf, 1000pf — **6p each**

1500pf, 2200pf, 3300pf, 4700pf, 6800pf, 10000pf — **10p each**

POLYESTER

MULLARD C280 SERIES
AN INEXPENSIVE WIDELY USED CAPAICTOR — DIMENSIONS IN MM

250 VDC-RADIAL LEADS
Metallized film capacitors
Tol .01 — .22 ± 20%
.33 — 2.2uf ± 10%



MULLARD

UF	Price	S	T	L	H
0.01	£0.05	10.2	4	12.5	9
0.015	£0.05	10.2	4	12.5	9
0.022	£0.05	10.2	4	12.5	9
0.033	£0.05	10.2	4	12.5	9
0.047	£0.05	10.2	4	12.5	9
0.068	£0.06	10.2	5	12.5	10
0.1	£0.06	10.2	6	12.5	11
0.15	£0.07	15.3	6	17.5	11
0.22	£0.08	15.3	7	17.5	12
0.33	£0.11	20.3	6.5	22.5	11.5
0.47	£0.13	20.3	7.5	22.5	12.5
0.68	£0.18	20.3	9.5	22.5	14.5
1	£0.22	27.9	9.5	30	14.5
1.5	£0.33	27.9	10.5	30	18
2.2	£0.37	27.9	12.5	30	20.5

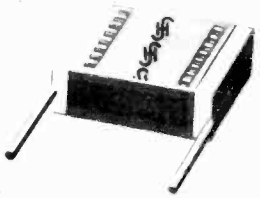
A. MARSHALL (LONDON) LTD. LONDON 01 452 0161

ATTRACTIVE QUANTITY DISCOUNTS

CAPACITORS

POLYCARBONATE

Polycarbonate — Polyester **B32540/60 SIEMENS**



7.5 and 10mm spacing

7.5mm lead spacing tinned

250 Volt working		1—99 Price
.001	9 x 2.6 x 7.3	£0.06
.0022	9 x 2.6 x 7.3	£0.06
.0033	9 x 2.3 x 7.3	£0.06
.0047	9 x 2.3 x 7.3	£0.06
.0068	9 x 2.7 x 7.3	£0.06
.0082	9 x 2.7 x 7.3	£0.06
.01	9 x 2.3 x 7.3	£0.06
.012	9 x 2.5 x 7.3	£0.06
.015	9 x 2.9 x 7.3	£0.06
.022	9 x 2.6 x 7.3	£0.06
.027	9 x 2.4 x 7.3	£0.06
.033	9 x 2.6 x 7.3	£0.06
.039	9 x 2.9 x 7.3	£0.07
.047	9 x 3.2 x 7.3	£0.07
.056	9 x 3.5 x 7.5	£0.07
.068	9 x 3.5 x 7.5	£0.08
.082	9 x 3.5 x 11	£0.10
.1	9 x 3.9 x 11	£0.10

100 Volt DC		1—99 Price
.12	9 x 3.5 x 8.3	£0.09
.15	9 x 3.6 x 10	£0.09
.18	9 x 4.1 x 10	£0.11
.22	9 x 4.7 x 10	£0.11
.27	9 x 5.0 x 11	£0.15
.33	9 x 5.5 x 11.5	£0.15
.39	9 x 6.6 x 11.5	£0.18
.47	9 x 7.2 x 12.5	£0.18
.56	9 x 8.4 x 12.5	£0.23
.68	9 x 8 x 13	£0.23

Self-healing layer capacitor with polycarbonate as dielectric. In accordance with DIN 41379 these types are designated MKC capacitors.

B32541/61 Polycarbonate/Polyester as B32540/60 but 10mm lead spacing — also available in 100 and 250 volt DC working

250 Volt working UF	Dimensions mm	1—99 Price
.01	11.5 x 3.2 x 6.6	£0.06
.015	11.5 x 3.2 x 6.6	£0.06
.022	11.5 x 3.2 x 6.6	£0.06
.047	11.5 x 3.2 x 6.6	£0.06
.068	11.5 x 3.2 x 6.6	£0.06

UF	Dimensions mm	1—99 Price
.1	11.5 x 3.5 x 8.3	£0.08
.15	11.5 x 4.2 x 9.6	£0.10
.22	11.5 x 4.9 x 11.5	£0.12
100 Volt working		
.22	11.5 x 3.9 x 9.5	£0.10
.47	11.5 x 5.3 x 11.5	£0.16
1.0	11.5 x 9.8 x 11.5	£0.28
2.2		£0.56

POLYESTER

B 32234

SIEMENS B32234 MKH 20% Tol
Self healing flat capacitor winding with polyethelene-terephtalene dielectric to DIN 41379 spec. Encapsulated and epoxy resin sealed. The case is provided with spacers to improve solderability in solder bath, parrallel leads, plug in, suitable for printed circuits.

100Vot DC uF	Dimensions mm	1—99 Price
.1	4 x 9.5 x 13	£0.13
.15	5 x 10.5 x 13	£0.15
.22	6 x 11.5 x 13	£0.16
.33	5.5 x 11 x 18	£0.18
.47	5.5 x 11 x 18	£0.23
.68	7 x 13 x 18	£0.27
1.0	9 x 14.5 x 18	£0.33
1.5	7 x 16.5 x 27	£0.43
2.2	8.5 x 18.5 x 27	£0.49
3.3	10.5 x 19 x 27	£0.64
4.7	11 x 20 x 32	£0.75
6.8	13 x 22.5 x 32	£1.01

250Volt DC uF	Dimensions	1—99 Price
.047	4 x 9.5 x 13	£0.12
.1	5.5 x 11 x 18	£0.13
.22	7 x 13 x 18	£0.14
1.0	8.5 x 18.5 x 27	£0.32
400 Volt DC		
.01	4 x 9.5 x 13	£0.10
.015	4 x 9.5 x 13	£0.10
.022	4 x 9.5 x 13	£0.10
.047	5.5 x 11 x 18	£0.14

PLASTIC FOIL—HIGH RELIABILITY

SIEMENS B32110
High reliability plastic foil
Axial lead 20% Tol MKL

63 Volt working uF	Dimensions	1—99 Price
.15	5.4 x 18.5	£0.48
.22	5.4 x 18.5	£0.51
.33	6.4 x 18.5	£0.54
.47	7.4 x 18.5	£0.60
.68	7.4 x 18.5	£0.65
1.0	7.4 x 21	£0.71
1.5	8.4 x 21	£0.73
2.2	10.7 x 21	£1.25

uF	Dimensions	1—99 Price
3.3	9.4 x 25	£1.41
4.7	10.7 x 25	£1.47
6.8	10.7 x 34	£2.00
10	12.7 x 34	£2.55
100 Volt Working		
.1	5.4 x 18.5	£0.56
1.0	9.4 x 21	£1.06

Self-healing tubular capacitor winding with cellulose acetate as dielectric. In accordance with DIN 41379 these types are designated MKU capacitors.
Enclosed in tubular metal case, shrunk sleeve insulated, epoxy resin sealed face ends. Central axial leads.

TRIMMERS

MINIATURE FILM DIELECTRIC

Type	Capacitance swing pF	Minimum capacitance pF	£. p
808 00005	8	2	0.18
808 00006	20	2	0.20
808 01001	59.5	5.5	0.25

QUALITY FROM MULLARD

METALLISED POLYESTER up to 630 volt

B32231 metallised Polyester from SIEMENS

Axial leads
Tolerance 20%
Type MKH similar to Mullard C281 range available in three voltages 250, 400 and 630 VDC

250 Volt DC uF	Dimensions mm	1—99 Price
.047	4.5 x 8.5 x 14	£0.13
.068	5.5 x 9 x 14	£0.14
.1	6 x 9 x 14	£0.14
.22	4.5 x 10.5 x 19	£0.15
.33	7 x 11 x 19	£0.17
.47	4.5 x 13.5 x 26.5	£0.20
.68	6 x 15 x 26.5	£0.24
1.0	8 x 17 x 26.5	£0.32
1.5	8.5 x 20.5 x 29	£0.39
2.2	10.5 x 22.5 x 29	£0.49
4.7	12 x 27.5 x 44	£1.06
10	19.5 x 34.5 x 44	£1.75

400 Vot DC		1—99 Price
.022	4.5 x 7.5 x 14	£0.13
.047	4.5 x 8 x 19	£0.14
.1	5.5 x 8.5 x 19	£0.15
630 Volt DC		
.01	4.5 x 8 x 14	£0.12
.015	4.5 x 8 x 14	£0.13
.022	5 x 8.5 x 14	£0.14
.047	5 x 10.5 x 19	£0.15
.1	5 x 12.5 x 26.5	£0.27
.15	6.5 x 14 x 26.5	£0.26
.22	7.5 x 16.5 x 26.5	£0.29
.47	10 x 22 x 29	£0.48

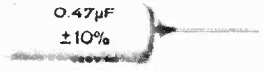
NB. 630 V.d.c. rating equivalent 250V rms.

Self-heating flat capacitor winding with polyethylene-teraphtalate as dielectric. In accordance with DIN 41379 these types are esignated MKT capacitors.

Capacitor winding coated with insulating material, epoxy resin sealed face ends.

METALLISED POLYESTER EXTENDED FOIL

MULLARD C296 SERIES
400 VDC WORKING
−10% Tolerance
Temp range — 40 to +80 C



uF	Dimensions		Price
0.001	21	7.5	£0.10
0.0015	**21**	**7.5**	**£0.10**
0.0022	21	7.5	£0.10
0.0033	21	7.5	£0.10
0.0047	21	7.5	£0.10
0.0068	21	7.5	£0.10
0.01	21	7.5	£0.11
0.015	21	7.5	£0.11
0.022	21	8.5	£0.11

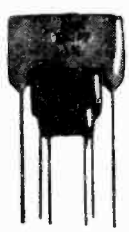
uF	Dimensions		Price
0.033	21	10	£0.13
0.047	21	11.5	£0.15
0.068	35	9.5	£0.16
0.1	35	11	£0.18
0.15	35	12.5	£0.23
0.22	35	14.5	£0.30
0.33	35	17	£0.43
0.47	35	19.5	£0.51

Radial leads

MICA

Close tolerance — suitable for pulse operation. Tol ± 5pF below 50pF ± 1% for 50pF and higher

SILVERED MICA CAPS
500 VDC WORKING



Values available in pF	Price
2.2, 3.3, 5, 10, 18, 20, 22	7p
25, 27, 30, 33, 39, 47, 50	7p
56, 68, 75, 82, 100, 120, 150	7p
180, 200, 220pf	7p
250, 270, 300, 390, 470	11p
500, 560, 580, 820pF	11p
1,000	15p

BRISTOL 0272 654201

GLASGOW 041 332 4133

DIODES, ZENERS AND RECTIFIERS

PRICES AND EQUIVALENTS

WHERE NO PRICE IS SHOWN, SEE PRICE OF EQUIVALENT
Si = Silicon, Ge = Germanium

Type	Case		Equiv	Case	Price
AA111	Ge	1	OA90	2	—
AA112	Ge	2	OA90	2	—
AA113	Ge	2	OA90	2	—
AA114	Ge	2	OA90	2	—
AA115	Ge	2	OA90	2	—
AA116	Ge	2	—	—	.12
AA117	Ge	2	OA91	2	—
AA118	Ge	2	—	—	.12
AA119	Ge	2	—	—	.14
AA120	Ge	3	OA90	2	—
AA121	Ge	2	OA90	2	—
AA123	Ge	2	OA90	2	—
AA129	Ge	2	—	—	.09
AA130	Ge	2	OA90	2	—
AA131	Ge	2	OA90	2	—
AA132	Ge	2	OA91	2	—
AA134	Ge	2	OA91	2	—
AA135	Ge	2	OA90	2	—
AA137	Ge	2	OA90	2	—
AA138	Ge	2	OA90	2	—
AA140	Ge	4b	OA90	2	—
AA142	Ge	4c	OA90	2	—
AA143	Ge	2	OA90	2	—
AA144	Ge	2	—	—	.10
AAY30	Ge	2	—	—	.16
AAY32	Ge	2	—	—	.16
AAY33	Ge	2	—	—	.18
AAY43	Ge	2	—	—	.18
AAY47	Ge	2	AAZ17	2	—
AAY49	Ge	2	AAZ17	2	—
AAZ13	Ge	2	—	—	.28
AAZ15	Ge	2	—	—	.22
AAZ17	Ge	2	—	—	.18
BA100	Si	2	—	—	.18
BA101	Si	2	BA111	2	—
BA102	Si	2	—	—	.18
BA103	Si	3	BAX16	7	—
BA104	Si	3	BAX16	7	—
BA105	Si	3	BYX10	5	—
BA108	Si	3	OA202	2	—
BA109	Si	2	BA102	2	—
BA110	Si	2	BA102	2	—
BA111	Si	2	—	—	.27
BA112	Si	2	BA102	2	—
BA114	Si	2	BA100	2	—
BA115	Si	2	—	—	.15
BA117	Si	2	BA100	2	—
BA119	Si	2	BA102	2	—
BA120	Si	2	BB105G	6	—
BA121	Si	2	BB105G	6	—
BA124	Si	2	BA102	2	—
BA125	Si	2	BA102	2	—
BA127	Si	2	—	—	.20
*BA128	Si	2	BA100	2	—
BA129	Si	2	BA148	5	—
BA130	Si	2	—	—	.10
BA131	Si	4	IN4005	4	—
BA132	Si	4	IN4006	4	—
BA133	Si	4	—	—	.25
BA136	Si	2	BA182	6	—
BA137	Si	2	BA148	5	—
BA138	Si	2	—	—	.25
BA139	Si	2	BB105A	6	—
BA140	Si	2	BB105G	6	—
BA141	Si	2	BB105A	6	—
BA142	Si	2	—	—	.17
BA144	Si	2	—	—	.12
*BA145	Si	5	—	—	.18
*BA148	Si	5	BY206	5	—
BA149	Si	2	BB105G	6	—
BA150	Si	2	BB103	2	—
*BA154	Si	2	—	—	.10
*BA155	Si	2	—	—	.12
BA156	Si	2	—	—	.15
BA157	Si	2	—	—	.29
BA158	Si	2	—	—	.38
BA159	Si	2	—	—	.51
BA161	Si	4a	BB105B	6	—
BA162	Si	4a	BB105G	6	—
BA165	Si	2	BA182	6	—
BA166	Si	7	BA100	2	—
BA167	Si	7	BA100	2	—
BA170	Si	2	BA100	2	—
BA173	Si	2	IN4004	4	—
BA174	Si	4c	IN4154	7	—
BA175	Si	4c	BA100	2	—
BA176	Si	2	BAX16	7	—
BA178	Si	6	BA182	6	—
BA180	Si	7	BA100	2	—
BA181	Si	7	BA100	2	—
BA182	Si	6	—	—	.20
BA187	Si	7	IS920	7	—
BA188	Si	7	IS921	7	—
BA189	Si	7	IS922	7	—
BA190	Si	7	IS923	7	—
BA195	Si	7	BA145	5	—
BA196	Si	7	BA145	5	—
BA197	Si	7	BA145	5	—
BA198	Si	7	BA145	5	—
BA201	Si	—	—	—	.08
BA202	Si	—	—	—	.09
BA203	Si	—	—	—	.12
BA209	Si	7	IN914	7	—
BA210	Si	7	IN916	7	.5
BA213	Si	7	IN4448	7	—
BA214	Si	7	BA100	2	—
BA243	Si	7	—	—	.35
BA244	Si	—	—	—	.50
BA316	Si	2	—	—	.06
BA317	Si	2	—	—	.06
BA318	Si	2	—	—	.06
*BAV10	Si	2	—	—	.08
*BAV19	Si	2	—	—	.10
*BAV20	Si	2	—	—	.11
BAW21	Si	2	BAX16	7	—
BAW75	Si	7	IN4154	7	—
BAW76	Si	7	IN4151	7	—
BAW49	Si	7	—	—	.15
*BAX13	Si	7	—	—	.07
*BAX16	Si	7	—	—	.10
BAX20	Si	7	BAX16	7	—
BAX21	Si	7	BAX16	7	—
BAX22	Si	7	BAX16	7	—
BAX25	Si	2	BAX13	7	—
BAX26	Si	2	BAX13	7	—
BAY14	Si	11	IN4005	4	—
BAY15	Si	11	IN4006	4	—
BAY16	Si	11	IN4008	4	—
BAY17	Si	9	BAX16	7	—
BAY18	Si	2	BAX16	7	—
BAY19	Si	2	BAX16	7	—
BAY20	Si	2	BA145	5	—
BAY21	Si	2	BA145	5	—
BAY23	Si	2a	BYX10	5	—
BAY31	Si	2	—	—	.15
BAY32	Si	2	BAX16	7	—
BAY33	Si	2	BAX16	7	—
BAY36	Si	2	—	—	.25
BAY38	Si	2	—	—	.25
BAY41	Si	2	IN914	7	—
BAY42	Si	2	IN914	7	—
BAY43	Si	2	IN914	7	—
BAY44	Si	2	—	—	.15
BAY45	Si	2	BAX16	7	—
BAY46	Si	2	BA145	5	—
BAY60	Si	2	IN4154	7	—
BAY61	Si	7	IN4148	7	—
BAY63	Si	2	IN4151	7	—
BAY71	Si	2	—	—	.16
BAY72	Si	2	—	—	.20
BAY74	Si	2	—	—	.17
BAY82	Si	2	BAX13	7	—
BAY86	Si	2	IN4001	4	—
BAY87	Si	2	IN4002	4	—
BAY88	Si	2	IN4004	4	—
BAY89	Si	2	BYX10	5	—
BAY90	Si	2	BYX10	5	—
BAY92	Si	2	BYX10	5	—
BAY94	Si	7	IN4154	7	—
BAY95	Si	7	IN4151	7	—
BAY98	Si	2	BAX16	7	—
BAY99	Si	2	BAX16	7	—
BB100	Si	2	BB105G	6	—
BB102	Si	2	BB105G	6	—
BB103	Si	2	—	—	.30
*BB104	Si	8	—	—	.40
*BB105A	Si	6	—	—	.30
*BB105B	Si	6	—	—	.30
*BB105G	Si	6	—	—	.36
*BB109	Si	6	—	—	.36
*BB139	Si	2	—	—	1.12
BY101	Si	9	BY134	11b	—
BY102	Si	10	BY127	11b	—
BY103	Si	11	—	—	.50
BY104	Si	11	BY127	11b	—
BY105	Si	9	BY133	11b	—
BY112	Si	12	BY133	11b	—
BY113	Si	12	BY134	11b	—
BY114	Si	9	BY134	11b	—
BY115	Si	11	BY134	11b	—
BY116	Si	11a	BY134	11b	—
BY120	Si	11a	BY134	11b	—
BY121	Si	—	BY134	11b	—
BY122	Si	—	BY164	—	—
BY126	Si	11b	—	—	.29
BY127	Si	11b	—	—	.36
BY130	Si	11b	BY134	11b	—
BY133	Si	11b	—	—	.32
BY134	Si	11b	—	—	.30
BY135	Si	11b	BY127	—	—
*BY140	Si	19a	BY182	—	—
BY142	Si	11b	—	—	—
BY143	Si	11b	BY134	11b	—
BY151N	Si	15	BY134	11b	—
BY152N	Si	15	BY133	11b	—
BY164	Si		BRIDGES	—	—
BY177	Si	5	BY134	11b	—
BY178	Si	5	BY133	11b	—
*BY182	Si	2a	—	—	1.50
BY183/50	Si	2	IN4001	4	—
BY189	Si	0a	—	—	3.50
BY183/600	Si	2	IN4005	4	—
BY190	Si	10a	—	—	3.45
BY206	Si	5	—	—	.20
BY207	Si	5	—	—	.22
BY242	Si	12	BY133	11b	—
BY250	Si	11a	BY133	11b	—
BYX10	Si	5	—	—	.27
BYX36/150	Si	5	IN4003	4	—
BYX36/600	Si	5	IN4005	4	—
BYX60/50	Si	2	IN4001	4	—
1000	Si	2	IN4007	4	—
BYY31	Si	11	BY127	11b	—
BYY32	Si	11	BY127	11b	—
BYY33	Si	11	BY127	11b	—
BYY34	Si	11	BY127	11b	—
BYY35	Si	11	BY127	11b	—
BYY36	Si	11	IN4007	4	—
BYY37	Si	11	IN4007	4	—
CL1002	Si	10a	—	—	.65
CL1003	Si	10a	—	—	.70
CL1004	Si	10	—	—	.75
CL1005	Si	10	—	—	.77
CL1503	Si	10	—	—	.75
CL1505	Si	10	—	—	.83
CL1506	Si	10	—	—	.85
CL1507	Si	10	—	—	.95
CL7001	Si	11b	IN5400	—	—
CL7002	Si	11b	IN5401	—	—
CL7003	Si	11b	IN5402	—	—
CL7004	Si	11b	IN5404	—	—
CL7005	Si	11b	IN5404	—	—
CL7006	Si	11b	IN5406	—	—
CL7007	Si	11b	IN5407	—	—
CV7047	G	10	—	—	.65
CV7071	Si	3	—	—	.50
CV7130	Si	2	—	—	.25
CV7641	Si	2	—	—	.50
*DD000	Si	4a	—	—	.15
D1300A	—	—	—	—	.36
DK13	Si	7	—	—	.22
DK14	Si	7	—	—	.22
DK110	Si	1	—	—	.33
GEX23A	Si	2	—	—	.07
ITT33	Si	7	—	—	.07
ITT44	Si	7	—	—	.07
ITT210	Si	7	—	—	.68
ITT920	Si	7	—	—	.10
ITT921	Si	7	—	—	.11
ITT922	Si	7	—	—	.12
ITT923	Si	7	—	—	.18
ITT2001	Si	7	—	—	.11
ITT2002	Si	7	—	—	.12
ITT2003	Si	7	—	—	.23
OA5	Ge	1a	CV7047	10	—
OA10	Ge	1a	—	—	.55
OA47	Ge	2	—	—	.13
OA70	Ge	1	OA90	2	—
OA72	Ge	1	OA90	2	—
OA79	Ge	1	OA90	2	—
OA81	Ge	1	OA91	2	—
OA85	Ge	1	OA91	—	.18
OA90	Ge	2	OA91	—	.08
OA91	Ge	2	—	—	.08
OA95	Ge	2	—	—	.10
OA127	Si	2	BA100	2	—
OA128	Si	2	BA100	2	—
OA129	Si	2	BAX16	7	—
OA130	Si	2	BAX16	7	—
OA131	Si	2	BA148	5	—
OA132	Si	2	BA148	5	—
OA150	Ge	1	BA144	2	—
OA159	Ge	1	OA90	2	—
OA160	Ge	1	OA90	2	—
OA172	Ge	1	OA90	2	—
OA174	Ge	1	OA90	2	—
OA179	Ge	1	OA90	2	—
OA181	Ge	1	OA90	2	—
OA200	Si	2	—	—	.10
OA202	Si	2	—	—	.14
OA210	Si	10	BY134	1 lb	—
OA211	Si	10	—	—	.25
OAZ200	—	1a	—	—	.27
OAZ201	—	1a	—	—	.27
OAZ204	—	1a	—	—	.27
OAZ206	—	1a	—	—	.27
OAZ209	—	1a	—	—	.27
OAZ212	—	1a	—	—	.27
OAZ237	—	9	—	—	.27
OAZ241	—	2	—	—	.27
OAZ244	—	2	—	—	.20
OAZ245	—	2	—	—	.20
OAZ270	—	2	—	—	.20
RAS50B	—	9	—	—	.50
TV12	Si	2	—	—	.15
Z344	Si	2	—	—	.25
IN34	Ge	2	OA90	2	—
IN34A	Ge	2	OA90	2	—
IN35	Ge	2	OA90	2	—
IN36	Ge	2	OA90	2	—
IN38	Ge	2	OA91	2	—
IN40	Ge	2	OA91	2	—
IN42	Ge	2	OA91	2	—
IN43	Ge	2	OA91	2	—
IN44	Ge	2	OA91	2	—
IN45	Ge	2	OA91	2	—
IN46	Ge	2	OA90	2	—
IN48	Ge	2	OA91	2	—
IN49	Ge	2	OA91	2	—
IN50	Ge	2	OA91	2	—
IN51	Ge	2	OA90	2	—
IN52	Ge	2	OA91	2	—
IN54	Ge	2	OA91	2	—
IN55	Ge	2	OA91	2	—
IN57	Ge	2	OA91	2	—
IN58	Ge	2	OA91	2	—
IN60	Ge	2	OA90	2	—
IN61	Ge	2	OA90	2	—
IN62	Ge	2	OA91	2	—
IN64	Ge	2	OA90	2	—
IN65	Ge	2	OA91	2	—
IN66	Ge	2	OA91	2	—
IN67	Ge	2	OA91	2	—
IN68	Ge	2	OA91	2	—
IN75	Ge	2	OA91	2	—
IN81	Ge	2	OA91	2	—
IN84	Ge	2	OA90	2	—
IN86	Ge	2	OA91	2	—
IN87	Ge	2	OA90	2	—
IN88	Ge	2	OA91	2	—
IN89	Ge	2	OA91	2	—
IN90	Ge	2	OA91	2	—
IN95	Ge	2	OA91	2	—
IN96	Ge	2	OA91	2	—
IN97	Ge	2	OA91	2	—
IN99	Ge	2	OA91	2	—
IN107	Ge	2	OA90	2	—
IN111	Ge	2	OA90	2	—
IN112	Ge	2	OA90	2	—
IN113	Ge	2	OA90	2	—
IN114	Ge	2	OA90	2	—
IN115	Ge	2	OA90	2	—
IN117	Ge	2	OA90	2	—
IN118	Ge	2	OA95	2	—
IN119	Ge	2	AA119	2	—
IN120	Ge	2	OA91	2	—
IN126	Ge	2	OA91	2	—
IN127	Ge	2	OA91	2	—
IN142	Ge	2	OA91	2	—
IN175	Ge	2	OA91	2	—
IN191	Ge	2	OA91	2	—
IN192	Ge	2	OA91	2	—
IN194	Si	2	BA100	2	—
IN196	Si	2	BA100	2	—
IN198	Ge	2	OA91	2	—
IN212	Si	2	BA100	2	—
IN215	Si	2	BA148	5	—
IN217	Si	2	BA148	5	—
IN251	Si	2	BAX16	7	—
IN252	Si	2	BAX16	7	—
IN265	Ge	2	OA91	2	—
IN266	Ge	2	OA91	2	—
IN267	Ge	2	OA91	2	—
IN268	Ge	2	OA91	2	—
IN290	Ge	2	OA91	2	—
IN294	Ge	2	OA91	2	—
IN297	Ge	2	OA91	2	—
IN298	Ge	2	OA91	2	—
IN304	Ge	2	OA90	2	—
IN316	Si	11	BY127	11b	—
IN317	Si	11	BY127	11b	—
IN318	Si	11	BY127	11b	—
IN319	Si	11	BY127	11b	—
IN320	Si	11	BY127	11b	—
IN321	Si	11	BY127	11b	—
IN330	Si	2	BA100	2	—
IN331	Si	2	BA100	2	—
IN345	—	—	—	—	.15
IN350	Si	3	BA100	2	—
IN351	Si	3	Ba145	5	—
IN352	Si	3	BA145	5	—
IN353	Si	3	BA145	5	—
IN354	Si	3	BA145	5	—
IN355	Ge	2	BA144	2	—
IN359	Si	10	BY127	11b	—
IN360	Si	10	BY127	11b	—
IN361	Si	10	BY127	11b	—
IN362	Si	10	BY127	11b	—
IN363	Si	10	BY127	11b	—
IN364	Si	10	BY127	11b	—
IN365	Si	10	BY127	11b	—
IN440	Si	11	BY127	11b	—
IN441	Si	11	BY127	11b	—
IN442	Si	11	BY127	11b	—
IN443	Si	11	BY127	11b	—
IN444	Si	11	BY127	11b	—
IN445	Si	11	BY127	11b	—
IN457	Si	2	BAX16	7	—
IN458	Si	2	BA145	5	—
IN459	Si	2	BA100	2	—
IN461	Si	2	—	—	.14
IN462	Si	2	BA100	2	—
IN463	Si	2	BA100	2	—
IN464	Si	2	BA100	2	—
IN476	Ge	2	OA91	2	—
IN477	Ge	2	OA91	2	—
IN478	Ge	2	OA91	2	—
IN479	Ge	2	OA91	2	—
IN480	Ge	2	OA91	2	—
IN482	Si	7	BA100	2	—
IN483	Si	7	BA100	2	—
IN484	Si	7	BA148	5	—
IN485	Si	7	BA148	5	—
IN486	Si	7	BA148	5	—
IN487	Si	2	BA148	5	—
IN488	Si	2	BA148	5	—
IN490	Si	2	BA148	5	—
IN530	Si	11	BY127	11b	—
IN531	Si	1	BY127	11b	—
IN532	Si	11	BY127	11b	—
IN533	Si	11	BY127	11b	—
IN534	Si	11	BY127	11b	—
IN535	Si	11	BY127	11b	—
IN536	Si	9	BY127	11b	—
IN537	Si	9	BY127	11b	—
IN538	Si	9	BY127	11b	—
IN539	Si	9	BY127	11b	—
IN541	Ge	2	OA90	2	—
IN543	Si	2	BYX10	5	—
IN547	Si	9	BY127	11b	—
IN560	Si	9	BY127	11b	—
IN561	Si	9	BY127	11b	—
IN599	Si	9	BY127	11b	—
IN600	Si	9	BY127	11b	—
IN601	Si	9	BY127	11b	—
IN602	Si	9	BY127	11b	—
IN603	Si	9	BY127	11b	—
IN604	Si	9	BY127	11b	—
IN605	Si	9	BY127	11b	—
IN606	Si	9	BY127	11b	—
IN616	Ge	2	OA91	2	—
IN617	Ge	2	OA91	2	—
IN618	Ge	2	OA91	2	—
IN625	Si	7	BA100	2	—
IN626	Si	7	BA100	2	—
IN627	Si	7	BA148	5	—
IN628	Si	7	BA148	5	—
IN629	Si	7	BA148	5	—
IN636	Ge	2	OA91	2	—
IN643	Si	2	BA145	5	—
IN658	Si	2	BAX16	7	—
IN659	Si	2	—	—	.08
IN660	Si	2	BAX16	7	—
IN661	Si	2	BAX16	7	—
IN770	Ge	2	OA90	2	—
IN805	Ge	2	OA91	2	—
IN821	—	—	—	—	.33
IN823	—	—	—	—	.50
IN825	—	—	—	—	.60
IN846	Si	2	IN4001	4	—
IN847	Si	2	IN4002	4	—
IN848	Si	2	IN4003	4	—
IN849	Si	2	IN4004	4	—
IN850	Si	2	IN4004	4	—
IN851	Si	2	IN4005	4	—
IN852	Si	2	IN4005	4	—
IN853	Si	2	IN4006	4	—
IN854	Si	2	IN4006	4	—
IN855	Si	2	IN4007	4	—
IN856	Si	2	IN4007	4	—
IN857	Si	2	IN4001	4	—
IN858	Si	2	IN4002	4	—
IN859	Si	2	IN4003	4	—
IN860	Si	2	IN4004	4	—
IN861	Si	2	IN4004	4	—
IN862	Si	2	IN4005	4	—
IN863	Si	2	IN4005	4	—
IN864	Si	2	IN4006	4	—
IN878	Si	2	IN4007	4	—
IN879	Si	2	IN4001	4	—
IN880	Si	2	IN4002	4	—
IN881	Si	2	IN4003	4	—
IN882	Si	2	IN4004	4	—
IN883	Si	2	IN4004	4	—
IN884	Si	2	IN4005	4	—
IN885	Si	2	IN4005	4	—
IN886	Si	2	IN4006	4	—
IN887	Si	2	IN4006	4	—
IN888	Si	2	IN4007	4	—
IN889	Si	2	IN4007	4	—
IN911	Ge	2	OA90	2	—
IN914	Si	7	—	—	.07
IN914A	Si	7	IN4446	7	—
IN914B	Si	7	IN4448	7	—
IN916	Si	7	—	—	.07
IN935B	—	—	—	—	.65
IN936B	—	—	—	—	.82
IN9378	—	—	—	—	.95
IN9418	—	—	—	—	.82
IN942B	—	—	—	—	1.00
IN943B	—	—	—	—	1.20
IN1100	Si	9	IN4002	4	—
IN1101	Si	9	IN4003	4	—
IN1102	Si	9	IN4004	4	—
IN1103	Si	9	IN4004	4	—
IN1104	Si	9	IN4005	4	—
IN1105	Si	9	IN4005	4	—
IN1183	Si	10	—	—	.84
IN1183R	Si	10	—	—	.84
IN1188	Si	10	—	—	2.25
IN1190	Si	10	—	—	2.52
IN1190R	Si	10	—	—	2.52
IN1192	Si	10	—	—	.90
IN1192A	Si	10	—	—	.90
IN1194	Si	10	—	—	1.10
IN1194A	Si	10	—	—	1.15
IN1196	Si	10	—	—	1.64
IN1196A	Si	10	—	—	1.64
IN1198	Si	10	—	—	2.40
IN1198A	Si	10	—	—	2.40
IN1199	Si	10	—	—	.65
IN1200A	Si	10	—	—	.68
IN1201A	Si	10	—	—	.70
IN1202A	Si	10	—	—	.73
IN1204A	Si	10	—	—	.77
IN1206A	Si	10	—	—	.80
IN1487	Si	9	IN4002	4	.80

Type		Case	Equiv	Case	Price
IN1488	Si	9	IN4003	4	—
IN1489	Si	9	IN4004	4	—
IN1490	Si	9	IN4004	4	—
IN1491	Si	9	IN4005	4	—
IN1492	Si	9	IN4005	4	—
IN1692	Si	9	IN4002	4	—
IN1693	Si	9	IN4003	4	—
IN1694	Si	9	IN4004	4	—
IN1695	Si	9	IN4004	4	—
IN1696	Si	9	IN4005	4	—
IN1697	Si	9	IN4005	4	—
IN2069	Si	11b	IN4003	4	—
IN2070	Si	11b	IN4004	4	—
IN2071	Si	11b	IN4005	4	—
IN3031A	—	—		—	.25
IN3193	Si	11	IN4003	4	—
IN3194	Si	11	IN4004	4	—
IN3195	Si	11	IN4005	4	—
IN3196	Si	11	IN4006	4	—

Type		Case	Equiv	Case	Price
IN3253	Si	11	IN4003	4	—
IN3254	Si	11	IN4004	4	—
IN3255	Si	11	IN4005	4	—
IN3256	Si	11	IN4006	4	—
IN3492	Si	P fit	—	—	.80
IN3493	Si	P fit	—	—	.85
IN3595	Si	P fit	—	—	.30
IN3602	Si	7	—	—	.15
IN3604	Si	7	—	—	.15
IN3754	—	—	D1300A	—	—
IN3766	Si	10	—	—	3.65
IN3766R	Si	10	—	—	3.70
IN3768	Si	10	—	—	4.20
IN3768R	Si	10	—	—	4.30
IN3826	Si	10	—	—	1.20
IN4001	Si	4	—	—	.06
IN4002	Si	4	—	—	.07
IN4003	Si	4	—	—	.08
IN4004	Si	4	—	—	.09

Type		Case	Equiv	Case	Price
IN4005	Si	4	—	—	.10
IN4006	Si	4	—	—	.11
IN4007	Si	4	—	—	.12
IN4009	Si	4	—	—	.25
IN4148	Si	7	—	—	.07
IN4150	Si	7	—	—	.19
IN4154	Si	7	—	—	.20
IN4446	Si	7	—	—	.14
IN4448	Si	7	—	—	.08
IN4517	Si	7	—	—	.11
IN5172	Si	7	—	—	.17
IN5173	Si	7	—	—	.20
IN5176	Si	7	—	—	.25
IN5233A	Si	7	—	—	.25
IN5400	Si	11b	—	—	.14
IN5401	Si	11b	—	—	.165
IN5402	Si	11b	—	—	.175
IN5404	Si	11b	—	—	.185
IN5406	Si	11b	—	—	.225

Type		Case	Equiv	Case	Price
IN5407	Si	11b		—	.27
IN5408	Si	11b		—	.40
IS44	Si	7	ITT44	—	.07
IS120	Si	7	—	—	.15
IS121	Si	7	—	—	.15
IS130	Si	7	—	—	.10
IS131	Si	7	—	—	.10
IS132	Si	7	—	—	.25
IS134	Si	7	—	—	.25
IS136	Si	7	—	—	.40
IS420	Si	10	—	—	.60
IS920	Si	7	ITT920	7	—
IS921	Si	7	ITT921	7	—
IS922	Si	7	ITT922	7	—
IS923	Si	7	ITT923	7	—
IS940	Si	7	—	—	.06
IS941	Si	7	—	—	.07
IS961	Si	7	—	—	.15

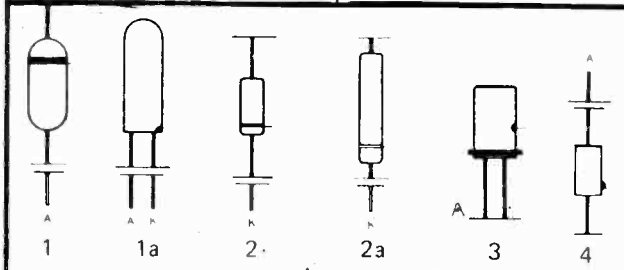
ZENERS

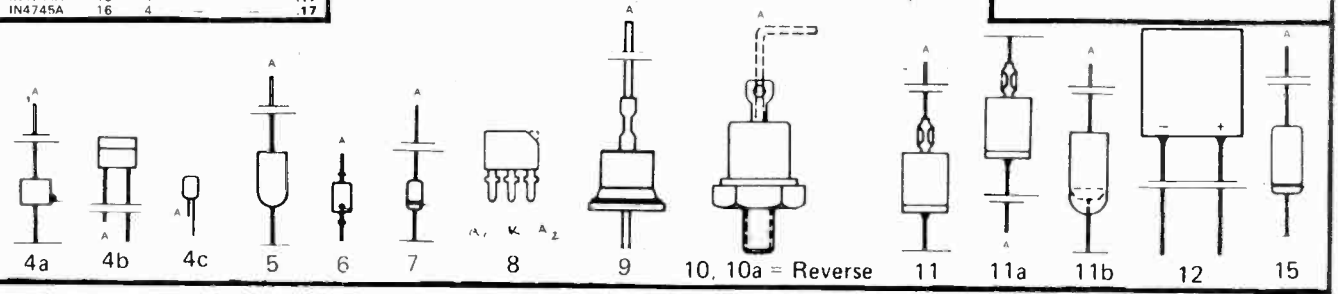
Type		Case	Equiv	Case	Price
ZENERS-400mW					
BZX83	C2 7	7	—	—	.11
BZX83	C3 0	7	—	—	.11
BZX83	C3 3	7	—	—	.11
BZX83	C3 6	7	—	—	.11
BZX83	C3 9	7	—	—	.11
BZX83	C4 3	7	—	—	.11
BZX83	C4 7	7	—	—	.11
BZX83	C5 1	7	—	—	.11
BZX83	C5 6	7	—	—	.11
BZX83	C6V2	7	—	—	.11
BZX83	C6V8	7	—	—	.11
BZX83	C7V5	7	—	—	.11
BZX83	C8V2	7	—	—	.11
BZX83	C9V1	7	—	—	.11
BZX83	C10	7	—	—	.11
BZX83	C11	7	—	—	.11
BZX83	C12	7	—	—	.11
BZX83	C13	7	—	—	.11
BZX83	C15	7	—	—	.11
BZX83	C16	7	—	—	.11
BZX83	C18	7	—	—	.11
BZX83	C20	7	—	—	.11
BZX83	C22	7	—	—	.11
BZX83	C24	7	—	—	.11
BZX83	C27	7	—	—	.11
BZX83	C30	7	—	—	.11
BZX83	C33	7	—	—	.11
BZX83	C36	7	—	—	.11
BZX83	C39	7	—	—	.11
BZX83	C43	7	—	—	.11
BZX83	C47	7	—	—	.11
ZENERS-1W					
IN4728A	3.3	4	—	—	.17
IN4729A	3.6	4	—	—	.17
IN4730A	3.9	4	—	—	.17
IN4731A	4.3	4	—	—	.17
IN4732A	4.7	4	—	—	.17
IN4733A	5.1	4	—	—	.17
IN4734A	5.6	4	—	—	.17
IN4735A	6.2	4	—	—	.17
IN4736A	6.8	4	—	—	.17
IN4737A	7.3	4	—	—	.17
IN4738A	8.2	4	—	—	.17
IN4739A	9.1	4	—	—	.17
IN4740A	10	4	—	—	.17
IN4741A	11	4	—	—	.17
IN4742A	12	4	—	—	.17
IN4743A	13	4	—	—	.17
IN4744A	15	4	—	—	.17
IN4745A	16	4	—	—	.17

Type		Case	Equiv	Case	Price
IN4746A	18	4	—	—	.17
IN4747A	20	4	—	—	.17
IN4748A	22	4	—	—	.17
IN4750A	27	4	—	—	.17
IN4751A	30	4	—	—	.17
IN4752A	33	4	—	—	.17
IN4753A	36	4	—	—	.17
IN4754A	39	4	—	—	.17
IN4755A	43	4	—	—	.17
IN4756A	47	4	—	—	.17
IN4757A	51	4	—	—	.17
IN4758A	54	4	—	—	.17
IN4759A	62	4	—	—	.17
ZENERS-1.5W					
BZY97	C3V9	2	—	—	.26
BZY97	C4V7	2	—	—	.26
BZY97	C5V6	2	—	—	.26
BZY97	C6V8	2	—	—	.26
BZY97	C8V2	2	—	—	.26
BZY97	C10V	2	—	—	.28
BZY97	C12V	2	—	—	.26
BZY97	C15V	2	—	—	.26
BZY97	C18V	2	—	—	.26
BZY97	C27V	2	—	—	.26
BZY97	C33V	2	—	—	.26
ZENERS-2.5 WATT					
BZX70	C7V5	11b	—	—	.48
BZX70	C8V2	11b	—	—	.48
BZX70	C9V1	11b	—	—	.48

Type		Case	Equiv	Case	Price
BZX70	C10	11b	—	—	.48
BZX70	C11	11b	—	—	.48
BZX70	C12	11b	—	—	.48
BZX70	C13	11b	—	—	.48
BZX70	C15	11b	—	—	.48
BZX70	C16	11b	—	—	.48
BZX70	C18	11b	—	—	.48
BZX70	C20	11b	—	—	.48
BZX70	C22	11b	—	—	.48
BZX70	C24	11b	—	—	.48
BZX70	C27	11b	—	—	.48
BZX70	C30	11b	—	—	.48
BZX70	C33	11b	—	—	.48
BZX70	C36	11b	—	—	.48
BZX70	C39	11b	—	—	.48
BZX70	C43	11b	—	—	.48
BZX70	C47	11b	—	—	.48
BZX70	C51	11b	—	—	.48
BZX70	C56	11b	—	—	.48
BZX70	C62	11b	—	—	.48
BZX70	C68	11b	—	—	.48
BZX70	C75	11b	—	—	.48
BZX61	7V5 to 62V	4	IN4737A to IN4759A	4	—
BZX95	—	9	BZX70	11b	—
BZX96	—	9	BZX70	11b	—
BZY88	—	2	BZX83	7	—
ZENERS-5W					
BZV40	C3V3	15	—	—	.60
BZV40	C3V6	15	—	—	.60

Type		Case	Equiv	Case	Price
BZV40	C3V9	15	—	—	.60
BZV40	C4V3	15	—	—	.60
BZV40	C4V7	15	—	—	.60
BZV40	C5V1	15	—	—	.60
BZV40	C5V6	15	—	—	.60
BZV40	C6V2	15	—	—	.60
BZV40	C6V8	15	—	—	.60
BZV40	C7V5	15	—	—	.60
BZV40	C8V2	15	—	—	.60
BZV40	C8V7	15	—	—	.60
BZV40	C9V1	15	—	—	.60
BZV40	C10V	15	—	—	.60
BZV40	C11V	15	—	—	.60
BZV40	C12V	15	—	—	.60
BVZ40	C15V	15	—	—	.60
BZV40	C33V	15	—	—	.60
BZV40	C68V	15	—	—	.60
BZV40	C120V	15	—	—	.60
ZENERS-20 WATT					
BZY93	C6V8	10	—	—	.75
BZY93	C7V5	10	—	—	.75
BZY93	8V2	10	—	—	.75
BZY93	9V1	10	—	—	.75
BZY93	10	10	—	—	.75
BZY93	11	10	—	—	.75
BZY93	12	10	—	—	.75
BZY93	C13V	10	—	—	.75
BZY93	15	10	—	—	.75
BZY93	16	10	—	—	.75
BZY93	18	10	—	—	.75
BZY93	20	10	—	—	.75
BZY93	22	10	—	—	.75
BZY93	24	10	—	—	.75
BZY93	27	10	—	—	.75
BZY93	30	10	—	—	.75
BZY93	33	10	—	—	.75
BZY93	36	10	—	—	.75
BZY93	39	10	—	—	.75
BZY93	43	10	—	—	.75
BZY93	47	10	—	—	.75
BZY93	51	10	—	—	.75
BZY93	56	10	—	—	.75
BZY93	62	10	—	—	.75
BZY93	68	10	—	—	.75
BZY93	75	10	—	—	.75
BZZ10	Si	2	BZXB3C6V2	7	—
BZZ11	Si	2	C6V87	—	—
BZZ12	Si	2	C7V5	7	—
BZZ13	Si	2	C8V2	7	—



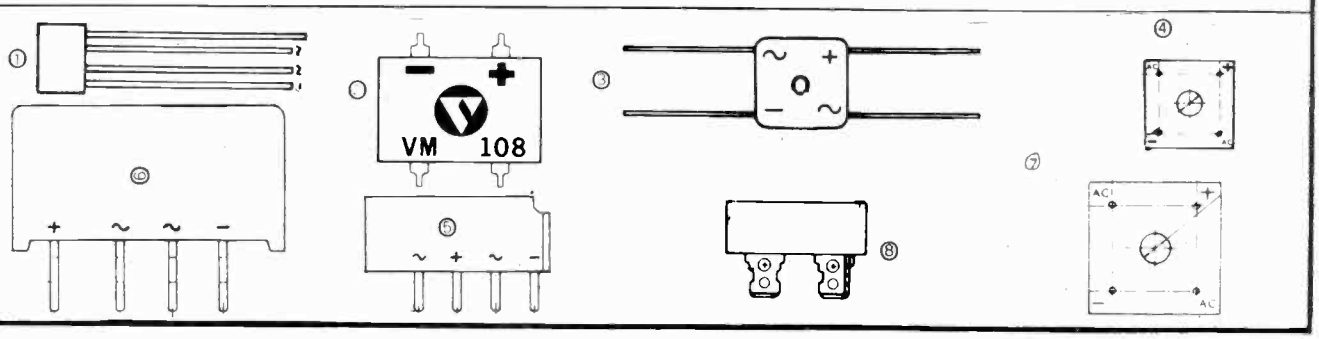


BRIDGE RECTIFIERS

TYPE	RATING		CASE	PRICE
W005/T1005	1A	50v		0.30
W01	1A	100V	Case	0.32
W02	1A	200v	1	0.34
W04	1A	400v		0.40
W06	1A	600v		0.50
VM18	1A	100v	New Dual	0.30
VM28	1A	200v	in line	0.32
VM48	1A	400v	2	0.35
SO05	2A	50v		0.36
SO1	2A	100v		0.40

TYPE	RATING		CASE	PRICE
SO2	2A	200v	Case	0.44
SO4	2A	400v	4	0.56
SO6	2A	600v		0.66
SO8	2A	800v		0.76
6A600	6A	600v	Leads	1.25
BY164	1.4A	120v		0.57
B40C1500	1.5A	100v	Case	0.48
B40C3200	3.2A	100v	5 & 6	1.10
B80C1500	1.5A	200v		0.75
B80C3200	3.2A	200v		1.15
PW005	6A	50v		0.84

TYPE	RATING		CASE	PRICE
PW01	6A	100v	Case	0.86
PW02	6A	200v	7	0.88
PW04	6A	400v		0.98
PW06	6A	600v		1.08
PW08	6A	800v		1.18
				1.32
K005	25A	50v		2.00
KO1	25A	100v	Case	2.16
KO2	25A	200v	8	2.48
KO4	25A	400v		3.12
KO6	25A	600v		3.86



BRISTOL 0272 654201 **GLASGOW 041 332 4133**

RESISTORS

FIXED

CARBON

	PRICE
0.25 watt ±5% Tol. Available in E12 range 10Ω to 1 meg	**2p** each
0.5 watt ±5% Tol. Available in E12 range 10Ω to 10 meg	**3p** each
1.0 watt ±10% Tol. Available in E12 range 10Ω to 10 meg	**5p** each
2.0 watt ±10% Tol. Available in E12 range 10Ω to 10 meg	**8p** each

WIRE WOUND

2.5 watt ±5% Tol. Available in the following values only — **9p** each
Ohms .1, .22, .33, .5, 1, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100, 120, 150, 180, 220, 270, 330.

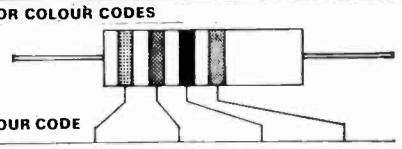
5 watt ±5% Tol. Available in the following values only — **10p** each
.5, 1, 2.2, 3.3, 3.9, 4.7, 6.8, 8.2, 10, 12, 15, 18, 22, 25, 33, 39, 47, 60, 75, 82, 100, 120, 130, 150, 180, 220, 250, 270, 300, 330, 470, 500, 560, 680, 820, 1k, 1k2, 1k5, 2k, 2k2, 2k5, 3k3, 4k7, 5k6, 6k8, 7k5, 8k2, 10k, 12k.

10 watt ±5% Tol. Available in the following values only — **12p** each
1, 2.2, 3.3, 4.7, 6.8, 7.5, 8.2, 10, 12, 15, 18, 22, 25, 33, 39, 47, 70, 82, 100, 120, 150, 200, 250, 330, 470, 560, 680, 750, 1k, 1k2, 1k5, 1k8, 2k, 2k2, 2k7, 3k, 3k5, 4k7, 5k, 5k6, 6k8, 10k, 15k, 18k, 20k, 25k.

METAL OXIDE

0.5 watt ±2% Tol. Available in E24 range 10Ω to 1 meg — **4p** each

RESISTOR COLOUR CODES



COLOUR CODE

Color	1st Digit	2nd Digit	Multiplier	Tolerance
Black	—	0	1	—
Brown	1	1	10	1%
Red	2	2	100	2%
Orange	3	3	1000	—
Yellow	3	4	10000	—
Green	5	5	100000	—
Blue	6	6	1000,000	—
Violet	7	7	—	—
Grey	8	8	—	—
White	9	9	—	—
Gold	—	—	0.1	5%
Silver	—	—	0.01	10%

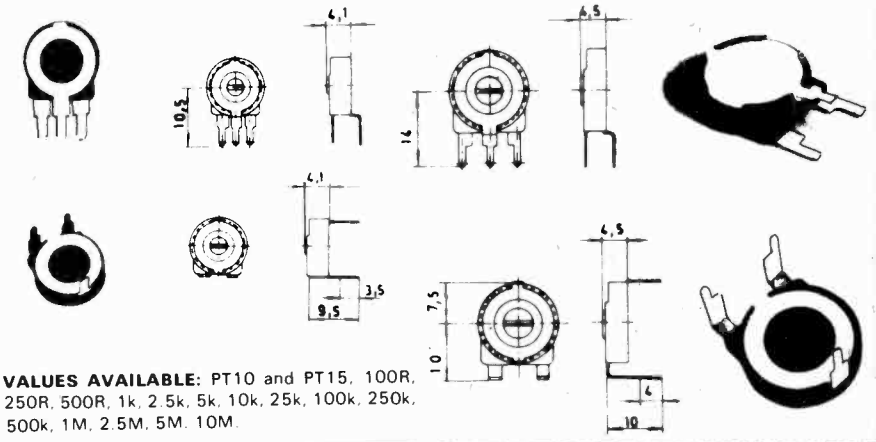
E24 series = 10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91, 100 PLUS DECADES.
E12 Series = 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82, 100 PLUS DECADES.

PRESET POTENTIOMETERS-TRIMMERS

PIHER — FOR THE PROFESSIONAL FINISH

PT10 SERIES (FULLY ENCLOSED) **12p**
PT10h (2.5) vertical mounting 0.15 watt at 40° C.
PT10V horizontal mounting 0.15 watt at 40° C.
Tol 20%.
Price 12p each. Please specify horizontal or vertical.

PT15 SERIES (FULLY ENCLOSED) **14p**
PT15 Nh vertical mounting 0.3 watt at 40° C
PT15 Nv horizontal mounting 0.3 watt at 40° C
Tol. 20%
Price 14p each. Please specify horizontal or vertical.
The PT15 range has the extra facility of clip in thumb wheels or spindles for easy adjustment without a screwdriver.
Thumb wheels ..... **5p** each
Spindles ..... **5p** each



VALUES AVAILABLE: PT10 and PT15, 100R, 250R, 500R, 1k, 2.5k, 5k, 10k, 25k, 100k, 250k, 500k, 1M, 2.5M, 5M, 10M.

POTENTIOMETER-VOLUME CONTROLS

ROTARY POTENTIOMETERS. All standard ¼" spindles

28p 1) SINGLE LESS SWITCH
Long spindle, double wiper, available in following values

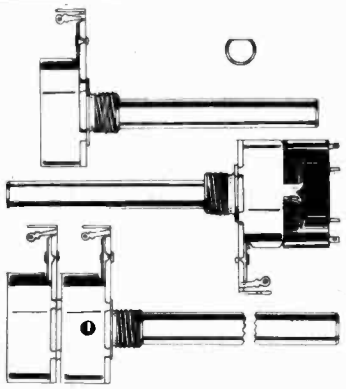
	5k	10k	LIN
25k	50k	100k	or
250k	500k	1Meg	LOG

55p 2) SINGLE SWITCHED
As above but with 2 Pole Switch 2 Amp 250V AC

5k	10k	25k	LIN
50k	100k	250k	or
500k	1Meg		LOG

75p 3) DUAL GANGED-STEREO
As above, but dual *No Switch*

5k	10k	25k	LIN
50k	100k	250k	or
500k	1Meg		LOG



SLIDER POTENTIOMETERS

45p 1) SINGLE—LOG OR LINEAR in following values 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M, 2M. Price 45p includes Knob.

80p 2) DUAL GANGED-STEREO—LOG OR LINEAR, matched to 2dB. 5k, 10k, 25k, 50k, 100k, 250k, 500k, 1M, 2M. PRICE 80p includes Knob.

NON LINEAR RESISTORS

Thermistors	R at 25° C.	Price
1) Rod type 0.6w Dissipation		
VA10665	4.7k	**0.17**
VA10555	15k	**0.17**
VA10565	47k	**0.17**
VA10655	150k	**0.17**
2) Disc Type 0.6w Dissipation		
VA1096	150	**0.15**
VA1097	470	**0.15**
VA1098	1.5k	**0.15**
VA1109	4.7k	**0.18**
VA1108	15k	**0.18**
VA1112	22k	**0.18**
VA1111	33k	**0.18**
3) Disc Types 1w Dissipation		
VA1086	2.2	**0.13**
VA1033	4	**0.13**
VA1074	6	**0.13**
VA1053	8	**0.13**
VA1110	10	**0.13**
VA1100	15	**0.13**
VA1077	32	—
VA1034	50	**0.13**
VA1040	130	**0.13**
VA1039	500	**0.13**

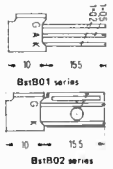
VOLTAGE DEPENDENT

1) Rod Types		Price
E298ED/A258	1500	**0.19**
E298ED/A260	1800	**0.19**
E298ED/A262	2200	**0.19**
E298ED/A265	2400	**0.19**
E298ED/P268	3000	**0.19**
E298ZZ/06	3020	**0.19**
2) Disc Types		
E299DD/P116	14	**0.16**
E299DD/P118	18	**0.16**
E299DD/P120	21	**0.16**
E299DD/P216	25	**0.16**
E299DD/P218	32	**0.16**
E299DD/P220	40	**0.16**
E299DD/P224	57	**0.16**
E299DD/P226	60	**0.16**
E299DD/P228	70	**0.16**
E299DD/P230	85	**0.16**
E299DD/P232	100	**0.16**
E299DD/P336	190	**0.16**
E299DD/P338	230	**0.16**
E299DD/P340	300	**0.16**
E299DD/P342	350	**0.16**
E299DD/P344	400	**0.16**
E299DD/P346	500	**0.16**
E299DD/P348	600	**0.16**
E299DD/P350	750	**0.16**
E299DD/P352	900	**0.16**
E299DD/P354	1100	**0.16**

THYRISTORS

TYPE	RATING		CASE	PRICE
*TIC44†	0.6A	30v	TO18	**0.32**
*TIC46†	0.6A	100v	TO18	**0.46**
*TIC47†	0.6A	200v	TO18	**0.67**
*2N5060	0.5A	25v	TO18	**0.29**
*2N5061	0.5A	50v	TO18	**0.30**
*2N5062	0.5A	100v	TO18	**0.36**
*2N5063	0.5A	150v	TO18	**0.39**
*2N5064	0.5A	200v	TO18	**0.41**

*BstB0126	1.2A	400v	Plastic	**0.67**
*BstB0140	1.2A	600v	Plastic	**0.95**
*BstB0146	1.2A	700v	Plastic	**1.25**
BstB0206	4.7A	100v	M478	**0.65**
BstB0213	4.7A	200v	Plastic	**0.75**
BstB0226	4.7A	400v	Plastic	**0.85**
BstB0240	4.7A	600v	Plastic	**1.15**
BstB0246	4.7A	700v	Plastic	**1.35**

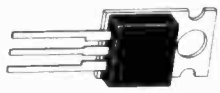


POWER THYRISTORS

C106A†	4A	100v	Plastic	**0.35**
C106B†	4A	200v	Plastic	**0.40**
C106C†	4A	300v	Plastic	**0.44**
C106D†	4A	400v	Plastic	**0.49**
C116A	8A	100v	Plastic	**0.43**
C116B	8A	200v	Plastic	**0.49**
C116C	8A	300v	Plastic	**0.56**
C116D	8A	400v	Plastic	**0.62**
C116M	8A	600v	Plastic	**0.74**
C126A	12A	100v	Plastic	**0.57**
C126B	12A	200v	Plastic	**0.65**
C126C	12A	300v	Plastic	**0.73**
C126D	12A	400v	Plastic	**0.81**
C126M	12A	600v	Plastic	**0.97**

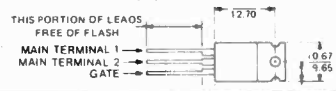
PLASTIC POWER

PLASTIC TO66 FROM TEXAS INST. QUALITY AND RELIABILITY



MECHANICAL INTERCHANGEABILITY OF THE PLASTIC PACKAGE WITH TO-66 OUTLINE

LOW COST HIGH STANDARDS



TRIACS-DIACS QUADRACS

TYPE			
ST2	DIAC		**0.20**
BR100	DIAC—	Mullard	**0.48**

TRIACS

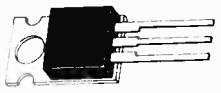
SC35D	3A	400v	Stud Mounting	**1.40**
TC4/40	4A	400v	Press Fitting	**1.35**
SC40D	6A	400v	Stud Mounting	**1.42**
SC45D	10A	400v	Stud Mounting	**1.89**
BTW37-600	12A	600v	TO64	**3.30**
BTW37-1	12A	1000v	TO64	**4.30**
BT123	14A	500v	TO127	**2.50**
BTX94-200	25A	200v	TO48	**6.25**
BTX94-400	25A	400v	TO48	**8.55**
BTX94-600	25A	600v	TO48	**11.00**

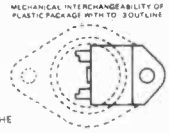
POWER TRIACS AT UNBEATABLE PRICES FROM

TEXAS INSTRUMENTS

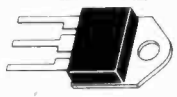
TIC225D	Plastic TO66	400V	6A	**.70**
TIC226D	Plastic TO66	400V	8A	**.75**
TIC236D	Plastic TO66	400V	12A	**.85**
TIC246D	Plastic TO66	400V	16A	**1.10**
TIC253D	Plastic TO3	400V	20A	**1.70**
TIC263D	Plastic TO3	400V	25A	**2.00**

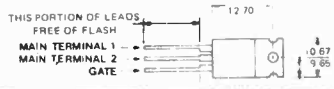
PLASTIC TO66





PLASTIC TO3



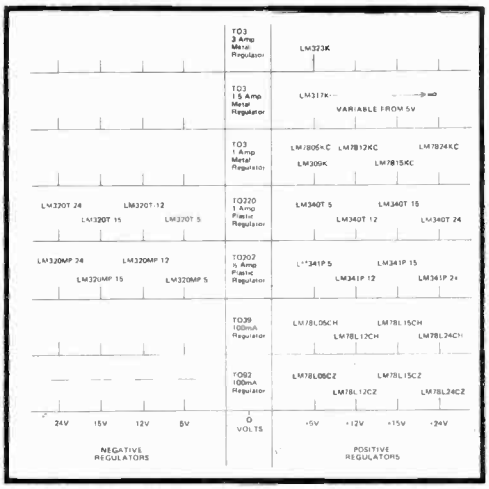


VOLTAGE REGULATORS

TYPE	RATING	PRICE
LM309K	1A+5 volt TO3	**2.59**
LM317K	1.5A variable TO3	**3.00**
LM320T-5	1A 5V—ve TO220	**2.86**
LM320T-12	1A 12v—ve TO220	**2.86**
LM320T-15	1A 15v—ve TO220	**2.86**
LM320T-24	1A 24v—ve TO220	**2.86**
LM320MP-5	0.5A 5v—ve TO202	**1.05**
LM320MP-12	0.5A 12v—ve TO202	**1.05**
LM320MP-15	0.5A 15v—ve TO202	**1.05**
LM320MP-24	0.5A 24v—ve TO202	**1.05**
LM323K	3A 5v+ve TO3	**6.46**
LM340T-5	1A 5v+ve TO220	**1.35**
LM340T-12	1A 12v+ve TO220	**1.35**
LM340T-15	1A 15v+ve TO220	**1.35**
LM340T-24	1A 24v+ve TO220	**1.35**
LM341P-5	.5A 5v+ve TO202	**1.10**
LM341P-12	.5A 12v+ve TO202	**1.10**
LM341P-15	.5A 15v+ve TO202	**1.10**
LM341P-24	.5A 24v+ve TO202	**1.10**
LM78L05CH	100mA 5v+ve TO5	**0.92**
LM78L12CH	100mA 12v+ve TO5	**0.92**
LM78L15CH	100mA 15v+ve TO5	**0.92**
LM78L24CH	100mA 24v+ve TO5	**0.92**
LM78L05KC	1A 5v+ve TO3	**1.75**
LM78L12KC	1A12v+ve TO3	**1.75**
LM78L15KC	1A 15v+ve TO3	**1.75**
LM78L24KC	1A 24v+ve TO3	**1.75**
LM78L05CZ	100mA 5v+ve TO92	**0.45**
LM78L12CZ	100mA 12v+ve TO92	**0.45**
LM78L15CZ	100mA 15v+ve TO92	**0.45**
LM78L24CZ	100mA 24V+ve TO92	**0.45**

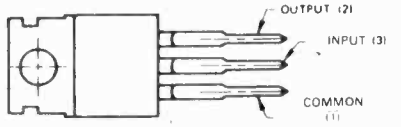
National

VOLTAGE REGULATOR SELECTOR GUIDE



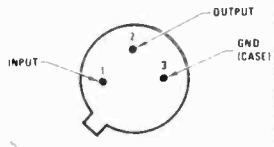
A SELECTED RANGE FROM NATIONAL SEMICONDUCTORS MAKERS OF QUALITY COMPONENTS

In cases of supply difficulty, we reserve the right to supply an equivalent device from another manufacturer at our own discretion.

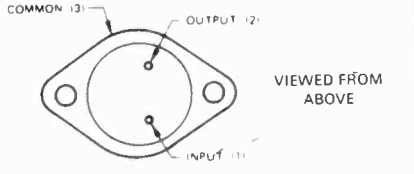


TO220/202 NEGATIVE REGS ONLY

THE SELECTOR GUIDE INDICATES THE RANGE OF REGULATORS NORMALLY KEPT IN STOCK, AND LISTS THEM IN ORDER OF THEIR RATINGS FOR QUICK REFERENCE.

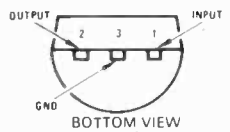


BOTTOM VIEW
TO-5 Metal Can Package (H)

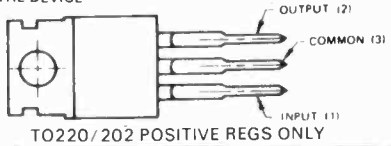


VIEWED FROM ABOVE

ALWAYS USE A HEAT SINK WHEN THE ANTICIPATED CURRENT IS APPROACHING THE MAXIMUM RATING OF THE DEVICE



BOTTOM VIEW

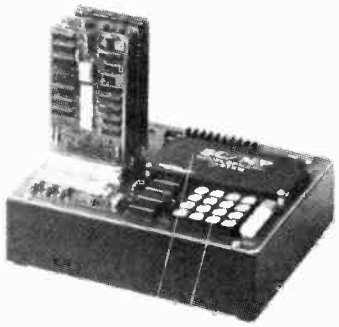


TO220/202 POSITIVE REGS ONLY

BRISTOL 0272 654201

GLASGOW 041 332 4133

SC/MP LOW COST DEVELOPMENT SYSTEM — FROM NATIONAL SEMICONDUCTORS



DESCRIPTION The SC/MP LCDS provides all the features necessary for development and testing of SC/MP hardware and software designs. For a user's application the system comes complete with one CPU card plugged into one of four sockets on the 10" x 12" motherboard. Also on the motherboard are a 16 key, dual function hexadecimal keyboard, four function keys, 3 control switches and a 6 digit hex display. Control logic, scratchpad memory and ROM based firmware on the motherboard allow user to examine and alter the SC/MP registers, and memory locations, run SC/MP programs in continuous or single instruction mode or operate optional teletype using SC/MP debug. The CPU card supplied provides the CPU interface for execution of user generated application programs and development system resident firmware.
Four prewired 72 pin edge connector sockets provide a plug-in interface for SC/MP family cards — a selection of which (listed below) may be used in conjunction with the SC/MP LCDS system to provide additional memory for user applications or system development. The cards can be plugged into any of the connectors on the card bus.

FEATURES provide the following software debug capability.

- Display contents of SC/MP program counter, registers and accumulator in hexadecimal.
- Alter contents of prog. counter and registers + accumulator.
- Display contents of any memory location in hexadecimal.
- Alter contents of any memory location.
- Initiate execution of user generated programs.
- Select single instruction or normal execution.
- Interrupt execution of program at any point.

NATIONAL

SC/MP Development System

LCDS — Comes complete and constructed (as illustrated) with one CPU card included.	ISP-8P/301	**£335.00**
RAM CARD — 2k x 8	ISP-8C/002	**£107.20**
ROM/PROM CARD 4k x 8 with sockets for 8 MM5204/5414's	ISP-8C/004B	**£83.75**
ROM/PROM CARD 4k x 8 includes 8 MM5204	ISP-8C/004P	**£351.75**
CPU CARD 256 x 8 of RAM and sockets for 512 x 8 of ROM	ISP-8C/100	**£167.50**

COMES COMPLETE WITH FULL DATA AND INSTRUCTIONS
OR SEND SAE + 30p FOR DATA

NEW FROM MOTOROLA MEK6800DII

A SELF-CONTAINED MICROCOMPUTER KIT

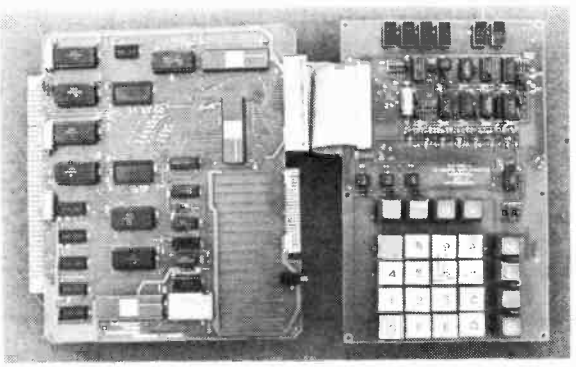
The kit, when assembled, is a fully functional microcomputer. The integral keyboard/display module can be used in conjunction with monitor program. For entering and debugging of user programs, a second P.I.A. allows operation via TTY or other input/outputs.

FEATURES

- 72 basic instructions
- 7 addressing modes
- On board monitor program
- On board cassette interface — connecting direct to cassette mike and earphone socket
- Spare prewired sockets for additional ROM/RAM, etc., + space for user's extra circuitry
- Expandable via data bus to 65k words using inbuilt motherboard techniques
- 256 words of RAM + monitor program
- Comprehensive literature/fact pack

A FULL RANGE OF SUPPORT DEVICES
WILL BE AVAILABLE SHORTLY

PRICE £190+VAT **DATA 30p+Sae**



MC6800P — Microprocessor chip-plastic	**£16.00**
MC6810A — 1k static (128 x 8) ram 24 pin	**£4.50**
MC6820P — Peripheral interface adaptor	**£8.50**
MC6850P — Interface adaptor	**£10.00**

DATA-MANUALS

		National Data Library
SC/MP	Programming and assembler manual	**£6.00**
SC/MP	Technical description	**£1.80**
SC/MP	Applications manual	**£6.00**
National	Linear IC data book	**£3.00**
National	TTL data book	**£1.90**
National	Interface data book	**£1.90**
National	Special function data book	**£1.30**
National	CMOS data book	**£1.30**
National	Memory data book	**£1.50**
National	Audio handbook	**£1.75**

PRICES ARE EXCLUSIVE OF POST/PACKING 50p PER BOOK

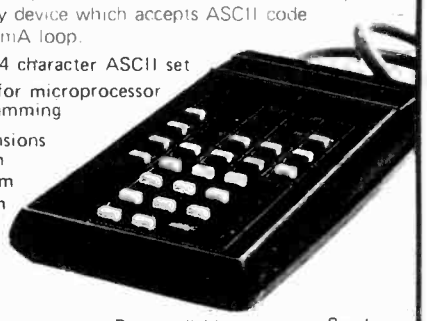
POCKET TTY

THE LOW COST ANSWER FOR DATA INPUT

The revolutionary Pocket TTY is a convenient, noiseless, hand-held unit which can replace a teletype in programming applications — at less than a quarter the cost.

It has full keyboard facilities, a nine-digit LED display of characters entered, and is compatible with any device which accepts ASCII code via a 20mA loop.

- Full 64 character ASCII set
- Ideal for microprocessor programming
- Dimensions 75mm x 155mm x 25mm



Price **£175.00** Data available **30p** Send S.A.E.

AUDIO VISUAL

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"WHAT IS A MICROPROCESSOR?" COMPLETE TEACH YOURSELF COURSE

The amazing response we experienced at our last two microprocessor forums in London — and the tremendous interest shown by individuals in microprocessor technology, has prompted us to release an edited recording of the lecture on cassette accompanied by a 72-page booklet keyed to the tapes — the forum was arranged by National Semiconductors, Practical Electronics and ourselves in an effort to remove the problems and uncertainties arising for anyone not familiar with this new and increasingly important subject. The lecture (on 1 x C90 and 1 x C60 cassettes) was given by two of National Semiconductors' leading microprocessor engineers. **£9.95** incl. VAT & P/P

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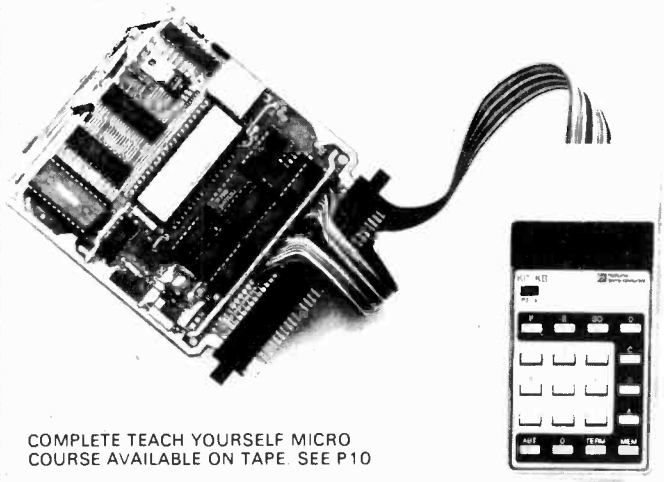
SC/MP MICROPROCESSOR



COMPLETE TEACH YOURSELF MICRO COURSE AVAILABLE ON TAPE. SEE P10

DATA PACK SC/MP **Price £1.50 + P/P 50p**

INTROKIT — NATIONAL **Price £68.61 + VAT**

SC/MP, the Microprocessor kit from **National Semiconductor** includes everything yu need to build a completely functional microprocessor system — featuring the National SC/MP microprocessor — the low cost microprocessor for every application. Test Systems and Instrument Control; Machine Tool Control; Small Business Machines; Word Processing Systems; Educational Systems; Multiprocessors Systems; Process Controllers; Terminal Control; Laboratory Instrumentation; Sophisticated Games; Automotive Controller and Appliance Controllers.

The kit, neatly packaged with all the components and literature you need, in a looseleaf binder, includes: The SC/MP Microprocessor — a single-chip Central Processing Unit in a 40-pin, dual in-line package. Features static operations, forty-six intruction types, single-byte and double-byte, software controlled interrupt structure, built in serial input/output ports; bidirectional 8-bit TRI-STATER bus, parrallel data/port and latched 12-bit TRI-STATER address port. ROM — 512 bytes (8-bits/byte) of pre-programmed Read-Only-memory containing KITBUG—a monitor and debugging program to assist int he development of your application programs. KJT8UGprovides teletypewrite input/output routines and allows examination, modification, and controlled execution of your programs. RAM-256 bytes of static read/write memory for storage of your application programs. Transfers of data to and from RAM are controlled by SC/MP and KITBUG. Teletypewriter Interface including buffer and drive capability for 20 MA current loop interface. Voltage REgulator. Data Buffer-providing interface between memory and bidirectional data lines. All the literature you need, including schematics and programming manuals. Timing Crystal—providing 1.000 MHz timing signal. Plus all the passive compnents and circuit board with 72 pin edge connector required to build and interconnect your microprocessor system with external hardware.

KEYBOARD KIT — National Semiconductors £65.84 + VAT

Replaces the need for a conventional teletype terminal for input/output data. The calculator type keyboard provides manual input commands to the SC/MP and a six digit hex display provides visual output. An umbilical cord connects it to the Introkit P.C.B. Using the keyboard, programmes can be entered in hexadecimal (easier to use than binary). As well as the 16 hexadecimal keys (0-9, A, B, C, D, E and F) there are 4 control keys, which allow the contents of any RAM address to be examined or modified.

MICROPROCESSOR SUPPORT DEVICES

		Price
UNIVERSAL INTERFACE		
DM81LS95	Tristate Octal Buffers (TRUE-8 COM)	£1.45
DM81LS96	Tristate Octal Buffers (INV.-8 COM)	£1.45
DM81LS97	Tristate Octal Buffers (TRUE-4/4)	£1.45
DM81LS98	Tristate Octal Buffers (INV.-4/4)	£1.45
MM74C173	Tristate Quad Latch	£0.95
MM74C174	Hex D Flip Flop	£0.95
MM74C175	Quad D Flip Flop	£0.95
DM74173N	Tristate Quad D Flip Flop (DM8551N)	£2.76
DM74174N	Hex D Type Flip Flop	£2.14
DM74175N	Quad D Type Flip Flop	£1.90
DM74LS173	Low Power Schottky Tristate Quad D Register	£2.93
DM74LS174	Low Power Schottky Hex D Flip Flop	£1.41
DM74LS175	Low Power Schottky Quad D Flip Flop	£1.34
LM555	Timer	£0.40
LM556	Dual Timer	£1.10
DS8833	Quad Tristate Receiver	£1.99
DS8835	Quad Tristate Transceiver (Inverting)	£1.99
DM74LS138	1 of 8 Binary Decoder	£1.27
DM8131	Hex Comparator	£2.76
DM8223	1-8 Line Demultiplexer	£1.38
DM9602	Resettable One Shot (DM8851)	£6.21
HUMAN INTERFACE		
DM8544	Tristate Quad Switch Debouncer	£1.03
CD4511CN	7 Segment Latch Decoder Driver	£2.30
DM8678CABN	CRT character Gen 5x7 upper case	£15.20
2513	CRT character generator 5x7 UC	£8.00
INSTRUMENT & MACHINE INTERFACE		
DA1200CD	12 Bit D to A Converter Binary	£29.63
DA1202CD	12 Bit D to A Converter 3 Digit BCD	£29.63
DA1201CD	10 Bit D to A Converter (12 Bit) Binary	£25.24
DA1203CD	10 Bit D to A Converter (12 Bit) BCD	£25.24
MM5357D	8 Bit A to D converter	£10.00
MM74C922N	16 key keyboard encoder	£4.00
MM74C923N	20 key keyboard encoder	£4.00
RAMS-STATIC		
MM2101-2N	N Channel 256x4 Bit, 650NS 22 Pin DIL	£3.00
MM2102-2N	N Channel 1024x1 Bit, 650NS 16 Pin DIL	£2.10
MM2111-2N	N Channel 256x4 Bit, 650NS 18 Pin DIL	£3.00
MM2112-2N	N Channel 256x4 Bit, 650NS 16 Pin DIL	£3.00
MM74C920D	CMOS RAM 256x4 Bit 22 Pin DIL	£12.57
ROMS		
MM5214	512x8 Bit 24 Pin DIL (Special Order)	£26.95
PROMS		
DM74S287	256x4 Bit Bipolar Fusible Link Prom	£5.33
MM5204Q	512x8 Bit Erasable Prom	£32.30
MM1702AQ	256x8 Bit Erasable Prom	£10.80
MM2708Q	8192 Bit (1024x8) Erasable Prom	£35.00
COMMUNICATIONS		
MM5307AA/N	Baud Rate Generator	£12.68
MM5303N	UART	£6.34
SC/MP MICROPROCESSOR FAMILY		
1SP-8A/500D	SC/MP CPU chip	£12.00
1SP-8A/600N	N-channel CPU chip	£10.00
8080A 8 BIT MICROPROCESSOR FAMILY		
INS8D80A	N Channel 40 Pin 8 Bit replacement for Intel 8080	£23.45
DP8224N	Clock Generator & Driver for 8D80A CPU	£6.16
DP8228D	System Controller & Bus Driver for 8080A CPU	£7.30
DP8212N	8 Bit Input/Output Port	£3.08
DP8216 =	DS8833	
Data Sheet for INS8080A available at		£0.50

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✱ THE SYSTEM

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Verowire is basically a new kind of interconnecting system for P.C. Boards enabling maximum density to be achieved using integrated and/or discrete components.
The Verowire wiring system is ideal for prototypes, bread boards and limited production runs. Finished results are of a high standard with a neat and orderly appearance achieved in significantly less time than required by more conventional methods previously available.

Spare Pen
Plus 1 Spool £2.65

KIT CONTAINS	
Wiring Pen	1
Circuit Board	1
Reels of Wire, 38 AWG. (Red) (one reel fitted to wiring pen)	3
Reels of Wire, 34 AWG. (Green)	2
Half pins	100
Shouldered Terminal Pins	100
Plastic Wiring Comb	20
Lead deformation tool	1
Pin insertions tool	1
Cutters	1
Inspection magnifier	1

4 spare spools
38 SWG for **£2.35**

PRICE **£17.50** FULL KIT

WIRE WRAPPING/ UNWRAPPING TOOL

PRICE £8.50

This tool does the job of two at less cost and with less weight. It is quick, convenient and easy-to-use.
TYPE 58-1908K

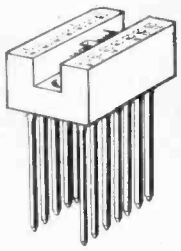
WIRE WRAPPING WIRE

Standard packs of 500 x 4" lengths of Kynar insulated wire — Silver plated soft copper wire — pre-stripped ready for use.
59-1766L PACK OF 500 4" **£5.50**

WIRE WRAPPING SOCKETS

8 PIN DIL	**30p**
14 PIN DIL	**40p**
16 PIN DIL	**45p**
24 PIN DIL	**70p**

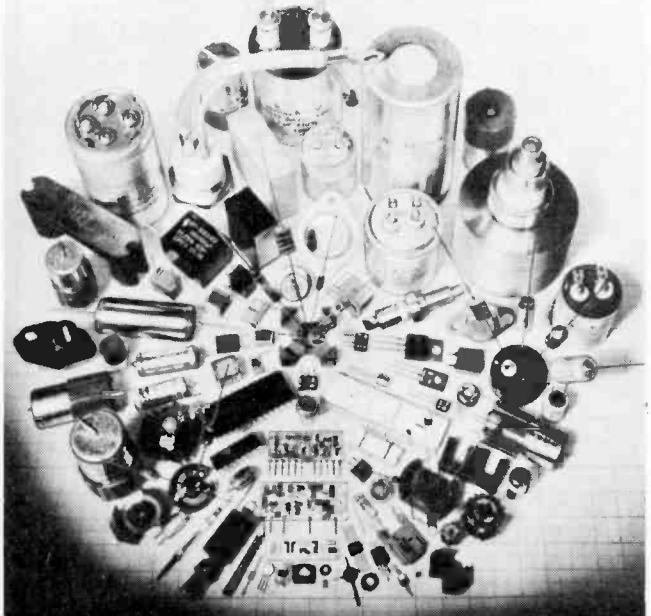
High quality sockets designed to provide max. reliability at a most economical cost.
Excellent performance.



NEW **vero**

SIEMENS

Maximum quality. Minimum size.



Examples from a range of thousands. Siemens.

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COOLING FANS

The new 'Mule' fan represents a breakthrough in slim axial fan design.
It reverses the drive principle in normal use with this type of fan by employing an outer stator/inner rotor design.
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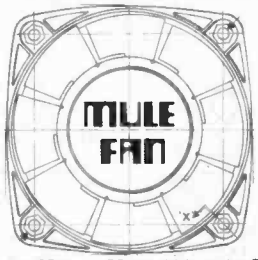
The impeller is glass re-inforced nylon with a specially-developed aerofoil section for maximum performance.
The fan is designed to be mounted either way round to enable induction or extraction and can be positioned inside or outside the cabinet.
Built to the highest standards of safety, the unit incorporates a thermal cut-out to eliminate overheating problems should the fan be jammed.
It will be of great use in electronics, vending machines, refrigeration, air conditioning, and other fields.

New design means
Lower price.
Up to 20% more output than other fans of its size.
Easily mounted for either induction or extraction.
High performance g.r.p. impellers.
Thermal cut-out to protect unit and installation.



STAY COOL!

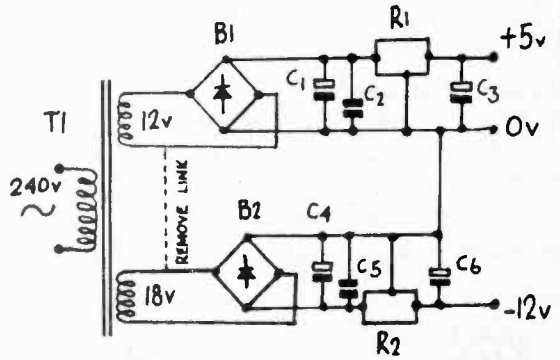
USE MULE

THE NEW LOW COST FAN

It's 95mm x 50mm thick at the Slim Price **£8.95 + VAT**

SC/MP POWER SUPPLY

POWER SUPPLY FOR SC/MP INTROKIT



Note: Disconnect common secondary winding

Parts list:	C1 1000μF 25v B41010
T1 MT 79AT	C2 0.22μF B37449
R1 LM309K	C3 2.2μF TANT B45134
R2 LM 320-12	C4 220μF 40v B41283
B1, B2 WOO5	C5 0.22μF B37449
	C6 2.2μF TANT B45134

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PHOTO TRANSISTORS

2N5777	Darlington Amplifier	0.80
2N5778	Darlington Amplifier	0.90
2N5779	Darlington Amplifier	1.30
BPX25	General Purpose Silicon	1.65
BPX29	General Purpose Silicon	1.65
BPX80	General Purpose Silicon Array (10)	6.50
BPX81	General Purpose Silicon	0.78
BPX86	General Purpose Silicon (5)	5.22
TIL63	General Purpose Silicon	1.45
TIL64	General Purpose Silicon	1.70
TIL65	General Purpose Silicon	1.95
TIL66	General Purpose Silicon	2.00
TIL67	General Purpose Silicon	2.10
OCP71	Germanium Photo Transistor	2.00

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BPW32	Low Dark Current Silicon	2.61
BPW34	Infra Red Photo Diode	1.96
BPX48	Differential (Precision)	3.89
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BPX61	10 MH	3.59
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BPX65	High Speed Silicon	4.70
BPX97	General Purpose Silicon	1.62
BPX68	General Purpose Silicon	2.00

SOLAR CELLS

BP100	Miniature Solar Cell	0.85
BPX79	Miniature Solar Cell Blue Sensitive	3.79
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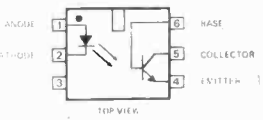
OPTO COUPLERS

4N25	Opto Couplers	2.15
CNY17	Opto Couplers	2.15

4N25 8 PIN DIL
2500V Isolation



LIGHT SWITCHES

TIL138	Transmissive Source & Sensor	2.00
TIL139	Reflective Source & Sensor	2.00

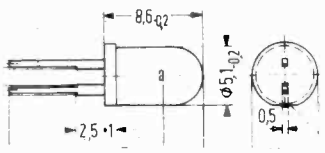
MISCELLANEOUS

ORP12	Photo Conductive Cell Cad.Sulph	0.84
ORP61	Photo Conductive Cell Cad.Sulph.	0.70
FW9802	Photo Conductive Cell Cad.Sulph.	0.75
RPY60	Photo Conductive Cell Cad.Sulphoselen	3.60
RPY63	Photo Conductive Cell Cad.Sulphoselen	3.60

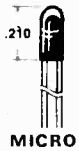
LED DISPLAYS

Type	Colour	Light Intens. Mcds		Price £
LD41A	RED	0.8		.21
LD55A	YELLOW	1.5	Panel	.26
LD57A	GREEN	0.8	Holders	.26
LD57C	BRIGHT GREEN	30.0	Price 3p	.60

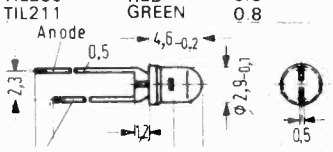
JUMBO



				Price £
LD30A	RED	0.8	Panel	.19
LD35A	YELLOW	1.5	Holders	.25
LD37A	GREEN	0.8	available	.25
TIL209	RED	0.8	Price 2p	.19
TIL211	GREEN	0.8		.25

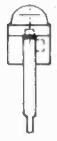


MICRO



QUANTITY PRICES P.31

Type	Description	Light Intensity Mcds		Price
LD241	Infra Red GaAs			1.00
LD261	Infra Red			1.00
LD266	Infra Red Array (5 LEDS)			4.50
LD269	Infra Red Array (9 LEDS)			7.50
LD461A	Red	1.0		.23
LD466	Red Array (5 LEDS)			1.70
LD469	Red Array (9 LEDS)			2.75
LD471A	Green	0.8	Cathode	0.35
LD476	Green Array (5 LEDS)			2.00
LD479	Green Array (9 LEDS)			3.75
LD481A	Yellow	1.0		.30
LD486	Yellow Array (5 LEDS)			2.22
LD489	Yellow Array (9 LEDS)		Anode	3.75



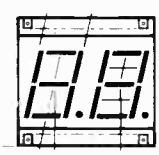
SEVEN SEGMENT

DL747	Common Anode	Red	'Single		2.50
DL750	Common Cathode	Red	Single		2.50
DL707(TIL 314)	Common Anode	Red	Single	.3"	2.00
DL704(TIL 315)	Common Cathode	Red	Single	.3"	2.00
NSN 373	Common Cathode	Red	Double	.3"	3.00
NSN 374	Common Anode	Red	Double	.3"	3.00
NSN 583	Common Cathode	Red	Double	.5"	3.40
NSN 584	Common Anode	Red	Double	.5"	3.40

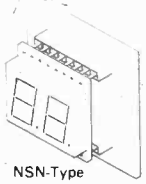
DL-Type

Single Digit Displays

NSN-Type Dual Displays are easily mounted



Dual Digit Displays from National



NSN-Type

MARSHALL'S INTEGRATED CIRCUIT

INTEGRATED CIRCUITS

Type	Description	Price £ p
CA3000	Temp. Comp. Diff. Amp. DC to 30MHZ	3.00
CA3001	Temp. Comp. Diff. Amp. LOZ out DC to 30MHZ	3.89
CA3002	Temp. Comp. Diff. Amp.	3.00
CA3005	RF Amplifier	2.25
CA3006	RF Amplifier	4.25
CA3007	Aud. Driver for Class B C/P	3.78
CA3008	Wide Band Op. Amp. Unty. GN. at 50MHZ	2.27
CA3012	IF Ltg. Amp. 100KHZ to 20MHZ	1.50
CA3013	IF Ltg. Amp. with Discrim. 100KHZ to 20MHZ	1.65
CA3014	IF Ltg. Amp. with Discrim. 100KHZ to 20MHZ	2.00
*CA3018	Transistor Array	0.81
*CA3018A	Transistor Array	1.06
*CA3020	Wide Band Pwr. Amp. 8MHZ/0.5W	2.00
*CA3020A	Wide Band Pwr. Amp. 8MHZ/1.0W	2.29
*CA3021	Lo. Pwr. Video 4MW/2MHZ 8W	2.18
*CA3022	Lo. Pwr. Video 12.5MW/7.5MHZ 8W	2.00
*CA3023	Lo. Pwr. Video 35MW/16DMHZ 8W	2.00
*CA3026	Dual Differential Amplifier	0.92
CA3028A	Diff./Cascade Amp. DC to 120MHZ	1.01
CA3028B	Premium Diff./Cascade Amp. DC to 120MHZ	1.29
CA3029	Wide Band Op. Amp. FT at 60MHZ	0.68
CA3029A	Precision Wide Band Op. Amp. FT at 60MHZ	0.80
CA3030	Wide Band Op. Amp. FT at 60MHZ	1.35
CA3030A	Premium Wide Band Op. Amp. FT at 60MHZ	2.00
CA3033	High Pwr. O/P Op. Amp. 1.2W	3.36
CA3034	Phase Detector	2.50
CA3035	Ultra Hi. Gain 3 Amp. ARR 129DB at 40KHZ	1.76
*CA3036	Dual Darlington Array	1.10
CA3038	Operational Amplifier	2.65
CA3038A	Operational Amplifier	3.68
CA3039	Diode Array	0.80
CA3040	Wide Band Amp. DC to 200MHZ	3.39
*CA3041	TV Sound Section/Driver—Tubes	1.49
*CA3042	TV Sound Section Dvr. Trans.	1.49
*CA3043	FM Receiver System to 20MHZ	2.01
CA3045	5 VHF Trans. Arr. DC to 120MHZ	1.40
*CA3046	5 Transistor Array (npn)	0.89
CA3047	Medium Pwr. Op. Amp. 0.75W	2.00
CA3047A	Premium Medium Pwr. Op. Amp. 0.75W	3.36
*CA3048	Quad-Low Noise Amp. NF 0.6DB	2.23
CA3049	Dual Differential Amp.	1.80
CA3050	Dual Differential Amp.	2.42
CA3051	Dual Differential Amp.	1.67
*CA3052	Quad-Audio Preamps 300KHZ BW	1.62
CA3053	Diff./Cascade Amp.	0.60
CA3054	Dual Differential Amp.	1.01
CA3059	Zero Voltage Trigger S.C.R., Triac	1.88
CA3062	Photo Det. and Pwr. Amp. 100MA O/P	3.41
*CA3064	Aft. System. Gen. Purpose and TV	1.64
*CA3065	Sound IF Amp. Det. DC Vol. Cont.	1.74
CA3068	TV Video IF System	3.46
*CA3070	TV Chrome Sig. Proc.	2.49
*CA3071	TV Chrome Amp.	2.31
*CA3072	TV Chrome Demod.	2.37
*CA3075	FM-IF Amp./Limited Det.	1.68
*CA3076	Hi Gain IF Amp./Limiter	1.93
CA3080	Op. Transconductance Amp.	0.75
CA3080A	Op. Transductance Amp.	1.88
*CA3086	Transistor Array (N-P-N)	0.60
*CA3088F	AM Receiver Sub. Sys. Network	1.70
*CA3089E	FM IF System	2.52
*CA3090Q	FM Stereo Multiplex Decoder	4.00
CA3130	FET Operational Amplifier	0.98
CA3140	FET Operational Amplifier	0.95
CD4000	Dual 3-Input NOR gate plus Inverter	0.24
CD4001	Quad 2-Input NOR Gate	0.24
CD4002	Dual 4-Input NOR Gate	0.24
CD4006	10-Stage Static Shift Register	1.34
CD4007	Dual Complementary Pair Plus Inverter	0.24
CD4008	4-Bit full Adder with Parallel Carry	1.10
CD4009	Hex Buffer/Converter (Inverting)	0.64
CD4010	Hex Buffer/Converter (Non-Inverting)	0.64
CD4011	Quad 2-Input NAND Gate	0.24
CD4012	Dual 4-Input NAND Gate	0.24
CD4013	Dual "D" Flip-Flop with Set/Reset	0.60
CD4014	8-Stage Static Shift Register	1.15
CD4015	Dual 4-Stage Static Shift Register	1.15
CD4D16	Quad Bilateral Switch	0.64
CD4017	Decade Counter/Divider	1.15
CD4018	Presettable Divide-By "N" Counter	1.15
CD4019	Quad AND-OR Select Gate	0.70
CD4020	1-Stage Binary Ripple Counter	1.27
CD4021	8-Stage Static Shift Register	1.15
CD4022	Divide-by-8 Counter/Divider	1.10
CD4023	Triple 3-Input NAND Gate	0.24
CD4024	7-Stage Binary Counter	0.84
CD4025	Triple 3-Input NOR Gate	0.24
CD4027	Dual J-K Master Slave Flip-Flop	0.64
CD4028	BCD-TO-Decimal Decoder	1.02
CD4029	Presettable Up/Down Counter	1.30
CD4030	Quad Exclusive-OR Gate	0.64
CD4031	64-Stage Static Shift Register	2.53
CD4035	4-Stage Parallel IN/OUT Shift Register	1.34
CD4037	Triple AND/OR Bi-Phase Pairs	1.10
CD4041	Quad True/Complement Buffer	0.96
CD4042	Quad Clocked "D" Latch	0.96
CD4043	Quad 3-State NOR R/S Latch	1.15
CD4044	Quad 3-State NAND R/S Latch	1.06
CD4045	21-Stage Counter	1.59
CD4046	Micropower Phase-Locked Loop	1.52
CD4047	Monostable/Astable Multivibrator	1.15
CD4049	Hex Buf./Con. (Invtg.)	0.64
CD4050	Hex Buf./Con. Non Inverting	0.64
CD4051	Single 7 Channel Multiplexer	1.06
CD4052	Differential 4 Channel Multiplexer	1.06
CD4053	Triple 2 Channel Multiplexer	1.06
CD4054	4-Line LIQ-XTAL Display Driver	1.32
CD4055	BCD 7 Segment Decoder/Driver	1.50
CD4056	BCD 7 Segment Decoder/Driver	1.50
CD4059	Programmable Divide-By-N Counter	5.45
CD4060	14 Stage Counter and Oscillator	1.27
CD4063	4 Bit Magnitude Comparator	1.25
CD4066	Quad Bilateral Switch	0.80
CD4067	1-16 Multiplexer	4.25
CD4068	8 Input NAND Gate	0.25
CD4069	Hex Inverter	0.25
CD4070	Quad Exclusive or Gate	0.66
CD4071	Quad 2 Input or Gate	0.25
CD4072	Dual 4 Input or Gate	0.25
CD4073	Triple 3 Input and Gate	0.25
CD4075	Triple 3 Input or Gate	0.25
CD4076	Quad "D" Type Flip Flop	1.17
CD4077	Quad Exclusive NOR Gate	0.66
CD4078	8 Input NOR Gate	0.25
CD4081	Quad 2 Input and Gate	0.25
CD4082	Dual 4 Input and Gate	0.25
CD4085	Dual 2 Wide 2 Input AOI Gate	0.81
CD4086	Expendable 4 Wide 2 Input AOI Gate	0.81
CD4089	Binary Rate Multiplier	1.77
CD4093	Quad 2 Input NAND Schmitt Trigger	0.91
CD4094	8 Bit Serial Parallel Holding Bus Register	2.13
CD4095	Gated J-K Flip Flop	1.19
CD4096	Gated J-K Flip Flop	1.19
CD4097	Dual 8-1 Multiplexer	4.25
CD4099	8 Bit Addressable Latch	2.09
CD4510	Presettable Up/Down Counter (BCD)	2.00
CD4511	Decade Counter/Driver 7 Segment	2.30
CD4516	Presettable Binary Up/Down Counter	2.00
CD4518	Dual BCD Up Counters	2.00
CD4520	Dual Binary Up Counters	2.00
DM8131	Hex Comparator	2.46
DM8280	Presettable Decade Counter	1.50
DM8281	Presettable Binary Counter	1.50
DM8288	Presettable Divide by Twelve Counter	1.50
DM8300	4-Bit Parallel-In-Out Shift Register	1.50
DM8601	Retriggerable Monostable Multivibrator	1.60
DM9601	Retriggerable Monostable Multivibrator	1.60
DM9097	Dula J-K Flip Flop Common Clock (2k)	0.80
DM9099	Dual J.K. Flip Flop Common Clock (6k)	0.80
FH101	8-Input NAND Gate without RC	2.50
FJL151	BCD-Decimal Decoder	1.50
FJY101	Dual 4-Input Expander	1.50
FJH111	TTL Dual 4/n NAND	2.50
LO05T1	5V-Voltage Reg. TO3 SGS	2.00
LM114H	High Gain Matched Dual Mono Lithic	2.59
*LM301AH	Improved Operational Amplifier TO99	0.67
*LM301-8	Improved Operational Amp. 8 Pin D.I.L.	0.40
LM304	Negative Voltage Regulator	2.45
LM307N	General Purpose Compensated Op. Amp.	0.65
*LM308H	Super Gain Op. Amp. TO5 Multi-Lead	1.82
*LM308N	Super Gain Op. Amp. 8 Pin D.I.L.	0.85
LM309K	5 Volt Regulator 1A. TO3 Case	1.85
LM317K	Three Term. Adjustable Positive Regulator	3.00
LM318N	High Slew Rate Op. Amp.	2.26
LM32DT-5	1.00 Amp. Negative 5 Volt Reg. TO220	2.86
LM32DT-12	1.00 Amp. Negative 12 Volt Reg. TO220	2.86
LM32DT-15	1.00 Amp. Negative 15 Volt Reg. TO220	2.86
LM32DT-24	1.00 Amp. Negative 24 Volt Reg. TO220	2.86
LM320MP-5	0.5 Amp. Negative 5 Volt Reg. TO202	1.30
LM320MP-12	0.5 Amp. Negative 12 Volt Reg. TO202	1.30
LM320MP-15	0.5 Amp. Negative 15 Volt Reg. TO202	1.30
LM320MP-24	0.5 Amp. Negative 24 Volt Reg. TO202	1.30
LM323K	Five Volt 3 Amp Regulator	6.46
LM339N	Quad Comparator	1.40
LM340T-5	Positive 3 Terminal 5 Volt Reg. 1A TO220	1.10
LM340T-12	Positive 3 Terminal 12 Volt Reg. 1A TO220	1.10
LM340T-15	Positive 3 Terminal 15 Volt Reg. 1A TO220	1.10
LM340T-24	Positive 3 Terminal 24 Volt Reg. 1A TO220	1.10
LM341P-5	Positive 3 Terminal 5 Volt Reg. 5A TO202	0.90
LM341P-12	Positive 3 Terminal 12 Volt Reg. 5A TO202	0.90
LM341P-15	Positive 3 Terminal 15 Volt Reg. 5A TO202	0.90
LM341P-24	Positive 3 Terminal 24 Volt Reg. 5A TO202	0.90
LM348N	Quad 741 Operational Amplifier	1.50
LM358N	Low Power Dual Operational Amplifier	0.70
LM360N	High Speed Comparator	2.75
*LM370N	AGC/Squelch Amplifier 14 Pin	2.50
*LM371H	Integrated RF/IF Amplifier	1.70
*LM372N	AF/IF Strip—Detector (14 Pin)	1.70
*LM373N	AM/FM/SSB Strip (14 Pin)	2.80
LM374N	AM/FM/SSB IF Video Amp.	3.10
*LM377N	Dual 2W Power Amp.	1.75
LM378N	Dual 4W Audio Amp.	2.25
*LM379S	Dual 6W Audio Amp.	3.95
*LM380N-8	0.6 Watt Audio Amplifier 8 Pin D.I.L.	0.90
*LM380N-14	2 Watt Audio Power Amp. 14 Pin D.I.L.	0.98
*LM381AN	Low Noise Dual Pre-Amp D.I.L. Package	2.45
*LM381N	Low Noise Dual Pre-Amp	1.60
LM382N	Low Noise Dual Pre-Amp	1.25
LM384N	5 Watt Audio Amp.	1.45
LM386N	Low Voltage Audio Amp.	0.80
LM387N	Low Noise Dual Pre-Amp	1.05
*LM388N	1.5 Watt Audio Amp.	0.90
*LM389N	Low Volt. Aud. pwr. amp. with NPN tran. array	1.00
*LM555CH	See NE555 atimer	0.40
*LM565CN	See NE565	1.10
LM701B	Operational Amplifier TO99	2.80
*LM701C	Operational Amplifier TO99	2.80
*LM702A	Wide Band D.C. Amp. Mil. Spec. TO99	2.80
*LM702C	Wide Band D.C. Amp. Commercial TO99	.75
*LM703LN	IF Limiting Amplifier	1.05
*LM709	Operational Amplifier TO5 Multi Lead	.65
*LM7D9-8	Operational Amplifier 8 Pin D.I.L.	.45
*LM709-14	Operational Amplifier 14 Pin D.I.L.	.45
LM710	Differential Comparator TO5	.60
LM710-14	Differntial Comparator 14 Pin D.I.L.	.60
*LM711CN	Differential Comparator — Dual 14 D.I.L.	.55
LM723C	Precision Voltage Reg. TO5	.85
LM723C-14	Precision Voltage Reg. 14 Pin D.I.L.	.75
*LM726	Temp. Controlled Diff. Pair T099	5.35
*LM733CN	14 Pin Video Amp.	1.35
*LM741C	Compensated Op. Amp. TO5	.65
*LM741C-8	Compensated Op. Amp. 8 D.I.L.	.40
*LM741C-14	Compensated Op. Amp. 14 D.I.L.	.40
*LM747CN	14 Pin D.I.L. Dual Comp. Op. Amp.	.90
*LM748-8	Operational Amp. 8 D.I.L.	.55
*LM748-14	Operational Amp. 14 D.I.L.	.55
LM716	National Semiconductor I/C Op. Amp.	.95
LM900	Buffer	.45
LM911	4-Input or NOR Gate	.45
LM921	Dual 2-Input Gate Expander	.45
LM923	J-K Flip Flop	.45
*LM1303N	Stereo Pre-Amp. (0.70°) MC1303	1.03
*LM1304N	F.M. Multiplexer Stereo Demodulator	1.40
*LM1305N	F.M. Multiplexer Stereo Demodulator	1.40
*LM1307N	F.M. Multiplexer Stereo Demodulator	1.10
*LM1310N	Stereo Demodulator NC 1310	1.91
*LM1351N	F.M. Detector Limiter and Audio Pre-Amp.	1.20
*LM1458N	Dual Comp. Op. Amp. (0-70°) 8 Pin D.I.L.	.91
*LM1496N	Balanced MOD/Demodulator (0.70°)	0.91
*LM1800N	PLL Demodulator	1.76
*LM1808N	Mono Lithic TV Sound System	1.92
LM1812N	Ultrasonic transceiver	5.69
*LM1820N	AM Radio	1.10
*LM1828N	Chroma Demodulator	1.75
LM1830N	Fluid level dector	1.72
*LM1841N	F.M. Detector Limiter	1.75
LM1845N	TV Signal Processor	1.35
LM1848N	Chroma Demodulator	1.80
LM1850N	Ground Fault Interrupter	1.75
LM1889N	TV video modulator	4.62
LM2907N-8	F to V converter	1.65
LM2917N-8	F to V convertor and zener	1.65
LM3302N	Quad Amplifier	.85
LM3302N	Quad Comparator	1.40
LM3401N	Quad Amplifier	.70
*LM3900N	Quad Amplifier D.I.L. 14 Pin	.75
LM3905N	Precision Timer	1.60
*LM3909N	Led Flisher/Oscillator D.I.L. 8 Pin	.68
LM4250CN	Programmable Op. Amp.	3.25
LM78L05CH	5 Volt Regulator TO5 100mA Positive	.92
LM78L12CH	12 Volt Regulator TO5 100mA Positive	.92
LM78L15CH	15 Volt Regulator TO5 100mA Positive	.92
LM78L24CH	24 Volt Regulator TO5 100mA Positive	.92
LM78L05KC	Positive 3 Terminal 5 Volt Reg. 1A TO3	1.75
LM78L12KC	Positive 3 Terminal 12 Volt Reg. 1A TO3	1.75
LM78L15KC	Positive 3 Terminal 15 Volt Reg. 1A TO3	1.75
LM78L24KC	Positive 3 Terminal 24 Volt Reg. 1A TO3	1.75
LM78L05CZ	Positive 3 Terminal 5 Volt Reg. 100fiA T092	.45
LM78L12CZ	Positive 3 Terminal 12 Volt Reg. 100fiA T092	.45
LM78L15CZ	Positive 3 Terminal 15 Volt Reg. 100fiA T092	.45
LM78L24CZ	Positive 3 Terminal 24 Volt Reg. 100fiA T092	.45
MC667P	DTL Delay Line — Variable	2.50
MC671P	Triple 3-Input NAND/NOR Gate ACTIVE Output	1.50
MC672P	Quad 2-Input NAND/NOR Gate — ACTIVE Output	1.50
MC717P	Quad 2-Input NOR Gate	1.50
MC724P	Quad 2-Input NOR Gate	1.90
MC789P	Hex Inverter	1.65
MC790P	Dual J-K Flip-Flop	2.75
MC798P	Dual 2-Input Buffer	2.00
MC799P	Dual Buffer	2.00
MC832P	Dual 4-Input NAND/NOR Buffer	.65
MC833P	Dual 4-Input Expander	.65
MC836P	Hex Inverter	.75
MC837P	Hex Inverter with Fast Rise Time	.75
MC838P	Synchronous 4 Bit Decade Counter	1.50
MC840P	Hex Inverter without Input Diodes	1.50
MC844P	Dual 4-Input NAND/NOR Power Gate	.65
MC846P	Quad 2-Input NAND/NOR Gate	.65
MC848P	Flip Flop with Set and Clear	1.00
MC849P	Quad 2-Input NAND/NOR — Fast Rise Time	.65
MC856P	Dual Flip Flop with Set Fast Rise Time	1.30
MC857P	Quad 2-Input NAND Buffer Gate	.75
MC861P	Dual 4-Input NAND/NOR Fast Rise Time	.75
MC1035P	Triple Line Receiver	1.75
*MC1327P	Dual Chroma Demodulator	1.54
MC1330P	3rd IF and Video Detector	1.00
*MC1350P	IF Amp Video AGC Range 60db	.90
*MC1352P	TV Vid IF Amp	1.10
*MC1433G	Operational Amp. Non-Comp	3.30
*MC1435G	Operational Amp. Non-Comp.	2.00
*MC1437L	Op. Amp. Dual Non-Comp	2.00
*MC1439G	Power Booster/Drivers	1.60
MC1440G	Operational Amplifier	1.50
MC1445G	Core-Memory-Sense Amplifier	1.95
*MC1455G	Wide Band Amplifier	1.70
*MC1456G	Op. Amp. Internally Compensated	2.50
MC1463R	Neg. Voltage Reg. ½A to -40V	3.70
MC1466L	Voltage and Current Reg.	5.25
MC1468L	Dual 115V Tracking Reg.	3.50
MC1469R	Positive Voltage Reg. ½A 2.5V 37V	2.80
MC1488L	Quad Line Driver	3.90
*MC1495L	Linear Four-Quadrant Multiplier Chip	5.00
*MC1496G	Balanced Mod./Demodulator	1.20
*MC1529G	Diff. Video Amplifier	6.50
*MC1545L	Frequency Amp. +AGC	5.75
*MC1550G	High Frequency Amp. +AGC	.80
*MC1552G	High Frequency Amp.	6.40
*MC1553G	High Frequency Amp.	6.40
MC4D24P	Dual Voltage Controlled Multivibrator	2.00
MC14000AE	See CD4000 Series CMOS	—
MC14553	3 Digit BCD Counter—MCMOS	6.00
MK50250	Digital Clock 1C 12 or 24 Hr. 7 Seg.	5.75
MM5314	Digital Clock 1C or 24 Hr. or 6 Digits	5.40
MM5316	Digital Clock 1C as above and Alarm (40 Pin)	5.40
MM5330N	4½ Digit Digital Voltmeter Chip	8.25
MM5865	Universal Timer	6.50
NE555	Precision Timer	.40
NE556	Dual Precision Timer	1.10
NE560D	Phase Locked Loop	1.10
NE560D	Phase Locked Loop	4.60
NE561	Phase Locked Loop	4.60
NE565	Phase Locked Loop	1.30
NE566CN	Voltage Controlled Oscillator	1.65
NE567CN	Tone Decoder Phase Locked Loop	1.80
SAS560	Switching Amp. for 4 Ch. Touch Switch	2.50
SASS570	Switching Amp. for 4 Ch. Touch Switch	2.50
SAS580	Touch tuner amplifier	2.20
SAS590	Touch tuner amplifier	2.20
SN7400N	Quad 2 Input Nand	.16
SN7401N	Quad 2 Input Nand O/C	.16
SN7402N	Quad 2 Input Nor	.16
SN7403N	Quad 2 Input Nand O/C	.16
SN7404N	Hex Inverter	.26
SN7405N	Hex Inverter O/C	.26
SN7406N	Hex Inverter/Buffer 30V O/P	.60
SN7407N	Hex Buffer 30V O/P	.60
SN7408N	Quad 2 Input Nand	.24
SN7409N	Quad 2 Input Nand O/C	.24
SN7401N	Triple 3 Input Nand	.20
SN7411N	Triple 3 Input and Gate	.26
SN7412N	Triple 3 Input Nand Schmitt	.21
SN7413N	Dual 4 Input Nand Schmitt	.60
SN7414N	Hex Inverter Schmitt	1.80
SN7416N	Hex Inverter/Buffer 15V O/C	.50
SN7417N	Hex Buffer 15V O/C	.50
SN7402N	Dual 4 Input Nand	.21
SN7423N	Expandable Dual 4 Input Nor Gate	.39
SN7425N	Dual 4 Input Nor-Strobe	.39
SN7427N	Triple 3 Input Nor	.39
SN743DN	8 Input Nand	.21
SN7432N	Quad 2 Input OR	.35
SN7437N	Quad 2 Input Nand Buffer	.55
SN7438N	Quad 2 Input Nand Buffer O/C	.55
SN7440N	Dual 4 Input Nand Buffer	.21
SN7441AN	BCD to Decimal Decoder/Driver	1.03
SN7442N	BCD-Decimal Decoder	.78
SN7445N	BCD-Decimal Decoder 30V O/C	1.35
SN7446AN	BCD-Seven Segment Decoder 30V	1.23
SN7447AN	BCD-Seven Segment Decoder 15V	1.10
SN7448N	BCD to 7 Segment Decoder/Driver	1.10
SN7450N	Dual-2-Wide-2-/Input A/O/1	.21
SN7451N	Dual-2-Wide-2-/Input A/O/1	.21
SN7453N	4-wide 2-Input A/O/1	.21
SN7454N	4-wide 2-Input A/O/1	.21
SN7460N	Dual 4-Input Expander	.21
SN7470N	J-K Flip-Flop (Nand Inputs)	.46
SN7472N	J-K Flip-Flop (Nand Inputs)	.34
SN7473N	Dual J-K Flip-Flop	.43
SN7474N	Dual D-Type Flip-Flop	.43
SN7475N	Quad Latch	.58
SN7476N	Dual J-K Flip-Flop	.51
SN7480N	Gated Full Adder	.45
SN7481N	16 Bit Memory	1.10
SN7482N	2 Bit Binary Full Adder	.67
SN7483N	4 Bit Binary Full Adder	1.33
SN7484N	Gated Input 16 Bit Memory	
SN748N	4 Bit Comparator	1.85
SN7486N	Quad Exclusive OR	.41
SN7491AN	Decade Counter	.61
SN7490AN	8 Bit Shift Register SISO	.98
SN7492N	Divide-By-12 Counter	.61
SN7493N	4 Bit Binary Counter	.61
SN7494N	4 Bit Shift Register PISO	.74
SN7495N	4 Bit Shift Register PIPO	.78
SN7496N	5 Bit Shift Register PIPO	1.03
SN7497N	6 Bit Binary Counter	4.60
SN74100N	Dual Quad Latch	1.15
SN74107N	Dual J-K Flip Flop	.43
SN74118N	Hex S-R Latch	.90
SN74119N	Hex S-R Latch	1.80

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SN74121N	Monostable Multivibrator	.49
SN74122N	Monostable Multivibrator	.45
SN74123N	Dual Monostable Multivibrator	.58
SN74141N	BCD-Decimal Decoder / Driver	1.03
SN74145N	BCD to Decimal Dec. / Driver	1.06
SN74150N	16 Bit Data Selector	1.66
SN74151N	8-Bit Data Selector	1.11
SN74153N	Dual 4-to 1-Line Selector	1.11
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SN74161AN	6 Synchronous Binary Counter	1.41
SN74162AN	Synchronous Decade Counter	1.41
SN74163AN	Synchronous Binary Counter	1.41
SN74164N	—Bit Shift Register SIPO	1.23
SN74165N	8 Bit Shift Register PISO	1.23
SN74167N	Synchronous Decade Decimal Rate Multiplier	3.70
SN74174N	Hex D-Type Flip-Flop	1.52
SN74175N	Quad D-Type Flip-Flop	1.35

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SN74176N	Decade Counter	1.23
SN74177N	Binary Counter	1.23
SN74180N	8 Bit Parity Generator	1.77
SN7418N	4 Bit Arithmetic Logic Unit	3.70
SN74182N	Carry Look Ahead	1.08
SN74184N	BCD to Binary Converter	2.46
SN74185AN	BCD to Binary Converter	2.46
SN7418BAN	256 Bit Field Prog Rom	2.46
SN74189N	TR1 State 64 Bit Ram (DM8599)	3.99
SN74190N	Synch. Decade Up / Down Counter	1.91
SN74191N	Synchronous Binary Up / Down Counter	1.91
SN74192N	Reversible Decade Counter	1.62
SN74193N	Reversible Binary Counter	1.62
SN74196N	Decade Counter	1.17
SN74197N	Binary Counter	1.17
SN74198N	Parallel In and Out 8 Bit Shift Reg.	2.93
SN74199N	Parallel In and Out 8 Bit Shift Reg	2.93
SAJ110	Frequency divider for electronic organs	1.84
SO41P	FM if amplifier & demodulator	1.25
SO42P	Mixer to 200MHz	1.25

SN74H00N	High Speed TTL	.50
SN74H01N	High Speed TTL	.50
SN740H04N	High Speed TTL	.55
SN74H05N	High Speed TTL	.55
SN74H10N	High Speed TTL	.50
SN74H11N	High Speed TTL	.57
SN74H20N	High Speed TTL	.50
SN74H21N	High Speed TTL	.57
SN74H30N	High Speed TTL	.50
SN75H40N	High Speed TTL	.50
SN74H51N	High Speed TTL	.50
SN74H53N	High Speed TTL	.50
SN74H54N	High Speed TTL	.50
SN74H55N	High Speed TTL	.57
SN74H60N	High Speed TTL	.50
SN74H62N	High Speed TTL	.50
SN74S00	Shottky TTL	.71
SN74S03	Schottky TTL	.71
SN74S04	Schottky TTL	.85
SN74S10	Schottky TTL	.71
SN74S20	Schottky TTL	.71
SN74S40	Schottky TTL	.71
SN74S64	Schottky TTL	.71
SN74S65	Schottky TTL	.71
SN74S112	Schottky TTL	1.56
SN74S114	Schottky TTL	1.56
SN74S140	Schottky TTL	1.17
SN74S287	256 x 4 Prom	5.33
SN74L00	Low Power TTL	.50
SN74L02	Low Power TTL	.50
SN74L04	Low Power TTL	.55
SN74L47	Low Power TTL	3.73
SN74L74	Low Power TTL	.83
SN74L85	Low Power TTL	3.23
SN74L93	Low Power TTL	2.51
SN74LS00	Low Power Schottky TTL	.24
SN74LS02	Low Power Schottky TTL	.24
SN74LS04	Low Power Schottky TTL	.27
SN74LS08	Low Power Schottky TTL	.24
SN74LS10	Low Power Schottky TTL	.24
SN74LS13	Low Power Schottky TTL	.65
SN74LS32	Low Power Schottky TTL	.25
SN74LS42	Low Power Schottky TTL	1.01
SN74LS74	Low Power Schottky TTL	.48
SN74LS75	Low Power Schottky TTL	.60
SN74LS76	Low power Schottky TTL	.40
SN74LS85	Low power Schottky TTL	1.45
SN74LS86	Low power Schottky TTL	.48
SN74LS90	Low power Schottky TTL	1.00
SN74LS92	Low power Schottky TTL	.90
SN74LS107	Low power Schottky TTL	.44
SN74LS138	Low power Schottky TTL	1.27
SN74LS151	Low power Schottky TTL	1.13
SN74LS157	Low power Schottky TTL	1.17
SN74LS160	Low power Schottky TTL	1.40
SN74LS161	Low power Schottky TTL	1.50
SN74LS162	Low power Schottky TTL	1.50
SN74LS162	Low power Schottky TTL	1.50
SN74LS163	Low power Schottky TTL	1.50
SN74LS164	Low power Schottky TTL	1.52
SN74LS173	Low power Schottky TTL	2.35
SN74LS174	Low power Schottky TTL	1.20
SN74LS175	Low power Schottky TTL	1.20
SN74C00	CMOS pin for pin TTL	.26
SN74C02	CMOS pin for pin TTL	.26
SN74C04	CMOS pin for pin TTL	.26
SN74C08	CMOS pin for pin TTL	.26
SN74C10	CMOS pin for pin TTL	.26
SN74C20	CMOS pin for pin TTL	.26
SN74C30	CMOS pin for pin TTL	.26
SN74C32	CMOS pin for pin TTL	.26
SN74C42	CMOS pin for pin TTL	.92
SN74C48	CMOS pin for pin TTL	2.30
SN74C73	CMOS pin for pin TTL	.58
SN74C74	CMOS pin for pin TTL	.59
SN74C76	CMOS pin for pin TTL	.58
SN74C85	CMOS pin for pin TTL	1.90
SN74C86	CMOS pin for pin TTL	.98
SN74C90	CMOS pin for pin TTL	.91
SN74C107	CMOS pin for pin TTL	1.30
SN74C151	CMOS pin for pin TTL	2.62
SN74C157	CMOS pin for pin TTL	2.35
SN74C160	CMOS pin for pin TTL	1.18
SN74C161	CMOS pin for pin TTL	1.18
SN74C162	CMOS pin for pin TTL	1.18
SN74C163	CMOS pin for pin TTL	1.18
SN74C164	CMOS pin for pin TTL	1.04
SN74C173	CMOS pin for pin TTL	.95
SN74C174	CMOS pin for pin TTL	.95
SN74C175	CMOS pin for pin TTL	.95
SN75451BP	Dual Peripheral Drivers	
SN75452BP	Dual Peripheral Drivers	

SN76001N	1 Watt Power Amplifier	1.30
SN76003N	Audio Amp & HT Sink 4W. 35V. 15R	2.20
SN76008KE	10 Watt Audio Amp 5 Pin	1.50
SN76013N	Audio Amp and HT Sink 4W. 24V. 8R	1.50
SN76012ND	As above, no HT Sink	1.30
SN76018KE	10 Watt Audio Amp. 5 Pin	1.50
SN76023N	Audio Amp. and HT Sink 4W. 24V. 8R	1.45
SN76023ND	As above, without HT Sink	1.26
SN76033N	Audio Amp and HT Sink	2.20
SN76110N	Stereo Demodulator	1.18
SN76115N	Stereo Demodulator	1.51
SN76116M	Stereo Decoder (Radiogram)	1.66
SN76131N	Dual Preamplifier	1.20
SN76226N	Colour (Pal) Decoder	1.56
SN76227N	Colour (Pal) Decoder	1.20
SN76228N	Colour (Pal) Decoder	1.41
SN76530N	Video IF	.75
SN76532N	Line Frame Processor (Spares Only)	1.40
SN76533N	Line Frame Processor (Spares Only)	1.20
SN76544N	Line Frame Processor	1.44
SN76545N	Line Frame Processor	1.65
SN76546N	Line Frame Processor	1.44
SN76550-2	Tuner Control Voltage Stabilis	.35
SN76552-2	Tuner Control Voltage Stabiliser	.52
SN76570N	Video IF	1.65
SN76620AN	Sound IF	.90
SN76650N	Video IF	1.10
SN76660N	Sound IF	.60
SN76666N	Sound IF	.92

SL610C	RF Amplifier	2.50
SL611C	RF Amplifier	2.50
SL612C	IF Amplifier	2.50
SL620C	Vogad	3.50
SL621C	AGC Generator	3.50
SL623C	AM Det & AGC Amp + SSB Demod	5.75
SL630C	AF Amplifer	2.35
SL640C	Double Balanced Modulator	4.00
SL641C	Receiver Mixer	4.00
SL701C	Operational Amplifier	2.00
TAA263	100mW A.F. Amp 8V	1.25
TAA300	1WAF Amplifier 4.5 — 9V	2.67
TAA320A	MOS IF Preamplifier	1.00
TAA350A	Wide Band Differential Amp	2.48
TAA521	Operational Amplifier	1.00
TAA522	Operational Amplifier	1.90
TAA550	Voltage Stabiliser 31-35V	.60
TAA560	Level Control Amplifier	1.75
TAA570	4 Stage Limiter Amp FM Detector	2.30
TAA370A	Hearing aid amplifier	2.88
TAA630	Synchronous demodulator (PAL)	3.91
TAA960	Triple amp for active filters	2.02
TAA970	Microphone amp TO74	2.25
TCA105	Threshold switch	1.36
TCA440	AM receiver circuit	1.52
TCA640	Chroma amp for Pal / Secam receivers	2.51
TCA650	Chroma demodulator Pal / Secam receivers	2.51
TCA660	Contrast saturation control receivers	2.51
TCA820	Wideband double balanced mod / demod	2.99
TCA980	Microphone amp (TO12)	2.34
TDA1022	Bucket Brigade delay line	6.23
TDA1024	Triac control I C	.88
TDA1034	High performance op. amp	1.80
TDA2540	VID IF amp & detector	2.99
TAA611B	3 Watt Audio Amplifer	1.85
TAA621	4 Watt 24V Audio Amplifier	2.15
TAA661A	Limiting IF Amp. / FM Detector	1.50
TAA661B	Limiting IF AmpsFM Detector	1.50
TAA700	TV Signal Processing Circuit	3.91
TAA930A	IF Amp-Limiter FM Demod	1.30
TAA930B	IF Amp Limiter FM Demond	1.30
TAD100	Pre-amp Stages of AM Receiver	1.95
	Filter for FM Reception—Filter Price	0.85
T8A120	Limiting IF Amp / FM Detector	.75
T8A231	Dual Operation Amplifier	1.20
T8A400	Adjustable Broadband Amplifier	2.00
T8A500	Colour Processing-TV Luminence Combination	2.21
T8A500Q	Quad-in-Line Version of above	2.30
T8A510	Colour Processing—Chrominance Comb	2.21
T8A510Q	Quad-in-Line Version of above	2.30
T8A520	Colour Demodulation Circuit	2.21
T8A520Q	Q11 Version of above	2.30
T8A530	R G B Matrix Preamplifier	1.98
T8A530Q	Q I L Version of above	2.07
T8A540	Reference Oscillator Circuit	2.21
T8A540Q	Q I L Version of above	2.30
T8A550	Signal Processing—TV Receivers	3.13
T8A550Q	Q I L Version of above	3.22
T8A560CQ	Luminance & Chrome Control	3.22
T8A570	AM / FM Radio Receiver Circuit 6V	1.29
T8A570Q	Q I L Version of above	1.38
T8A641B	Audio Power Amp 4 5W (1kV-4R)	2.70
T8A651	Tuner and IF Amplifier	2.20
T8A700	AM / FM Radio Receiver 1W Output	1.52
T8A700Q	Q I L Version of above	1.61
T8A720AQ	Line Oscillator combination for TV	2.30
T8A750	Limiter Amp & FM Det D C Vol Control and Preamp	1.98
T8A750Q	Q I L Version of above	2.07
T8A800	5 Watt Audio Amp 24V 16R	1.25
T8A810	7 Watt Audio Amp 16V 4R	1.25
T8A820	2 Watt Audio Amp 12V 8R	1.25
T8A920	Line Oscillator Combination (Mullard)	2.90
T8A920Q	Line Oscillator Combination (Mullard)	2.99
T8A940	Pulse Separation & Line Sync in TV Rec	1.62
T8A990Q	I C Colour Demodulator for TV	3.00
TCA160C	Audio Amp 2 watt battery op 5 16V and Ht Sink	1.85
TCA1608	Audio Amp 2 Watt Battery Op 5-16V D I L	1.61
TCA270	Synchronous Demodulator & Processing	2.25
TCA280A	Trigger I C for Thyristors & Triacs	1.30
TCA290A	Stereo Decoder for F.M. 15V Supply	3.13
TCA420A	10 7MHZ Limiter I.F. Amp for F.M. Recept	1.84
TCA730	D C Stereo Audio Vol & Balance Circuit	3.22
TCA740	D C Stereo Audio Tone Control Circuit	2.76
TCA750	Multi-Stabilizer for Elec Tuning	2.30
TCA760	Audio Amp Battery Op. 4-14V 1 Watt 16DIL	1.38
TCA800	I C Colour Demod. with Feed Back Clamps for TV	3.13
TDA1002	I C Tape Recorder Circuit Preamp & Record Amp	1.61
TDA1003	I C Tape Recorder-Motor Regulator Bias Erase and Stop	1.38
TDA1004		2.48
TDA1005	Phase locked loop Stereo Decoder F.M.	2.76
TDA2610	4-7 Watt Sound Output Circuit for TV Rec	2.60
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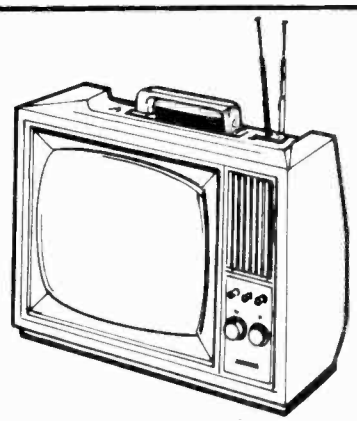

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2G345A	P54	.65
2G371	P54	.65
2G374	P54	.65
2G374B	P54	.65
2G381A	P54	.50
2G417	P70	.60
2G425	N73	.65
2N174	P58	3.00
2N335	N70	2.75
2N388	N70	.75
2N388A	N70	.70
2N398	P70	.75
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2N489A	U71	5.00
2N489B	U71	5.50
2N490	U71	4.60
2N490B	U71	5.90
2N490C	U71	6.32
2N491	U71	5.00
2N491A	U71	5.33
2N491B	U71	5.70
2N491	U71	6.90
2N492	U71	5.75
2N492A	U71	6.20
2N492B	U71	7.13
2N492C	U71	9.20
2N493A	U71	7.36
2N493B	U71	8.05
2N494	U71	6.32
2N494A	U71	7.00
2N494B	U71	7.70
2N494C	U71	8.62
2N549	N70	3.00
2N681	THY72	2.00
2N696	N70	.35
2N697	N70	.30
2N698	N70	.62
2N699	N70	.55
2N706	N70	.28
2N706A	N70	.28
2N708	N70	.28
2N709	N70	.50
2N718	N70	.27
2N718A	N70	.50
2N720A	N70	.80
2N721	P70	.95
2N722	P70	.30
2N727	P70	1.50
2N744	N70	.28
2N753	N70	.28
2N760	N70	.28
2N869	P70	.68
2N914	N70	.35
2N916	N70	.30
2N917	N65	.35
2N918	N65	.38
2N929	N70	.25
2N929A	N70	.30
2N930	N70	.26
2N930A	N70	.30
2N976	P70	.50
2N1131	P70	.30
2N1132	P70	.37
2N1204	P70	1.50
2N1300	P70	.90
2N1302	N70	.70
2N1303	P70	.70
2N1304	N70	.70
2N1305	P70	.70
2N1306	N70	.85
2N1307	P70	.85
2N1308	N70	.95
2N1309	P70	.95
2N1370	P70	.45
2N1420	N70	.45
2N1483	N70	1.70
2N1485	N70	2.00
2N1507	N70	.55
2N1524	P54	.55
2N1553	P66	1.30
2N1613	N70	.30
2N1637	P70	.75
2N1638	P54	.65
2N1671A	U71	2.30
2N1671B	U71	2.45
2N1671C	U71	4.98
2N1700	N70	1.50
2N1702	N66	3.50
2N1711	N70	.30
2N1889	N70	.35
2N1890	N70	.36
2N1893	N70	.38
2N1907	P66	5.50
2N1974	N70	.90
2N1990	N70	1.32
2N1991	P70	.98
2N2060	N73	5.00
2N2102	N70	.98
2N2147	P66	1.40
2N2160	U71	1.40
2N2192	N70	.49
2N2193	N70	.44
2N2193A	N70	.45
2N2194	N70	.36
2N2194A	N70	.39
2N2195	N70	.45
2N2195A	N70	.45
2N2217	N70	.53
2N2218	N70	.33
2N2218A	N70	.37
2N2219	N70	.35
2N2219A	N70	.36
2N2220	N70	.35
2N2221	N70	.25
2N2221A	N70	.26
2N2222	N70	.25
2N2222A	N70	.25
2N2223	N73	3.60
2N2223A	N73	4.30
2N2270	N70	.45
2N2303	P70	.45
2N2368	N70	.25
2N2369	N70	.25
2N2369	N70	.25
2N2405	N70	1.00
2N2410	N70	1.30
2N2411	P70	2.75
2N2412	P70	2.75
2N2476	N70	1.30
2N2477	N70	1.00
2N2483	N70	.30
2N2484	N70	.30
2N2491	P58	2.20
2N2613	P59	.80
2N2614	P59	.60
2N2646	U71	.75
2N2647	U71	1.40
2N2696	P70	1.20
2N2711	N50	.25
2N2712	N50	.16
2N2713	N50	.23
2N2714	N50	.20
2N2848	N70	1.00
2N2865	N75	2.00
2N2890	N70	3.80
2N2891	N70	3.80
2N2892	N70	9.90
2N2894	P70	.30
2N2903	N73	1.45
2N2904	P70	.36
2N2904A	P70	.37
2N2905	P70	.37
2N2905A	P70	.38
2N2906	P70	.28
2N2906A	P70	.35
2N2907	P70	.25
2N2907A	P70	.25
2N2920	N73	3.00
2N2923	N50	.14
2N2924	N50	.15
2N2925	N50	.17
2N2926G	N50	.15
2N2926Y	N50	.15
2N29260	N50	.15
2N3010	N70	.95
2N3011	N70	.30
2N3012	P70	.35
2N3013	N70	.35
2N3014	N70	.50
2N3015	N70	.45
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2N3020	N70	.48
2N3053	N70	.26
2N3054	N28	.60
2N3055	N66	.70
2N3107	N70	.50
2N3108	N70	.60
2N3109	N70	.55
2N3119	P70	3.75
2N3133	P70	.45
2N3134	P70	.45
2N3135	P70	.35
2N3136	P70	.35
2N3232	N66	1.35
2N3242	N70	.60
2N3242A	N70	.80
2N3250	P70	.30
2N3251	P70	.36
2N3300	N70	.40
2N3301	N70	.40
2N3302	N70	.35
2N3367	NF76	1.20
2N3390	N50	.20
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2N3391A	N50	.20
2N3392	N50	.16
2N3393	N50	.15
2N3394	N50	.15
2N3395	N50	.21
2N3396	N50	.21
2N3397	N50	.24
2N3402	N57	.40
2N3404	N57	.45
2N3405	N57	.45
2N3414	N50	.15
2N3415	N50	.17
2N3416	N50	.23
2N3417	N50	.40
2N3420	N70	8.60
2N3439	N70	.88
2N3440	N70	.64
2N3441	N28	.85
2N3442	N66	1.35
2N3444	N70	1.20
2N3445	N66	5.90
2N3446	N66	8.90
2N3447	N66	9.50
2N3448	N66	11.50
2N3468	P70	.50
2N3507	N70	9.00
2N3512	N70	1.00
2N3553	N70	2.99
2N3563	N54	.20
2N3564	N54	.20
2N3565	N54	.20
2N3566	N70	.20
2N3567	N70	.20
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2N3570	N65	6.50
2N3571	N65	3.70
2N3572	N65	3.50
2N3583	N66	1.10
2N3584	N66	1.23
2N3585	N66	1.40
2N3605	N50	.17
2N3606	N50	.17
2N3607	N50	.16
2N3632	N10	11.50
2N3638	N70	.16
2N3638A	P70	.16
2N3639	P70	.30
2N3640	P70	.23
2N3641	N70	.20
2N3642	N70	.20
2N3643	N70	.35
2N3644	P70	.37
2N3645	P70	.35
2N3646	N54	.24
2N3662	N50	.23
2N3663	N50	.26
2N3690	N59	.40
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2N3692	N54	.40
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2N3702	N50	.13
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2N3707	N50	.18
2N3708	N50	.13
2N3709	N50	.15
2N3710	N50	.16
2N3711	N50	.16
2N3712	N70	1.20
2N3713	N66	2.30
2N3714	N66	2.45
2N3715	N66	2.55
2N3716	N66	3.00
2N3724	N70	.70
2N3725	N70	.93
2N3732	P66	1.75
2N3734	N70	1.00
2N3735	N70	6.50
2N3738	N66	1.20
2N3740	P28	1.80
2N3741	P28	1.90
2N3766	N28	1.37
2N3767	N28	1.60
2N3771	N66	1.95
2N3772	N66	2.00
2N3773	N66	2.90
2N3779	P70	6.00
2N3789	P66	2.90
2N3790	P66	3.10
2N3791	P66	3.10
2N3792	P66	3.50
2N3794	N77	.20
2N3819	NF78	.36
2N3820	PF78	.38
2N3821	NF79	1.00
2N3822	NF79	.90
2N3823	NF79	.80
2N3824	NF79	.70
2N3826	N50	1.50
2N3827	N50	.25
2N3831	N70	4.50
2N3854A	N50	.25
2N3855	N50	.25
2N3855A	N50	.25
2N3856A	N50	.25
2N3858	N50	.20
2N3858A	N50	.20
2N3859	N50	.21
2N3859A	N50	.21
2N3860	N50	.18
2N3866	N70	1.80
2N3877	N50	.26
2N3877A	N50	.28
2N3879	N66	1.95
2N3900	N50	.28
2N3901	N50	.28
2N3902	N66	6.00
2N3903	N57	.21
2N3904	N57	.21
2N3905	N57	.22
2N3906	N57	.22
2N3945	N70	.56
2N3962	P70	.85
2N3993	PF80	3.30
2N4030	P67	.48
2N4031	P67	.50
2N4032	P70	.60
2N4033	P67	.60
2N4036	P70	.67
2N4037	P70	.55
2N4058	P50	.20
2N4059	P50	.15
2N4060	P50	.20
2N4061	P50	.17
2N4062	P50	.18
2N4064	N81	1.20
2N4074	N70	2.40
2N4091	NF79	1.20
2N4092	NF79	.75
2N4093	NF79	1.00
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2N4871L	U85	.47
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2N4889	P59	.70
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2N4902	P66	2.00
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2N4908	P66	6.50
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2N5182	N20	.65
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2N5220	N57	.14
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2N5355	P41	.18
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2N6107	P67	.42
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2N6111	P67	.45
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2N6122	N67	.41
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2S103	N70	.75
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2S304	P70	2.50
2S305	P70	2.00
2S306	P70	2.95
2S307	P70	3.30
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2S324	P70	1.75
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2S703	N70	3.95
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2S745A	N70	3.50
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40316	N28	.85
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40406	P70	.66
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40410	P70	.75
40411	N66	2.85
40412	N68	.62
40414	N65	4.65
40422	N66	2.00
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40447	P70	3.00
40462	P66	.82
40467A	NF82	.95
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40513	N84	1.45
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40543	N84	1.35
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40595	P70	.90
40600	NF92	.75
40601	NF92	.75
40602	NF92	.55
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40608	N70	1.50
40625	N68	.55
40626	P66	.95
40631	N38	.65
40632	N38	.85
40633	N84	1.10
40635	N70	.53
40636	N66	1.25
40673	NF92	.75
40669	TR196	1.20
40822	NF92	.60
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AC126	P69	.45
AC127	N69	.45
AC128	P69	.45
AC151	P69	.40
AC152	P69	.50
AC153	P69	.55
AC153K	P70	.55
AC176K	N70	.65
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AC188K	P70	.60
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ACY21	P70	.80
ACY22	P70	.60
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ACY30	P70	.80
ACY44	P70	.80
A0136	P59	2.50
A0142	P66	1.30
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A0149	P66	2.60
A0150	P66	2.90
AD161	N66	1.00
AD162	P66	1.00
AF106	P65	.55
AF109	P65	.75
AF114	P64	.65
AF115	P64	.65
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AF117	P64	.65
AF118	P64	.65
AF124	P20	.65
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AF126	P20	.65
AF139	P65	.89
AF172	P98	.65
AF178	P64	1.20
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AF239	P65	.65
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ASY28	N70	1.20
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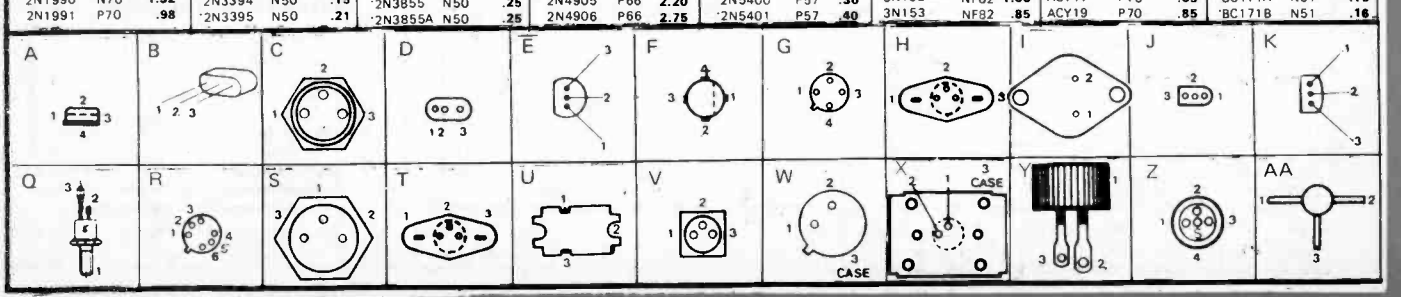

PRICE LIST AND DATA

MARSHALL'S

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BC178	P70	.20
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BCY79	P70	.40
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BCZ10	P68	1.50
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BD132	P67	.54
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BD158	N37	.65
BD159	N37	.65
BD160	N66	2.50
BD181	N66	1.60
BD182	N66	1.90
BD183	N66	2.10
BD187	N37	.87
BD201	N67	.95
BD202	P67	1.05
BD203	N67	1.00
BD204	P30	1.15
BD220	N67	.60
BD221	N67	.60
BD222	N67	.60
BD223	P67	.68
BD224	P32	.68
BD232	N37	.68
BD233	N37	.40
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BD237	N37	.40
BD238	P37	.40
BD239A	N37	.40
BD239C	N37	.55
BD240A	P37	.45
BD240C	P37	.55
BD241A	N37	.45
BD241C	N37	.60
BD242A	P37	.50
BD242C	P37	.57
BD243A	N37	.60
BD243C	N37	.80
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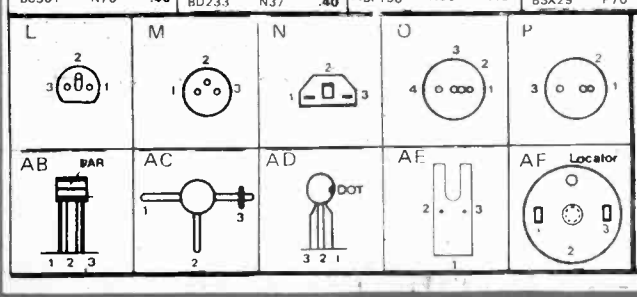
BD244C	P37	.80
BD245A	N37	.65
BD245C	N37	.78
BD246A	P37	.66
BD246C	P37	.85
BD249A	N37	2.20
BD249C	N37	2.75
BD250A	P37	2.50
BD250C	P37	3.10
BD370A	P57	.25
BD370D	P57	.30
BD371A	N57	.25
BD371D	N57	.30
BD372A	P67	.25
BD372D	P67	.30
BD373A	N67	.25
BD373D	N67	.30
BD433	N37	.40
BD434	P37	.42
BD435	N37	.42
BD436	P37	.42
BD437	N37	.50
BD438	P37	.50
BD441	P37	.40
BD442	P37	.40
*BD529	N102	.45
*BD530	P102	.50
BD535	N36	.65
BD536	P36	.65
BD537	N36	.68
BD538	P36	.70
BD539	P36	.55
BD540	P36	.55
BD581	N67	1.00
BD582	P67	1.20
BD675	ND4	.55
BD676	PD4	.60
BD677	NP4	.65
BD678	PD4	.75
BDX14	P28	1.20
BDX18	P66	1.70
BDY11	N66	3.00
BDY17	N66	3.00
BDY18	N66	3.50
BDY20	N66	1.00
BDY23	N66	2.23
BDY24	N66	2.40
BDY25	N66	2.60
BDY38	N66	1.00
BDY55	N66	1.74
BDY56	N66	1.90
BDY57	N66	5.40
BDY58	N66	6.00
BDY60	N66	1.50
BDY61	N66	2.50
BDY62	N66	2.50
BDY92	N66	2.40
BF115	N20	.38
BF119	N70	1.00
BF121	N19	.55
BF123	N19	.55
BF134	N59	.55
BF137	N70	.55
BF152	N54	.25
BF153	N54	.25
BF154	N54	.25
BF157	N70	.44
BF159	N54	.35
BF160	N54	.30
BF161	N65	.60
BF166	N65	.40
BF167	N20	.35
BF170	N70	.70
BF173	N20	.35
BF177	N70	.25
BF178	N70	.25
BF179	N70	.30
BF180	N65	.35
BF181	N65	.35
BF182	N65	.35
BF183	N65	.40
BF184	N20	.38
BF185	N20	.35
*BF194	N60	.15
*BF195	N60	.15
*BF196	N60	.15
*BF197	N60	.17
*BF198	N52	.18
*BF199	N52	.18
BF200	N65	.35
*BF224J	N18	.20
*BF225J	N18	.25
BF238	N18	.50
BF240	N52	.22
BF241	N52	.22
*BF244A	NF78	.35
BF244B	NF78	.30
*BF245A	NF103	.40
*BF245B	NF103	.40
*BF246A	NF78	.75
BF246B	NF78	.75
BF247A	NF78	.45
BF247B	NF78	.45
BF254	N52	.24
BF255	N52	.24
BF257	N70	.37
BF258	N70	.45
BF259	N70	.49
BF262	N99	.62
BF263	N99	.68
BF270	N65	.50
BF271	N65	.25
BF273	N53	.50
BF274	N53	.50
*BF324	P51	.32
*BF336	N70	.38
*BF337	N70	.45
*BF338	N70	.48
*BF355	N70	.49
*BF362	N104	.49
*BF363	N104	.49
BF450	P52	.22
BF451	P52	.22
*BF457	N2	.40
*BF458	N2	.45
*BF459	N2	.50
*BFR39	N50	.28
*BFR40	N37	.27
*BFR41	N37	.28
*BFR79	P50	.28
*BFR80	P50	.27
*BFR91	P50	.28
BFS21A	NF79	2.60
BFS28	NF79	1.38
*BFS61	N48	.30
*BFS98	P48	.30
BFW10	NF79	.75
BFW11	NF79	.75
BFW30	N65	2.25
BFW43	P70	1.50
BFW59	N61	1.60
BFW87	P61	1.60
BFW90	P61	1.60
BFX12	P70	.32
BFX13	P70	.30
BFX19	N65	.45
BFX20	N65	1.00
BFX29	P70	.35
BFX30	P70	.35
BFX34	N70	.60
BFX37	P70	.45
BFX68	P70	1.00
BFX84	N70	.35
BFX85	N70	.35
BFX86	N70	.30
BFX87	P70	.30
BFX88	P70	.30
BFX89	N70	1.25
BFY10	N70	1.00
BFY18	N70	1.00
BFY19	N70	1.00
BFY20	N73	1.00
BFY37	N70	1.00
BFY39	N70	.35
BFY41	N70	.80
BFY50	N70	.25
BFY51	N70	.25
BFY52	N70	.30
BFY53	N70	.34
BFY72	N70	.90
BFY75	N70	.70
BFY76	N70	1.00
BFY90	N65	1.20
BR101		.50
BRY30	THY106	.50
BRY39	SCS90	.50
*BRY56	THY106	.35
BSW41	N70	1.50
BSW66	N70	.82
BSW67	N70	.90
BSW68	N70	.98
BSW70	N70	1.50
BSX19	N70	.33
BSX20	N70	.33
BSX21	N70	.32
BSX26	N70	.80
BSX27	N70	.75
BSX29	P70	.48
BSX39	N70	1.10
BSX60	N70	.65
BSX61	N70	.48
BSX76	N70	.55
BSX77	N70	.55
BSY10	N70	1.00
BSY24	N70	.48
BSY25	N70	.60
BSY26	N70	.50
BSY27	N70	.50
BSY28	N70	.40
BSY29	N70	1.00
BSY38	N70	.30
BSY39	N70	.30
BSY51	N70	.30
BSY52	N70	.30
BSY53	N70	.30
BSY54	N70	.33
BSY65	N70	.40
BSY78	N70	.92
BSY79	N70	1.30
BSY95A	N70	.34
*BU104	N66	1.65
*BU105	N66	1.40
*BU126	N66	1.90
*BU204	N66	2.02
*BU205	N66	2.20
*BU206	N66	2.50
*BU208	N66	2.50
*ME0401	P54	.20
*ME0402	P54	.20
*ME0404	P54	.15
*ME0411	P54	.20
*ME0412	P54	.20
*ME0413	P54	.15
*ME0414	P54	.20
*ME0461	P54	.25
*ME0462	P54	.25
*ME1001	N54	.15
*ME1002	N54	.15
*ME1075	N54	.20
*ME1100	N54	.20
*ME1120	N54	.25
*ME3002	N54	.25
*ME4001	N54	.15
*ME4002	N54	.15
*ME4003	N54	.15
*ME4101	N54	.10
*ME4102	N54	.10
*ME4103	N54	.10
*ME4104	N54	.10
*ME6001	N54	.15
*ME6002	N54	.15
*ME6003	N54	.15
*ME6101	N54	.20
*ME6102	N54	.20
*ME8001	N70	.20
*ME8002	N70	.20
*ME8003	N70	.20
*ME9001	N54	.20
*ME9002	N54	.20
MJ400	N66	1.30
MJ430	P70	1.30
MJ481	N66	1.55
MJ490	P66	1.35
MJ491	P66	1.85
MJ901	PD66	2.25
MJ1001	ND66	1.90
MJ2500	PD66	2.45
MJ2501	PD66	2.50
MJ2955	P66	1.25
MJ3000	ND66	1.95
MJ3001	ND66	2.15
MJ4502	P66	4.50
*MJE340	N37	.58
MJE370	P37	.58
MJE371	P37	.60
*MJE520	N37	.45
MJE521	N37	.65
MJE2955	P67	1.50
MJE3055	N32	.95
MM8111	N111	.35
MP8112	N111	.40
MP8113	N111	.45
MP8121	N111	.35
MP8122	N111	.40
MP8123	N111	.45
MP8513	N111	.45
*MPF102	NF86	.30
MPF103	NF86	.40
*MPF104	NF86	.40
MPF105	NF86	.40
*MPF111	NF86	.28
*MPF112	NF86	.28
MPS005	N57	1.00
*MPS3563	N57	.18
*MPS3638	P57	.20
*MPS3640	P57	.21
*MPSA05	N57	.25
*MPSA06	N57	.25
*MPSA10	N57	.20
*MPSA12	ND57	.40
MPSA14	ND57	.30
MPSA16	N57	.20
MPSA18	N57	.20
MPSA55	P57	.25
MPSA56	P57	.25
MPSL01	N57	.29
MPSL51	P57	.29
MPSU01	N36	.45
MPSU05	N36	.50
MPSU06	N36	.56
MPSU07	N36	.55
MPSU51	P36	.50
MPSU55	P36	.55
MPSU56	P36	.60
MPSU57	P36	.65
OC20	P66	3.40
OC22	P66	3.00
OC24	P66	2.75
OC25	P28	2.75
OC26	P66	1.50
OC28	P66	2.00
OC29	P66	2.00
OC35	P66	1.50
OC36	P66	1.50
OC42	P68	.50
OC43	P68	1.20
OC45	P68	.75
OC70	P68	.50
OC71	P68	.45
OC72	P68	.45
OC81	P68	.75
OC81D	P68	.75
OC82	P68	.75
OC83	P54	.50
OC139	P68	1.40
OC170	P68	.75
OC201	P64	.75
OC201	P68	1.50
OC204	P68	2.00
OC205	P68	2.50
OC206	P68	2.50
R2008B	N66	2.25
R2010B	N66	2.00
*TIP29A	N37	.45
*TIP29C	N37	.60
*TIP30A	P37	.49
*TIP30C	P37	.65
TIP31A	N37	.50
TIP31C	N37	.66
TIP32A	P37	.55
TIP32C	P37	.75
TIP33A	N37	.80
TIP33C	N37	1.10
TIP34A	P37	.90
TIP34C	P37	1.20
TIP35A	N37	2.50
TIP36A	P37	2.80
TIP41A	N37	.70
TIP41C	N37	.90
TIP42A	P37	.80
TIP42C	P37	1.00
TIP2955	P37	.65
TIP3055	N37	.55
*TIS34	N51	.95
*TIS42	NF78	.45
*TIS43	U110	.43
*TIS45	N50	.70
*TIS46	N50	.50
*TIS49	N50	.50
*TIS50	P50	.55
*TIS52	N50	.75
*TIS53	P50	1.40
*TIS54	P50	.80
*TIS58	NF78	.80
*TIS60	N50	.18
*TIS61	P50	.23
*TIS62	N51	.45
*TIS64	N51	.45
*TIS88A	NF78	.40
*TIS90	N50	.20
*TIS91	P50	.25
*TIS92	N51	.30
*TIS93	P51	.33
*ZTX300	N48	.16
*ZTX301	N48	.16
*ZTX301	N48	.25
*ZTX303	N48	.25
*ZTX304	N48	.25
*ZTX310	N48	.16
*ZTX311	N48	.17
*ZTX312	N48	.18
*ZTX313	N48	.20
*ZTX314	N48	.25
*ZTX320	N48	.30
*ZTX330	N48	.20
*ZTX341	N48	.20
*ZTX500	P48	.15
*ZTX501	P48	.16
*ZTX502	P48	.18
*ZTX503	P48	.15
*ZTX504	P48	.27
*ZTX510	P48	.17
*ZTX530	P48	.23
*ZTX531	P48	.25

QUALITY AND RELIABILITY
EXPRESS SERVICE
BRAND NEW
FULLY GUARANTEED COMPONENTS

PIN CONNECTIONS

Data Ref	Drwg Ref	Pin Configurations 1	2	3	4	5	6
2	A	E	C	B	C	—	—
4	B	E	C	B	—	—	—
10	C	E	B	C	—	—	
16	D	B	C	E	—	—	—
18	E	C	E	B	—	—	—
19	F	C	S	B	E	—	—
20	G	B	E	C	S	—	—
27	H	E	B	C	—	—	—
28	I	E	B	C	—	—	—
36	A	E	B	C	C	—	—
37	A	B	C	E	C	—	—
38	A	B	—	E	C	—	—
41	J	C	B	E	—	—	—
48	K	C	B	E	—	—	—
50	E	E	C	B	—	—	—
51	L	C	B	E	—	—	—
52	L	C	E	B	—	—	—
53	M	B	E	C	—	—	—
54	M	E	B	C	—	—	—
57	E	E	B	C	—	—	—
58	AF	E	C	B	—	—	—
59	M	E	C	B	—	—	—
60	N	B	C	E	—	—	—
61	N	E	B	C	—	—	—
64	P	E	B	C	S	—	—
65	G	E	B	C	S	—	—
66	I	E	B	C	—	—	—
67	A	E	C	B	C	—	—
68	P	E	B	C	—	—	—
69	M	E	B	C	—	—	—
70	G	E	B	C	—	—	—
71	G	E	B_1	—	B_2	—	—
72	Q	A	G	K	—	—	—
73	R	C	B	E	E	B	C
74	S	C	E	B	—	—	—
76	G	S	D	G	—	—	—
77	J	E	C	B	—	—	—
78	E	S	G	D	—	—	—
79	G	S	D	G	—	—	—
80	G	S	D	G	Sub	—	
81	T	E	B	C	—	—	—
82	G	D	S	G	Sub	—	
83	M	S	D	G	—	—	—
84	U	E	C	B	—	—	—
85	E	B_1	E	B_2	—	—	—
86	E	D	S	G	—	—	—
87	G	1	G	2	—	—	—
88	E	A	K	G	—	—	—
89	V	E	B	C	—	—	—
90	G	K	GK		GA		A
91	G	S	G_1	D	G_2		—
92	G	D	G_2	G_1	S	—	—
93	I	1	G	2	—	—	—
94	W	1	G	2	—	—	—
95	X	1	G	2	—	—	—
96	Y	2	1	G	—	—	—
97	A	1	2	G	2	—	—
98	Z	E	B	C	S	—	—
99	AA	E	B	C	—	—	—
100	AB	B	C	E	—	—	—
101	R	E_1	E_2	C_2	C_1	B_1	B_2
102	A	E	B	C	—	—	—
103	E	G	S	D	—	—	—
104	AC	E	B	C	—	—	—
105	AD	E	C	B	—	—	—
106	G	K	G	A	—	—	—
107	E	A	G	K	—	—	—
109	G	C	E	B	—	—	—
110	E	E	B_2	B_1	—	—	—
111	AE	C	B	E	—	—	—



PREFIX CODES

N	=	NPN or N-Channel
P	=	PNP or P-Channel
U	=	Unijunction
F	=	F.E.T. or Field Effect Trans
THY	=	Thyristor
TRI	=	Triac
D	=	Darlington
PU	=	P.U.T.
SCS	=	Silicon Controlled Switch
Q	=	Quadrac

HOW TO USE THIS GUIDE

Example: 2N706 in price list has a data code "N70." The prefix "N" denotes "NPN" transistor (see left). The data ref "70" in table of pin connections is cross referenced to drawing NR G. From drawing "G" we see pin 1 = emmitter, pin 2 = base and pin 3 = collector

LONDON: 01-452 0161
GLASGOW: 041-332 4133
BRISTOL: 027-2654201

TRANSFORMERS DOUGLAS AND REPANCO

TYPE No.	SECONDARY VOLTAGES	CURRENT	WEIGHT	P/P	PRICE
MT111CS	0-12+0-12 (24 volt)	250mA	275g	60p	**£2.35**
MT213CT	0-12+0-12 (24 volt)	500mA	450g	60p	**£2.85**
MT71AT	0-12+0-12 (24 volt)	1 amp	825g	90p	**£3.66**
MT68AT	0-12+0-12 (24 volt)	1.5 amp	1.05kg	£1.00	**£4.20**
MT18AT	0-12+0-12 (24 volt)	2 amps	980g	90p	**£4.50**
MT85AT	0-12+0-12 (24 volt)	5 amps	1.3kg	£1.00	**£4.90**

MT111CT - MT85AT may have their secondaries parallel to give 0-12v at twice the secondary current ratings; i.e. MT71AT to give 0-12v at 2A or 0-24v at 1A.

TYPE No.	SECONDARY VOLTAGES	CURRENT	WEIGHT	P/P	PRICE
MT112CT	0, 12, 15, 20, 24, 30v	500mA	575g	60p	**£2.85**
MT79AT	0, 12, 15, 20, 24, 30v	1 amp	725g	60p	**£3.95**
MT3AT	0, 12, 15, 20, 24, 30v	2 amp	1.35kg	£1.00	**£5.65**
MT20AT	0, 12, 15, 20, 24, 30v	3 amp	1.95kg	£1.00	**£6.60**
MT21AT	0, 12, 15, 20, 24, 30v	4 amp	2.73kg	£1.25	**£7.90**
MT51AT	0, 12, 15, 20, 24, 30v	5 amp	3.025kg	£1.50	**£9.00**

Secondary output of MT112CT to MT51AT may be taken from between any of the following voltages 2, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30v or 15-0-15v.

TYPE No.	SECONDARY VOLTAGES	CURRENT	WEIGHT	P/P	PRICE
MT102AT	0, 19, 25, 33, 40, 50v	500mA	800g	90p	**£3.90**
MT103AT	0, 19, 25, 33, 40, 50v	1A	1.3kg	£1.00	**£4.95**
MT104AT	0, 19, 25, 33, 40, 50v	2A	2.35kg	£1.25	**£7.45**
MT105AT	0, 19, 25, 33, 40, 50v	3A	2.9kgm	£1.25	**£9.00**
MT107AT	0, 19, 25, 33, 40, 50v	4A	5.25kgm	£2.00	**£15.50**

The secondary output of MT102AT to MR107AT may be taken from between any of the above tappings to give the voltages. 6, 7, 8, 10, 14, 15, 17, 19, 21, 25, 31, 33, 40, 50v or 25-0-25v.

TYPE No.	SECONDARY VOLTAGES	CURRENT	WEIGHT	P/P	PRICE
MT124AT	0, 24, 30, 40, 48, 60v	500mA	700gm	60p	**£4.20**
MT126AT	0, 24, 30, 40, 48, 60v	1A	1.4 kgm	£1.00	**£5.95**
MT127AT	0, 24, 30, 40, 48, 60v	2A	2.4 kgm	£1.25	**£8.00**
MT123AT	0, 24, 30, 40, 48, 60v	4A	5.25 kgm	£2.00	**£13.20**

Following voltages available from secondary tappings. MT124AT to MT123AT: 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60v or 30-0-30v.

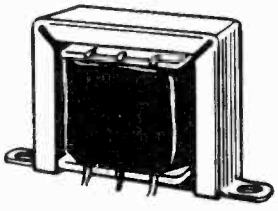
MINIATURE MAINS TRANSFORMERS

TYPE No.	SECONDARY VOLTAGES	CURRENT	WEIGHT	P/P	PRICE
MT6	6-0-6v	500mA	200g	40p	**£1.50**
MT12	12-0-12v	250mA	200g	40p	**£1.50**
MT20	20-0-20v	150mA	200g	40p	**£1.50**

SUB MINIATURE MAINS TRANSFORMERS

TYPE No.	SECONDARY VOLTAGES	CURRENT	WEIGHT	P/P	PRICE
TR1	6-0-6	100mA	75.9	40p	**£1.00**
TR2	9-0-9	75mA	75.9	40p	**£1.00**
TR3	12-0-12	50mA	75.9	40p	**£1.10**
TR4	12-0-12	100mA	75.9	40p	**£1.25**

TYPE No.	SECONDARY VOLTAGES	CURRENT	WEIGHT	PRICE
MT207CT	0, 8, 9v	500mA	510g	**£3.00**

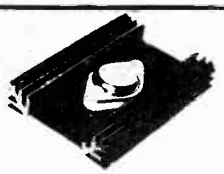


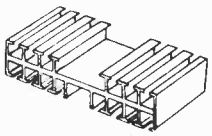
DON'T FORGET POSTAGE

SIZES IN MM OF TRANSFORMERS

MT6	60x40x45	MT79AT	70x60x70
MT12	60x40x45	MT85AT	95x70x70
MT20	60x40x45	MT102AT	75x75x65
TR1	45x25x27	MT103AT	80x60x65
TR2	45x25x27	MT104AT	80x70x100
TR3	45x25x27	MT105AT	100x90x90
TR4	50x27x30	MT107AT	140x105x120
MT3AT	75x55x90	MT112CT	70x65x60
MT18AT	95x60x70	MT123AT	125x100x100
MT20AT	100x75x85	MT124AT	75x75x65
MT21AT	100x90x85	MT126AT	100x70x85
MT51AT	120x80x110	MT127AT	
MT68AT	85x80x75	MT207CT	75x50x60
MT71AT	75x75x75	MT213CA	81x45x45

HEATSINKS-REDPOINT





Y-TYPE POWERSINKS

		PRICE
2Y1 Undrilled	6.2 C/W 55gms	**£0.50**
2Y2 1 x TO3	6.2 C/W 55gms	**£0.55**
4Y1 Undrilled	3.9 C/W 110gms	**£0.75**
4Y4 2 x TO3	3.9 C/W 110gms	**£1.00**
4Y5 2 x TO66	3.9 C/W 110gms	**£1.20**

Compact design stocked in 2 lengths 2" and 4". For moderate power involvement.

W-TYPE POWERSINKS

ORDER CODE	RATING	WEIGHT	PRICE
2W1 Undrilled	1.9 C/W	150gms	**£0.80**
4W1 Undrilled	1.3 C/W	280gms	**£1.25**
4W4 2 x TO3	1.3 C/W	280gms	**£1.50**
6W1 Undrilled	1.1 C/W	425gms	**£1.80**
6W4 2 x TO3	1.1 C/W	425gms	**£2.15**

Stocked as Standard HT-Sink in three lengths 2", 4" and 6" with Transistor Drillings as shown.

M-TYPE POWERSINKS

2M1 Undrilled	4.2° C/W	90gms	**£0.55**
2M2 1 x TO3	4.2 C/W	90gms	**£0.65**
2M3 1 x TO66	4.2 C/W	90gms	**£0.80**
4M1 Undrilled	2.8 C/W	170gms	**£0.95**
4M2 1 x TO3	2.8 C/W	170gms	**£1.00**
4M3 1 x TO66	2.8 C/W	170gms	**£1.15**

Stocked in 2" and 4" lengths Transistor Mountings as shown.

CH-TYPE HEATSINK

PRICE		
.30	CH77	23 C/Watt for TO126 Plastic and Motorola Case 77 19 x 8 x 25mm
.30	CH90	18 C/Watt for TO127 Plastic and Motorola Case 90 19 x 8 x 32mm
.30	CH106	18 C/Watt for C106D etc. 19 x 8 x 32mm.

F-TYPE HEATSINK

.10	18F	50 C/Watt Clip on for TO-5 Case
.10	5F	50 C/Watt clip on for TO-18 Case.

TV-TYPE HEATSINK

.30	TV-2	10.5 C/Watt for TO66 Power
.30	TV-3	10.5 C/Watt for TO3 Power
.30	TV-4	10.5 C/Watt for Plastic Power

VEROBOARDS

● .1 MATRIX COPPER BACKED

10345/P16	2.5"×5"	**£0.50**
10346/P16	2.5"x3.75"	**£0.42**
13236/P16	2.5"x17"	**£1.54**
10347/P16	3.75"x5"	**£0.56**
10348/P16	3.75"x3.75"	**£0.50**
13237/P16	3.75"x17"	**£1.98**
Packets of 5pcs	2.5"x1"	**£0.61**
126/P16	4.7"x17.5"	**£2.55**
14354/P16	2.5"x1"	**£0.15**

● PLAIN BOARD .1

520	2.5"x3.75"	**£0.28**
521	3.75"x5"	**£0.45**
522	3.75"x17"	**£1.28**

● INDUSTRIAL BOARD .1

VB111001	9.95"x4.4"	**£2.30**
VB111004	6.95"x7.9"	**£2.95**
VB111005	9.95"×7.9"	**£3.85**
VB124	7.05"x17.9"	**£4.10**

● .15 PLAIN BOARD

441/4501	2.5"x17"	**£0.84**
442/4505	3.75"x17"	**£1.09**
444/8023	4.95"x17"	**£1.66**
14352	3.75"x5"	**£0.39**
11990	2.5"x5"	**£0.28**
11991	2.5"x1.75"	**£0.22**

.15 STANDARD COPPER BACKED

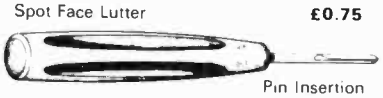
41/P16	2.5"x17"	**£1.23**
42/P16	2.5"x5"	**£0.45**
43/P16	2.5"x3.75"	**£0.33**
44/P16	3.75"x17"	**£1.64**
45/P16	3.75"x5"	**£0.61**
46/P16	3.75"x3.75"	**£0.45**
Pkts. of 5 pcs	2.5"x1"	**£0.56**
14353/P16	2.5"x1"	**0.15**

.2 PITCH

4/1101/P16	4.80"x18"	**£2.00**

GROUP BOARDS

11986 (0.15)	8.4"x1.5"	**£0.48**
13897 (0.1)	8.4"x1.5"	**£0.48**
Spot Face Lutter		**£0.75**



Pin Insertion Tools **£1.00**

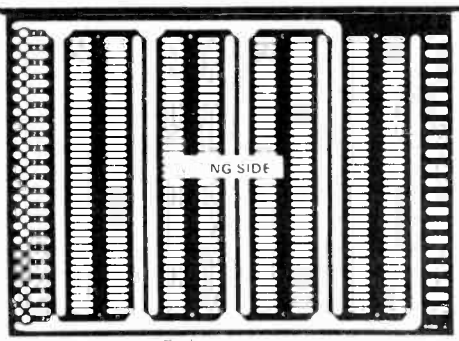
Specify .1 or .15

PINS

Available in .1 & .15

Price per bag

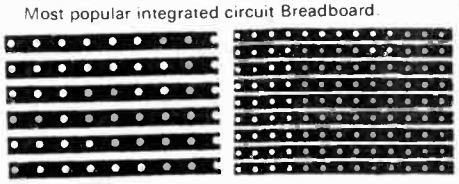
	.1	.15
36 Pins	**£0.37**	**£0.37**
200 Pins	**£1.35**	**£1.32**
1000 Pins	**£5.01**	**£4.67**



IC BREADBOARD (DIP) **£2.50**

VERO TYPE 13401, 4.15" x 6.15"

Most popular integrated circuit Breadboard.



0.15 x 0.15 Matrix 0.1 x 0.1 Matrix

Standard sizes available

.1 Matrix is suitable for DIL ICs

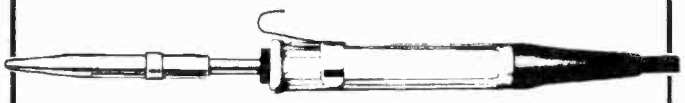
A. MARSHALL (LONDON) LTD. LONDON 01 452 0161

SOLDERING-EQUIPMENT

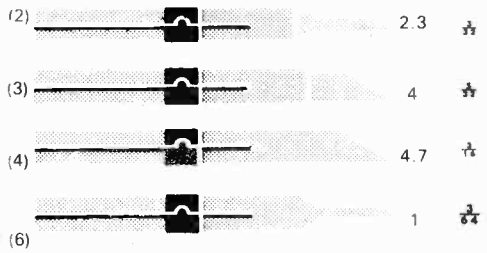
MODEL C15 — 15 watt **£3.40**

Miniature soldering iron. Bits slide on and off stainless steel shaft. Efficient heat transfer. Length 16cm.

Spare Elements **£1.45**



SPARE BITS AVAILABLE

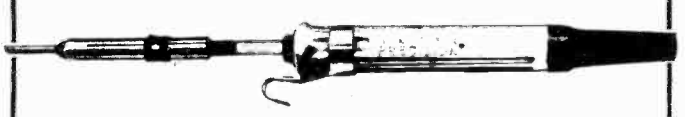


All Bits are Nickel Plated Price **46p**

MODEL CCN15 — 15 watt **£3.65**

Unique Ceramic shaft—no measurable leakage. Capacitance 30pf. Tested at 2kV A.C. Length 16 cm.

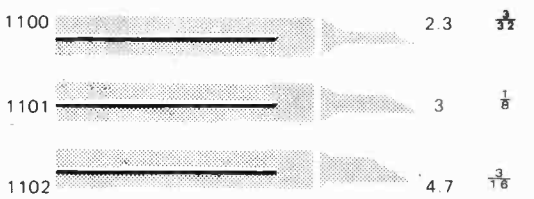
Elements **£1.40**



CCN

15 watt 240 volts miniature soldering iron with ceramic shaft to ensure perfect insulation.

SPARE BITS AVAILABLE

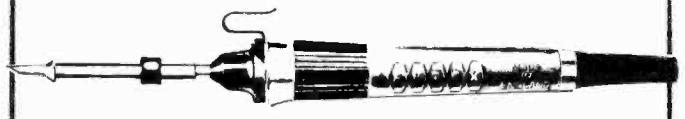


All Bits are Iron Coated Price **46p**

MODEL X25 — 25 watt **£3.40**

Near perfect insulation. Breakdown voltage 1,500v A.C. Leakage 3.5uA. Stainless steel shaft and phenolic handle. Length 22cms, weight 50g.

Element **£1.90**

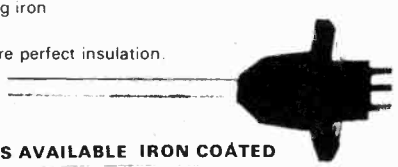


25 watt 240 volts soldering iron

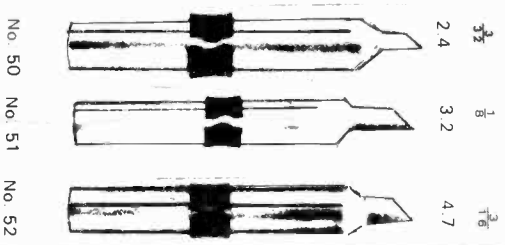
X25 Soldering Iron

with ceramic shaft to ensure perfect insulation.

Element X25E



SPARE BITS AVAILABLE IRON COATED



Price **50p**

THE 17 WATT MODEL CX **NEW PRICE £3.40**

Model CX is manufactured on the same principle as the model X.25 which has proved such as success since its introduction.

The *double shaft* principle of the X.25 has now been applied to a miniature iron, giving it the strength of the model C and the superb insulation of the CCN and the X.25. It is virtually *free of current leakage*, like model CCN, but it is not so delicate as that model. The addition of a steel shaft has of course meant that it has an *earth contact* and it is supplied with 3-core flexible cable.

Specification

Voltage range:	220-250 volts A.C./D.C.
Power consumption:	17 watts at maximum voltage
Breakdown voltage:	4000 volts A.C.
Current leakage:	3-5 uA.
Lead:	3-core
Length:	19cm (7½")
Weight:	40 grams (without lead)

Spare Elements available Price **£1.45**

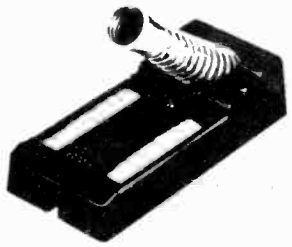
Uses same tips as Model CCN i.e. No. 1100, 1101 & 1102

PRICE 46p

ST3 Stand **Price £1.40**

This stand is made from high grade insulation material with a chromium plated strong steel spring. It is suitable for all models and replaces all previous stands.

The two sponges at the side which are easily replaceable, serve to keep the soldering bits clean. Spare bits can be accommodated as shown on the illustration.



DESOLDERING TOOL. £6.00

SPARE TIPS **50p**

A new and improved model to deal with solder removal where components are tightly grouped or otherwise inaccessible. Instantly removes all unwanted solder from printed circuits and all other solder joints. Simple, reliable, speedy and accurate.

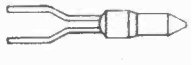
CORDLESS SOLDERING IRONS

7500 — "Iso-Tip" Soldering Iron Kit (Standard). Price **£14.50**

7700 — Quick Charge Soldering Iron Kit Price **£17.50**

NEW AND EASY TO USE

Spare tip **£2.10**



● Quick charge iron comes complete with one spare tip.

No. 7535 — Regular Tip

BRISTOL 0272 654201

GLASGOW 041 332 4133

AUDIO CONNECTORS

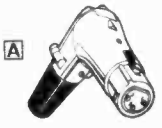
SWITCHCRAFT® INC.

Compatible with Cannon XLR Series

A(')F CORD PLUGS

Fresh, streamlined design includes rugged, diecast zinc body, satin nickel finish, high-impact resistant thermosetting plastic socket insert, moulded latchlock, dual pressure plates, keyed neoprene relief bushing. Features "Ground Terminal" and "Ground Contactors" offers 4-, 5-, 6-, and 7-contact versatility. Mates with Switchcraft A( )M and other connectors with similar contact arrangements. Overall length 3 7/32"; diameter ¾".

Has "Captive Design" insert screw, one-piece pin insert assembly easily removable for fast soldering. Polarizing groove. Die-cast zinc shell, satin nickel finish. Mates with Switchcraft A( )F and other connectors with similar contact arrangements. Brass, silver plated chromate dipped pins to resist tarnishing. Overall length 2 25/32"; dia. ¾".

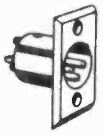


RIGHT-ANGLE CORD PLUGS

Newly styled right angle cord plugs with rugged die-cast housings in two types. A R( )F female and, B R( )M male. Ideal for equipment with limited space for connectors. Satin nickel finish, high-impact resistant thermosetting plastic insert, moulded latch-lock, dual pressure plates. Features "Ground Terminal" and "Ground Contactors". Mates with Switchcraft A( )M, R( )M, S( )FM and other connectors and receptacles with similar contact arrangements.

D(')F RECEPTACLES

Rectangular flange design receptacle permits close mounting on crowded panel or chassis. Features "Captive Design" loss-proof insert screw, positive latch locking device and high impact thermosetting socket insert. Mates with Switchcraft A( )M and other connectors with similar contact arrangements. Dimensions: Flange 1 1/16" x 1 7/16"; Barrel 1 13/64" overall; pin extension ¼".



D(')M RECEPTACLES

Narrow, rectangular flange design receptacle for mounting on compact panel or chassis. Mates with Switchcraft A( )F and other connectors with similar contact arrangements. Dimensions: Flange ⅞" x 1 7/16"; Barrel 13/16" overall; pin extension 9/32".

THE ABOVE ARE AVAILABLE IN 3 & 5 PIN VERSIONS

A3F	3 Pin	£1.70		R3M	3 Pin	£3.75	
A5F	5 Pin	£3.50		D3F	3 Pin	£2.50	
A3M	3 Pin	£1.50		D5F	5 Pin	£3.75	
A5M	5 Pin	£3.00		D3M	3 Pin	£1.45	
R3F	3 Pin	£4.00		D5M	5 Pin	£2.60	

15% DISCOUNT for 50-piece Mix

THE PROFESSIONAL CONNECTION

MULLARD VALVES

QUALITY VALVES BY MULLARD

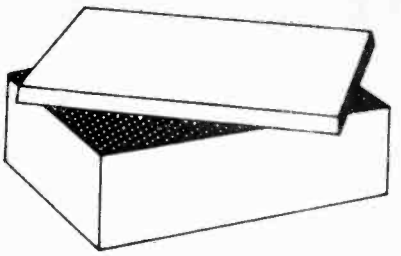
Type	Price	Type	Price	Type	Price
DY87/802	.85	EL95	1.30	PCL83	1.26
ECC81	.85	EYB6/802	.85	PCL84	1.20
ECC82	.85	GY501	2.11	PCL86	1.26
ECC83	.85	GZ34	1.50	PCL805/8S	1.26
ECC84	1.04	PC86	1.72	PD500	3.10
ECC85	1.30	PC88	1.72	PFL200	1.50
EC88	1.50	PC92	1.26	PL36	1.72
ECF80	1.04	PC97	.85	PL83	2.10
ECH83	1.93	PC900	1.04	PL84	1.30
ECH84	1.93	PCC84	1.04	PL95	1.04
ECL80	1.30	PCC85	1.30	PL504	1.72
ECL82	1.20	PCC89	1.26	PL508	2.10
ECL86	1.26	PCC189	1.50	PL509	3.00
EF80	.85	PCF80	1.04	PL519	4.50
EF85	.85	PCF86	1.26	PL802	3.00
EF86	2.10	PCF200	1.80	PY800	.97
EF183	1.20	PCF201	1.80	PY88	1.04
EF184	1.20	PCF801	1.26	PY500A	1.75
EL34	1.72	PCF802	1.30	UCH81	2.10
EL36	1.92	PCF806	1.26	UCL82	1.30
EL84	.85	PCH200	2.10	UCL83	1.30
EL86	1.72	PCL82	1.04	UL84	1.55

WHY SETTLE FOR ANYTHING LESS — ASK FOR MULLARD

BOXES AND CASES

ALUMINIUM BOXES

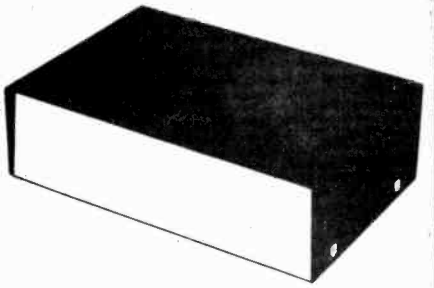
BA1	2¾x5¼x1½"	65p
BA2	4x4x1½"	70p
BA3	4x2¾"x1½"	65p
BA4	4x5¼x1½"	85p
BA5	4x2½x2"	75p
BA6	3x1x2"	50p
BA7	6x4x2"	£1.00
BA8	7x5x2½"	£1.20
BA9	8x6x3"	£1.50
BA10	10x7x3"	£2.00
BA11	10x4½x3"	£1.80
BA12	12x5x3"	£1.95
BA13	12x8x3"	£2.35



REXINE COVERED

R81	6x4½x1¾"	£1.40
RB2	8x5x2"	£1.65
RB3	9x5x2½"	£1.90
RB4	11x6x3"	£2.30
RB5	11x7½x3½"	£2.90
RB6	13x8x4½"	£4.00
R87	15x8x4"	£4.25

Complete with screws and feet.



VERO POTTING BOXES

VP81	2x3x1 Black	45p
VP82	2x3x1 White	45p

A small high quality ABS plastic box supplied complete with lid and screws — 75-1413E.

HAND HELD CONTROL BOX

The new Vero Hand Held Control Box — ideal for remote control uses — specially designed for the purpose. White ABS plastic. Measures 94x61x22.6mm. Price **62p**

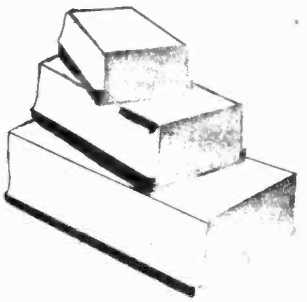
VERO CASES

1 PLASTIC BOXES

V81—65x120x40mm £2.27
CODE 65-2518H

VB2—80x160x50mm £2.55
CODE 65-2520J

V83—110x188x160mm £3.40
CODE 65-2522K



Moulded in 2 tone high impact polystyrene — screw fixing — very strong — ideal for wall mounting or bench use — threaded brass inserts for P.C. mounting.

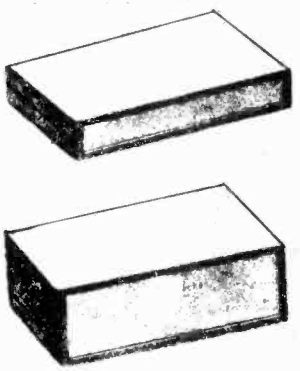
2 PLASTIC CASES

a) illustrated

VC1—205x140x40mm £2.93
CODE 75-1410J

VC2—205x140x75mm £3.29
CODE 75-1411D

VC3—205x140x110mm £4.27
CODE 75-1412K



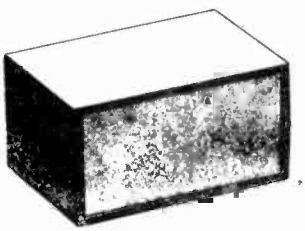
Moulded in light grey high impact ABS — includes internal P.C.B. fixing screws and anodised aluminium front panel held in place by the two halves of the case — screw fixing plus rubber feet.

3 PLASTIC CLIP CASES

VCC1—85x40x154mm £2.07
CODE 75-1237J

VCC2—85x60x154mm £2.58
CODE 75-1238D

VCC3—85x80x154mm £3.09
CODE 75-1239K

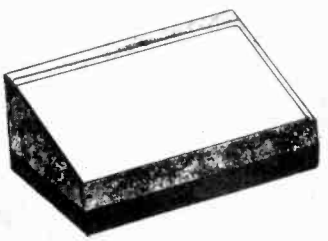


Similar to plastic boxes (1) but with anodised aluminium front panel, two tone halves clip together solidly without screws for ease of access. P.C.B. fixings inside.

4 PLASTIC SLOPING CASE

VSC1—220x174x100/50mm
CODE 65-2523E £5.57

VSC2—171x121x75/37.5mm
CODE 75-1798K £3.83

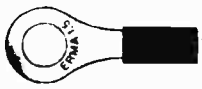


Two tone case — removable anodised alu. front panel and recess at rear for cable entry, ideal instrument case.

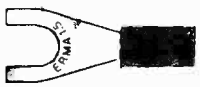
A. MARSHALL (LONDON) LTD. LONDON 01 452 0161

SOLDERLESS TERMINALS

RING TONGUE

Red	Blue			
15715 **£1.50**	15735 **£1.50**		15715	M5 2BA
15714 **£1.35**	15734 **£1.35**		15714	M4 6BA
15713 **£1.25**	15733 **£1.25**		15713	M3 6BA

FORK TONGUE

15607 **£1.75**	15617 **£1.75**		15607	M5 2BA
15606 **£1.45**	15616 **£1.45**		15606	M4 4BA

PIGGY-BACK ADAPTOR

15652 **£2.50**	15653 **£2.50**		15652	6.3x0.8 0.250x0.03

SLIDE-ON SOCKET

15671 **£1.45**	15673 **£1.45**		15671	6.3x0.8 0.250x0.03

BUTT CONNECTOR

15666 **£1.30**	15667 **£1.30**		15666	25.0 long 1.0 long

WIRE PIN

15661 **£1.70**	15662 **£1.70**		15661	wire pin

SLIDE-ON PLUG

15681 **£1.66**	15683 **£1.66**		15681	6.3x0.8 0.250x0.03

CRIMPING TOOL/ WIRE STRIPPER **£3.75** + VAT

Prices are per pack of 50 Terminals

RED for Cable 5mm²—1.5mm² BLUE for 1.5mm² to 2.5mm²

SERVICE AIDS

ELECTROLUBE — SERVICE AIDS

Product Description		Price
Electro-mechanical lubricant	340g	.95
Electronic cleaning solvent	340g	.95
Freezer	340g	.95
Contact treatment oil	170g	.95
Contact treatment grease	170g	£1.00
Anti-static foam cleanser	397g	.75
Clear protective lacquer	397g	£1.50
Electro-mechanical lubricant	5cc pen	.50
Contact cleaning strips	(20 strips)	.40

Postage **50p** per can
Reliable and safe to use

RELAYS—DIL

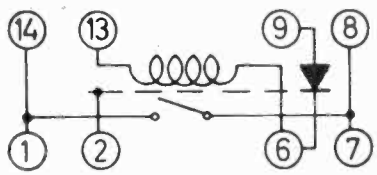
D.I.L. REED RELAYS

Low power drive — 35 mW — for operation direct from TTL
5, 12 and 24 V nominal coils available
Contact rating 10 VA switched to carry 1 A
Optional internal diode and electrostatic screen
Isolation between coil and contacts:
10,000 M-ohms — proof tested to 500 V min
At present available with 1 form A contact configuration

	Coil Resistance	VOLTAGE DC Operate	Release	Max	Nom	PRICE
15002	530	8	2	18	12	**£2.00**
15003	2000	16	4	32	24	**£2.00**
15005	360	3.5 (FROM TTL O/P)	1	15	5	**£2.00**
15005AB	360	3.5 (FROM TTL O/P)	1	15	5	**£2.75**
15005B	360	3.5 (FROM TTL O/P)	1	15	5	**£2.25**
15015AB	2000	11.5	4	32	15	**£2.85**

Modification 'A' — Electrostatic shield connected to pin 2.
Modification 'B' — Diode connected between pin 6 and 9.

PIN CONNECTIONS



DIL PACKAGE

PICOREED

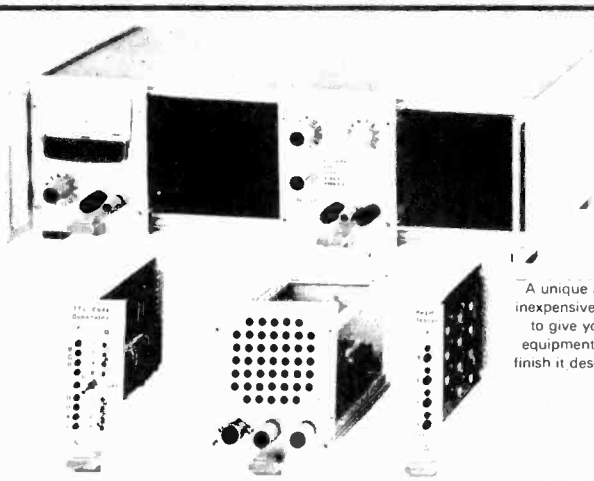
INSTRUMENT CASE

THE PROFESSIONAL TOUCH!

CASE—A housing unit for plug in Eurocards (100x160) and/or modules. Can be used free standing or in 19" racking. Consists of aluminium frame, 34 prs. of guides and separate mounting rail for 31-way connectors — top, rear and base removable — blue PVC clad aluminium — base and rear are ventilated — inside width is 17" — to take a combination of modules and front panels.
4" MODULE—Consists of 4" front panel, 4 guide rails with fixing holes, a rear and base plate — rigid construction.
FRONT PANELS available 1" or 2" wide made of anodised aluminium — easily attached to Eurocards with mounting angles and screws — economic way of building control units.
CARDS—Standard Eurocards — designed to slide in and out easily.
CONNECTORS—A 31-way plug and socket array — designed to work quickly and efficiently — accurately guided together when cards are inserted.

Description:		Price
● **CASE** (including guides)	71-3841-L	**£21.00**
● **4" MODULE**	71-3844G	**£3.25**
● **2" F**	71-3845-G	**£1.02**
● **1" FRONT PANEL**	71-3846-H	**£1.00**
● **VEROBOARD**	09-1034F	**£1.20**
● **DIP BOARD**	10-1041J	**£3.25**
● **31-WAY PLUG**	17-0267H	**£1.30**
● **31-WAY SOCKET**	17-0268C	**£1.50**

POSTAGE
Although the case comes flat, please allow an extra **£1.00** for postage. Many thanks



A unique and inexpensive way to give your equipment the finish it deserves

A wide range of combinations for the amateur and electronics lab

19" CARD FRAME/CASE SYSTEM FOR YOUR ELECTRONIC EQUIPMENT

vero

BRISTOL 0272 654201 GLASGOW 041 332 4133

CABLE

AUDIO-SCREENED CABLE

Price per metre

Z.1–MICROPHONE, SINGLE (STANDARD) — 10p
WHITE, GREY or BLACK

Z.2–MICROPHONE, SINGLE, HEAVY DUTY — 15p
BLACK

Z.3–MICROPHONE, TWIN — 17p
GREY

Z.8–MULTICORE, STANDARD, 8-WAY — 40p
GREY

Z.12–MULTICORE, STANDARD 12-WAY — 50p
GREY

Z.14–MULTICORE, MINIATURE, 4-WAY — 27p
GREY

Z.19–MULTICORE, MINIATURE, 9-WAY — 40p
GREY

Z.20–MULTISCREENED 4-WAY — 25p
GREY

Z.21–PICK-UP, SINGLE SUB MINIATURE — 10p
GREY

Z.22–PICK-UP, TWIN SUB MINIATURE — 12p
GREY

Z.23–STEREO SCREENED LEAD — 15p
GREY

MAINS CABLE

Z.25–FIGURE 8–RIB POLARISED — 8p
WHITE

Z.31–2 CORE OVAL – 2½ AMPS — 10p
WHITE

Z.33–3 CORE ROUND, STANDARD 2½ AMPS — 15p
WHITE

Z.34–3 CORE ROUND, HEAVY DUTY, RIBBED — 25p
WHITE
6 AMPS

COAXIAL CABLES

Z.41–U.H.F. (BANDS I-V) 75 OHMS — 20p
BROWN

Z.45–V.H.F. (BANDS I-III) 75OHMS — 15p
BROWN

V.H.F. FEEDER CABLES

Z.50–V.H.F./F.M. TWIN RIBBON FEEDER — 10p
300 OHMS

TOOLS & CUTTERS

GENERAL PURPOSE 100mm (4½")

DIAGONAL CUTTERS	**£3.15**
ROUND NOSE PLIERS	**£2.95**
FLAT NOSE PLIERS	**£2.90**
SNIPE NOSE PLIERS	**£2.90**
END/TOP CUTTERS	**£3.35**

A quality range of tools for the service man and enthusiast. Box joint construction for strength. Small compact and reliable, insulated handles and smart individual wallet.

20% DISCOUNT If all five tools are bought at the same time deduct 20%

FROM BAHCO & BRINDLEY

PROFESSIONAL TOOLS/CUTTERS

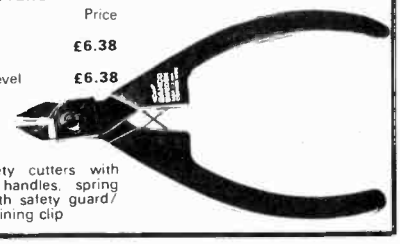
DIAGONAL CUTTERS TYPE 2111-4 with bevel on outer edge	**£9.00**
DIAGONAL CUTTERS, TYPE 2112-4 with no bevel — cuts flush	**£9.00**
SNIPE NOSE PLIERS TYPE 2411-4	**£6.54**

A high quality range of Swedish electronic pliers and cutters from Bahco — combine highest cutting accuracy with precision at reasonable cost. Spring loaded, insulated handles 115mm.

QUALITY FROM BAHCO

NEW CUTTERS

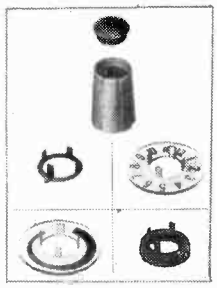
Type	Price
2131-4 with bevel	**£6.38**
2132-4 without bevel	**£6.38**



New safety cutters with insulated handles, spring loaded with safety guard/offcut retaining clip

INSTRUMENT KNOBS

SIFAM COLLET KNOBS



Function, styling, handling & simplicity of assembly are the main features of this new range of collet knobs. The various accessories — caps, pointers & nut covers — are simply plugged into basic knobs to form a vibration proof unit. Full size illustrations shown here indicate the possible combinations of colours available.

Two basic ranges are stocked along with related accessories, these are a 15mm diameter range and a 21mm diameter range

KNOBS available in black or grey

S150 — 15mm short knob, plain	**£0.27**
S151 — 15mm short knob and line pointer	**£0.30**
K150 — 15mm standard knob and plain	**£0.30**
K151 — 15mm standard knob and line pointer	**£0.33**
W151 — 15mm wing knob and line pointer	**£0.35**
K210 — 21mm standard knob, plain	**£0.35**
K11 — 21mm standard knob and line pointer	**£0.38**
W211 — 21mm wing knob and line pointer	**£0.40**

CAPS available in black, red, grey, green, blue or yellow

C150 — cap for 15mm knob, specify colour	**£0.02**
C210 — cap for 21mm knob, specify colour	**£0.02**

POINTERS available in same colours as caps

P150 — pointer for 15mm knobs	**£0.03**
P210 — pointer for 21mm knobs	**£0.03**

NUT COVERS available black, red, grey

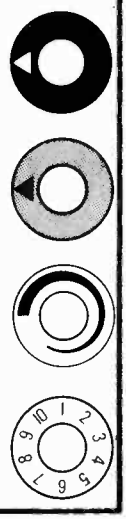
N150 — nut cover for 15mm knobs	**£0.03**

Nut covers not needed on 21mm knobs

FIGURE DIALS available as shown

Black with white pointer	15mm 11p	21mm **14p** each
Grey with black pointer	15mm 11p	21mm **14p** each
Clear with black taper	15mm 11p	21mm **14p** each
Figure dial 1-10 clear	15mm 12p	21mm **14p** each

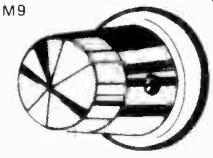
ALL KNOBS ARE FOR ¼" SPINDLES
DON'T FORGET TO SPECIFY COLOUR REQD.



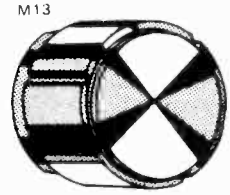
STANDARD KNOBS

STANDARD INSTRUMENT KNOBS

M9

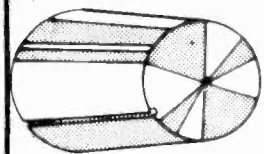


M13



M15

M12

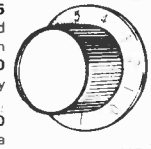


M14

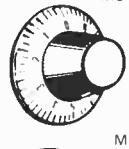
M1 Black plastic with mach. metal insert 25mm dia **£0.25**
M2 As M1 but 33mm dia with pointer **£0.30**
M3 Black plastic with machined metal insert and skirt 36mm dia **£0.35**
M4 Black plastic with machined metal insert and skirt 36mm dia **£0.35**
M5 Black plastic with machined metal insert and skirt 30mm dia **£0.30**
M6 Heavy metal matt black inlay — compact and very stylish, diameter 17mm **£0.40**
M7 As above but 24mm dia **£0.50**
M8 As above but 28mm dia **£0.60**
M9 Black plastic with chrome top and skirt for car radios, dia 24mm depth 30mm **£0.30**
M11 Solid aluminium 16mm dia **£0.25**
M12 All metal pointer, diameter 18mm **£0.30**
M13 All metal with black pointer, diameter 25mm **£0.30**
M14 Metal/plastic push knob for car, OD 11mm depth 43mm 3.5mm spindle hole **£0.20**
M15 Black plastic pointer knob with white marker, OD 18mm (skirt) pointer 31mm long **£0.15**

M1

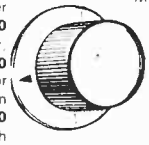
M4



M5



M3



M11

M6

ALL KNOBS ARE FOR ¼" SPINDLEX EXCEPT M14

MULTITESTERS

1 MM1-LT101 1000 ohms/volt

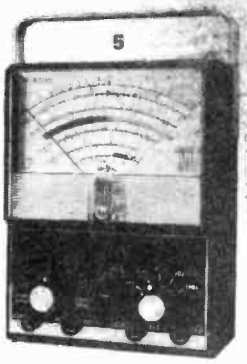
AC volts	0 to 10, 50, 250, 1000
DC volts	0 to 10, 50, 250, 1000
DC current	0 to 1mA, 0-100mA
Resistance	0-3000 ohms 0-150 Kohms

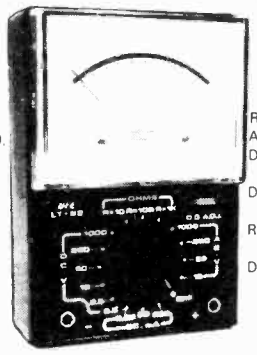
Size 2 x 3½ x 1 inch
Price **£6.25**
+ VAT

3 MM7-C7200EM
20,000 ohms/volt

Ranges	
AC volts	0-6, 30, 120, 600, 1200
DC volts	0-6, 30, 120, 600, 1200, 3000, 6000
DC current	0-60uA, 6mA, 60mA, 600mA
Resistance	0-6k, 600k, 6meg, 30meg, 60meg
Decibels	—20dB to +63dB

Size 6 x 4¼ x 2 inch
Price **£15.50**
+ VAT





2 MM-2-LT22 20,000 ohms/volt

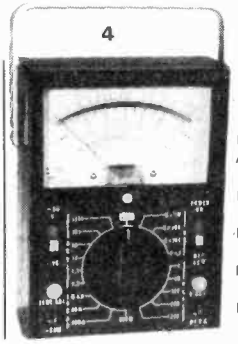
Ranges	
AC volts	0-10, 50, 250, 1000
DC volts	0-05, 2.5, 10, 50, 250, 1000
DC current	0-0.05, .25, 250mA
Resistance	0-300, 3k, 30, 50k, 500k, 5meg ohms
Decibels	—20 to +62dB

Size 5 x 3½ x 1¾ inch
Price **£12.00**
+ VAT

4 MM11-7081GN
50,000 ohms/volt

Ranges	
AC volts	0-1.5 to 0-500 in ten ranges
DC volts	0-0.5 to 0-500 in twelve ranges
DC current	0-25 uA to 0-10A in ten ranges
Resistance	0-100 to 0-16megohms in four ranges
Decibels	—20 to + 62db in ten ranges

Size 6½ x 4½ x 2¼ inch
Price **£20.00**
+ VAT



5 MM8-PROE 20,000 ohms/volt

Ranges	
AC volts	0-2.5 to 0-5000 in six ranges
DC volts	0-0.25 to 0-5000 in eight ranges
DC current	0-50uA to 0-10A in six ranges
Resistance	0-12 to 0-20megohms in six ranges
Decibels	—20 to +50dB

Size 7½ x 6½ x 2¾ inch
Price **£25.00**
+ VAT

DIGITAL MULTITESTERS-PORTABLE

COMPLETE WITH CHARGER

THREE DIGIT
Accuracy 1% reading

Model: LM-3A **£82.00** + VAT

MAINS/BATTERY OPERATED — COMPLETE WITH RECHARGEABLE NiCad BATTERIES & CHARGER UNIT

Features

- ★ Measures DC volts, AC volts, ohms and current
- ★ Automatic polarity, decimal and overload indication
- ★ No zero adjustment and no full scale ohms adjust
- ★ Battery operated — NiCad batteries; also AC line operation
- ★ Large LED display for easy reading without interpolation
- ★ Size 1-9"H x 2.7"W x 4" deep
- ★ Parts and labour guaranteed for one year
- ★ Input voltage protection in ohms and current range

Ranges

Volts DC — 0-1, 10, 100, 1000 volts
Volts AC — 0-1, 10, 100, 1000 volts
Resistance — 0-1k, 10k, 100k, 1meg, 10megohms
Current — 0-1mA, 10mA, 100mA, 1A

Complete with tilt stand for benchwork or optional case **£8.00**

NEW

IDEAL FOR SERVICEMEN

THREE & A HALF DIGITS
Accuracy 0-5% reading

Model: LM-3.5A **£95.00** + VAT

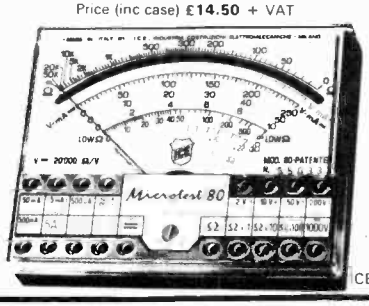
MICROTESTERS

MICROTEST 80

The smallest precision tester available with 8 fields of measurement and 40 ranges features 20,000 ohms/volt, fully screened, dimensions 90 x 70 x 18mm. Electronic zero ohms complete with case and instructions.

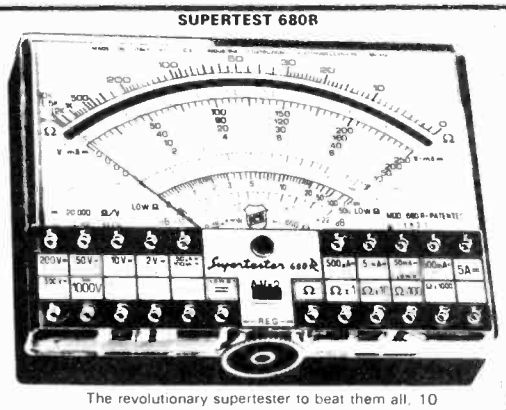
Volts DC	6 ranges	100mV-1000v
Volts AC	5 ranges	1-5v-1000v
Amps DC	6 ranges	50uA-5A
Amps AC	5 ranges	250uA-2.5A
Ohms	4 ranges	1Ω-5megΩ
V output	5 ranges	1.5V-1000V
Decibels	5 ranges	+6dB +62dB
Capacitance	4 ranges	25uF to 25,000uF

Accuracy and stability (2% of FSD AC & DC)
Size 90 x 70 x 18mm
Price (inc case) **£14.50** + VAT



CE MILANO

SUPERTEST 680R



The revolutionary supertester to beat them all, 10 fields of measurement and 80 ranges, 20,000 ohms/volt mirror scale — complete with case and instructions.

Volts AC	11 ranges	2-2500v
Volts DC	13 ranges	100mv-2000v
Amp DC	12 ranges	50uA-10A
Amp AC	10 ranges	250uA-5A
Ohms	6 ranges	1Ω-10megΩ
Freq out	2 ranges	0.500 and 0-5mhz
Volt out	9 ranges	10-2500v
Decibels	10 ranges	—24 to +70dB
Capacity	6 ranges	0-20,000uF

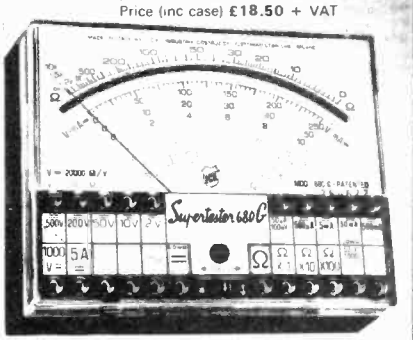
Accuracy & stability 1% in DC 2%in AC
Size 128 x 95 x 32mm
Price (inc case) **£23.00** + VAT

SUPERTESTER 680G

New supertester 680G — shockproof, mirror scale, magnetically screened 20,000 ohms/volt, 10 fields of measurement and 48 ranges

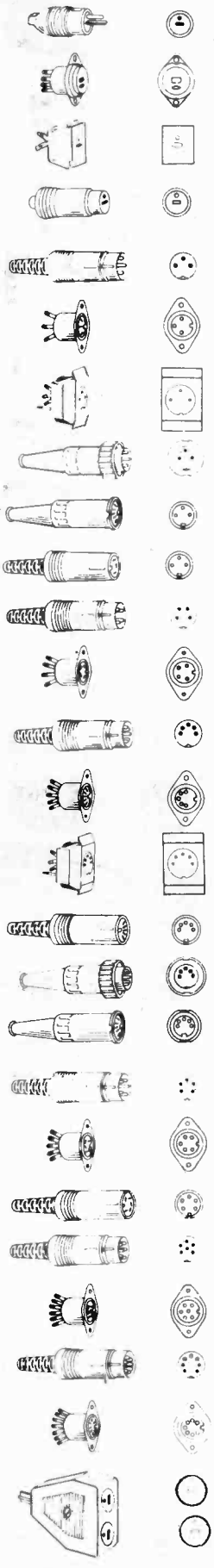
Volts DC	7 ranges	100mv-1000v
Volts AC	6 ranges	2v-2500v
Amps DC	6 ranges	50uA-5A
Amps AC	5 ranges	250uA-2.5A
Ohms	6 ranges	1Ω-100megΩ
Capacity	4 ranges	0-200uF
Freq out	2 ranges	0.500 & 0.5000Hz
Volt out	6 ranges	2-2500v
Decibels	5 ranges	—10dB to +62dB

Accuracy and stability 2% AC & DC
Size 105 x 84 x 32mm
Price (inc case) **£18.50** + VAT



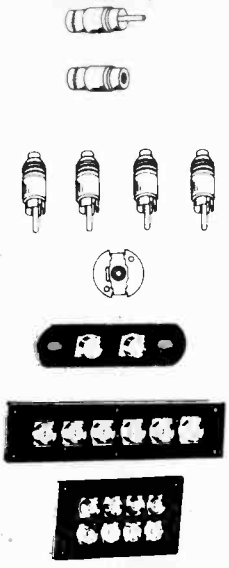
BRISTOL 0272 654201 **GLASGOW 041 332 4133**

DIN PLUGS & SOCKETS



2 PIN LOUDSPEAKER PLUG	10p
2 PIN LOUDSPEAKER CHASSIS SOCKET	7p
2 PIN LOUDSPEAKER SNAP-IN SOCKET	10p
2 PIN LOUDSPEAKER LINE SOCKET	10p
3 PIN PLUG FULLY SCREENED	15p
3 PIN CHASSIS SOCKET	12p
3 PIN CHASSIS SNAP-IN SOCKET	12p
3 PIN SCREENED LOCKING PLUG	68p
3 PIN LOCKING LINE SOCKET	60p
3 PIN LINE SOCKET	15p
4 PIN PLUG	15p
4 PIN SOCKET CHASSIS MOUNTING	12p
5 PIN 180° PLUG FULLY SCREENED	15p
5 PIN 180° CHASSIS SOCKET	12p
5 PIN 180° CHASSIS SNAP-IN SOCKET	12p
5 PIN 180° LINE SOCKET	15p
5 PIN 180° LOCKING PLUG	75p
5 PIN 180° LOCKING LINE SOCKET	75p
5 PIN 240° PLUG FULLY SCREENED	15p
5 PIN 240° CHASSIS SOCKET	12p
5 PIN 240° LINE SOCKET	15p
6 PIN PLUG FULLY SCREENED	15p
6 PIN CHASSIS SOCKET	12p
7 PIN PLUG FULLY SCREENED	15p
7 PIN PLUG FULLY SCREENED	12p
ADAPTOR 2 PIN SPEAKER PLUG TO TWO 2 PIN SOCKETS	60p

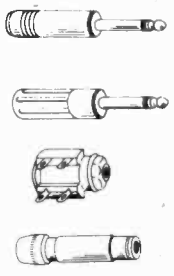
PHONO PLUGS & SOCKETS



PHONO PLUG—METAL FULLY SCREENED	15p
PHONO LINE SOCKET FULLY SCREENED	15p
PHONO PLUGS & LINE SOCKETS—SCREW TOP PLASTIC RED, BLACK, WHITE GREEN & YELLOW	10p
PHONO SINGLE CHASSIS SOCKET ON PAXOLIN	7p
DOUBLE PHONO SOCKET	10p
FOUR-WAY PHONO SOCKET	20p
SIX-WAY PHONO SOCKET	25p
EIGHT-WAY PHONO SOCKET ON PAXOLIN	35p

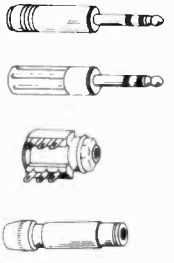
JACK PLUGS & SOCKETS

MONO

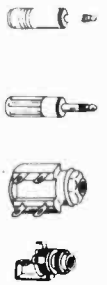


¼" STANDARD JACK PLUG — FULLY SCREENED	25p
¼" STANDARD JACK PLUG — UNSCREENED	16p
¼" STANDARD JACK CHASSIS SOCKET SWITCHED	20p
¼" STANDARD LINE SOCKET PLASTIC or METAL	20p 30p

STEREO



¼" STEREO JACK PLUG FULLY SCREENED	35p
¼" STEREO JACK PLUG UNSCREENED	25p
¼" STEREO JACK CHASSIS SOCKET—SWITCHED	25p
¼" STEREO LINE SOCKET 1) METAL 2) PLASTIC	45p 25p

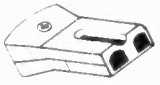


3.5mm JACK PLUG FULLY SCREENED PLUG LINE SOCKET	16p 16p
3.5mm JACK PLUG PLASTIC—UNSCREENED LINE SOCKET	10p 10p
3.5mm JACK SOCKET CHASSIS—PLASTIC	12p
3.5mm JACK SOCKET CHASSIS—METAL	10p

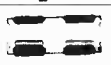
2.5mm JACK PLUG PLASTIC METAL	10p 15p
2.5mm JACK SOCKET CHASSIS, SWITCHED PLASTIC	10p

A. MARSHALL (LONDON) LTD. **LONDON 01 452 0161**

POWER CONNECTORS

30p	12 WAY FLEXIBLE CONNECTOR BLOCK 2 AMPS	
8p	BANANA PLUGS RED OR BLACK	
6p	BANANA SOCKET RED OR BLACK	
15p	POWER PLUG USA 2 PIN MAINS CONNECTOR PLASTIC	
15p	USA MAINS POWER LINE SOCKET PLASTIC	
15p	USA MAINS POWER CHASSIS SOCKET PLASTIC	
10p	PP3 BATTERY SNAPS	
14p	PP9 BATTERY SNAPS	
20p	MAINS CONNECTOR NON-REVERSIBLE 2 PIN CALCULATOR PLUG	
30p	NON-REVERSIBLE CHASSIS MOUNTING CALCULATOR SOCKET	
14p	ROCA PLUG— BATTERY USE, SLIDING SLEEVE	
12p	ROCA SOCKET SWITCHED FOR BATTERY CONNECTION	

U.S.A. COAXIAL CONNECTORS

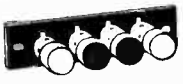
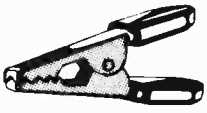
£0.60	UHF Plug suits Uniradio 67	PL259	
£0.50	UHF Chassis Mounting Square Socket 18 x 18 x 3.2 Fixing	SO239	
£0.50	UHF Round Socket Panel Mounting	SO239SH	
£0.65	UHF Double Ended Female Coupler	PL258	

BNC CONNECTORS (75R)

TYPE FS75	TYPE FP75	TYPE CP75
£0.75	**£0.75**	**£0.70**

75Ω COAXIAL CONNECTORS BY GREENPAR

TERMINALS & CLIPS

20p	TWO POLARISED SCREWS &/OR PHONO SOCKET 2-3/8" x ¾"	
35p	DOUBLE, SPRING LOADED PUSH TO RELEASE CABLE TERMINAL ONE RED ONE BLACK	
45p	DOUBLE SPRING LOADED TRIGGER TERMINALS ONE RED ONE BLACK	
80p	FOUR WAY SPRING LOADED TRIGGER TERMINALS 2 RED & 2 BLACK	
65p	FOUR WAY SPRING LOADED PUSH TO RELEASE CABLE TERMINAL	
6p	CROCODILE CLIPS 1½" long Red or Black PLASTIC HANDLES	
14p	2mm METER PLUG 4mm METER PLUG Red or Black	
10p	2mm CHASSIS SOCKET 4mm CHASSIS SOCKET Red or Black. Not insulated	
15p	SPADE TERMINALS Red or Black	
20p	TERMINAL POST—Will accept 4mm Meter Plug Red or Black	
10p	4mm LINE COUPLER Red or Black	
25p	CROC CLIP 4mm PLASTIC—Red or Black— Takes 4mm plug	
6p	CROC CLIP MINIATURE FULLY INSULATED Red or Black	

COAXIL CONNECTORS

14p	COAXIAL TV AERIAL ALUMINIUM PLUG	
10p	COAXIAL PLASTIC PLUG	
10p	COAXIAL CHASSIS SOCKET Plastic or metal	
15p	COAXIAL SNAP-IN CHASSIS SOCKET	
30p	COAXIAL LINE SOCKET METAL	
10p	COAXIAL IN LINE ALUMINIUM COUPLER	
15p	CAR AERIAL PLUG	

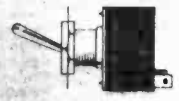
BRISTOL 0272 654201

GLASGOW 041 332 4133

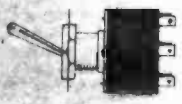
SWITCHES

QUANTITY DISCOUNTS
CONTACT US NOW

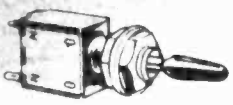
STANDARD TOGGLES



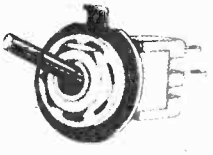
STANDARD PRICE
SPST (2 tags) 2A 250V
Chrome toggle—on/off plate **30p**
DIMS 25x14x14mm



DPDT (6 tags) 2A 250V
Extra long toggle + plate **40p**
DIMS 29x18x17mm

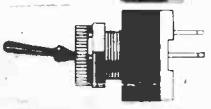


SUB MINIATURE 2A 250V
SPST (2 tags) 12x6x9mm
Red toggle **60p**
SPDT (3 tags) 12x6x9mm
Red toggle **65p**
DPDT (6 tags) 12x11x9mm
Red toggle **70p**
DPDT (6 tags) 12x11x9mm
Centre off Red toggle **80p**

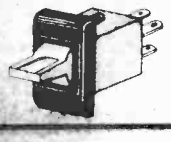


MICRO MINIATURE 2A 250V
SPST (2 tags) 8x5x7mm
Chrome toggle **50p**
SPDT (3 tags) 8x5x7mm
Chrome toggle **55p**
DPDT (6 tags) 8x7x7mm
Chrome toggle **60p**

STANDARD
SPST (2 tags) 24x16x17mm
6A 250 extra long paddle
shaped chrome toggle **45p**



250v, 15 amp. SPST (2 tags)
Body dims: 24x13x14mm
Black plastic toggle **40p**



FLAT TOGGLE
250V, 3 amp. SPST (2 tags) **80p**
Flat toggle, two screw fixing
eschtcheon covers screws.
As above but SPCO (3 tags) **85p**

QUALITY TOGGLES

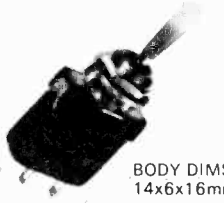
ARROW

CT SERIES Approved to BS3955 Spec.
2A 250V AC, 5A 29V DC

Low cost subminiature toggle switches, designed for applications where compact size, low weight and rugged construction are required. Fitted with solder lug terminals of silver alloy, moving contacts of silver alloy and fixed contacts of silver alloy.

Initial Contact Resistance	10M Max (at 4Vd.c. IA)
Proof Voltage	2000V r.m.s. at sea level
Insulation Resistance	1000M Min.
Electrical Life	50,000 cycles Min.
Mechanical Life	100,000 cycles Min.
Operational Force	150-200 grms.
Temp. Range	—40 C to +80 C
Angular Movement	24 ±3

1 POLE, 2 AND 3 POSITIONS — 3 TAGS **1.99**



BODY DIMS
14x6x16mm

		Price
CTS3	S.P. Change Over	**£0.81**
CTM3	S. P. Biased C/Over	**£0.99**
CTC3	S.P. Centre Off	**£0.87**
CTE3	S.P. Centre Off ½ Biased	**£0.99**
CTG3	S.P. Biased Centre Off	**£0.99**

2 POLE, 2 AND 3 POSITIONS — 6 TAGS

BODY DIMS
14x13x16mm

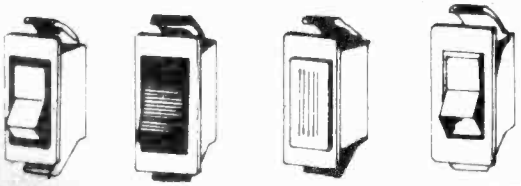
		Price
CTS6	D.P. Change Over	**£1.16**
CTM6	D.P. Biased C/Over	**£1.26**
CTC6	D.P. Centre Off	**£1.23**
CTE6	D.P. Centre Off ½ Biased	**£1.30**
CTG6	D.P. Biased Centre Off	**£1.26**

ROCKER SWITCHES

ARROW

SPECIFICATION: 16A. 250 Volts A.C. Contact Rating.
Dimensions:
1600 Series Cutout 27.4 x 12.3 mm.
2600 Series Cutout 27.4 x 22x3mm.

FEATURES:
- **Low cost**
- **Compact design with popular snap-in fixing.**
- **Choice of colour and termination.**
- **Complementary pilot lights and illuminated switches.**
- **Slow, make and break action providing Class B disconnections as defined in BS. 3955 Part 3, 1972.**
- **Overseas approved.**
- **Choice of single pole 1600 Series or double pole 2600.**

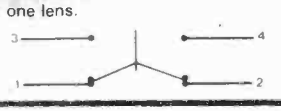


		PRICE
1 POLE 2 AND 3 POSITION		**1.99**
1600-22E	1 Pole On-Off (2 tags)	**£0.41**
1602-22E	1P2W Changeover 3 tags	**£0.46**
1603-22E	1P2W Changeover biased one way 3 tags	**£0.48**
1604-22E	1P2W Changeover 3 position centre off 3 tags	**£0.49**
1622-R22E	1P2W as 1602 but with 250v red neon	**£0.95**
1622-R52E	As above but for 12v-filament indicator	**£0.87**
2 POLE 2 AND 3 POSITION		
2600-22E	2 Pole On-Off (4 tags)	**£0.48**
2602-22E	2P2W Changeover 6 tags	**£0.60**
2603-22E	2P2W Changeover biased one way 6 tags	**£0.62**
1604-22E	2P2W Changeover 3 position centre off	**£0.64**
1600-R22E	2P2W On/Off with red mains neon 4 tags	**£0.97**
2600-R52E	As above but for 12v filament indicator	**£0.88**
PILOT LIGHTS/INDICATORS		
1609-R22E	250v Red mains neon indicator	**£0.48**
1609-G22E	250v Green mains neon indicator	**£0.67**
1609-R52E	12v Filament indicator red	**£0.42**
1609-G52E	12v Filament indicator green	**£0.42**

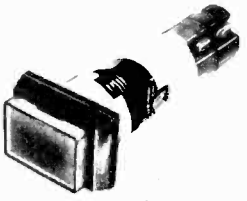
ILLUMINATED PUSH BUTTON—ADAPT-A-SWITCH

This switch is available in two basic forms
1) Momentary action Type 83502 **£3.15** ea.
2) Alternate action Type 83505 **£3.85** ea.
The Switch comes complete with one SPCO contact block. Extra contact blocks may be ordered to add on to the basic switch (maximum 3/switch).
Coloured lenses available in Red, White, Green, Blue, Yellow, Amber — these are available separately at 14p each, but each switch comes with one lens.

DIMENSIONS



HOW TO ORDER
Specify momentary or alternate action.
Specify colour of lens required.
Specify number of contact blocks required.
Miniature flange bulbs included in price.
Specify 6V. 12V and 28V.



Extra Contact Blocks
£1.53 ea.
Code 83500-30

ARROW

A. MARSHALL (LONDON) LTD. LONDON 01 452 0161

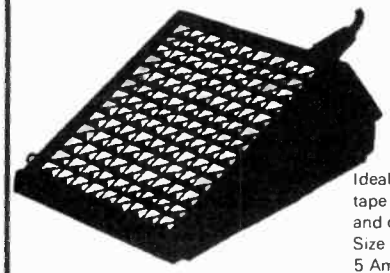
CONSUMER PRODUCTS SPECIALISTS

SWITCHES

FOOT SWITCHES

Very stylish unit — non-slip base and foot pad switch permanently off until depressed—release off complete with flex and 2.5mm plug.

PRICE **£2.40**



Ideal for remote control operation of tape recorders, amplifiers, dictating and other bench equipment.
Size 2½" x 3½" x 1"
5 Amp 250 Volt

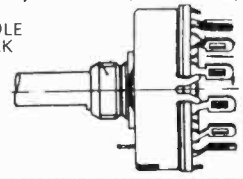
ROTARY SWITCHES

Available in four types all having adjustable rotation limit stop. (Located under fixing nut and washer).

RSW12	1 Pole—Adjustable from 2 to 12 Way	**£0.50**
RSW6	2 Pole—Adjustable from 2 to 6 Way	**£0.50**
RSW4	3 Pole—Adjustable from 2 to 4 Way	**£0.50**
RSW3	4 Pole—Adjustable from 2 to 3 Way	**£0.50**

STANDARD ¼" SPINDLE
MAKE BEFORE BREAK

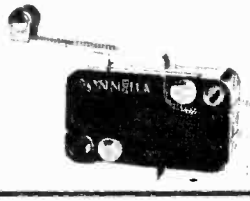
See Page 22
for knobs to suit.



MICROSWITCHES

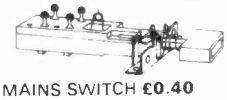
Miniature Microswitches—10A 250v AV Changeover type
BODY DIMS. 28 x 16 x 10mm. Available as standard (S160) Or with free action lever-roller 17mm long (S162)

S.160



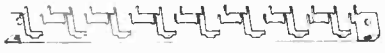
Price **50p**

S.162



MAINS SWITCH **£0.40**

4 POLE BUSH-BUTTON **£0.35**



8-WAY MOUNTING FRAME **£0.10**

Both the push-button and the mains switch are supplied with a single mounting frame, which can be removed enabling them to be mounted on the mounting frame—up to 8 Way. The push-button is a latching action, Push-on, Push-off but can be converted to momentary contact by removal of the locating pin. All switches include knobs. Independent action.

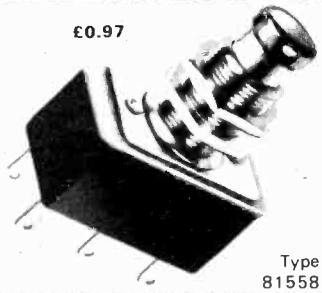
FOOT SWITCH

£0.97

2 Pole Change Over
Alternate Action
(Latching)

A Professional Switch — sturdy and rugged construction with strong metal button
Body DIMS
17 x 32 x 18mm
Rated 3A 250 AC

ARROW

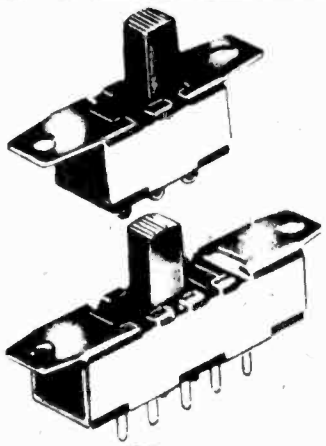


Type 81558

SLIDE SWITCHES

STANDARD

	PRICE
DPDT 1A 250V Small 15 x 8 x 12	**15p**
DPDT 1A 250V Medium 16 x 11 x 9	**15p**
DPDT 1A 250V Large 22 x 13 x 8	**15p**
DPDT 1A 250V Large 22 x 13 x 8 Centre off	**15p**



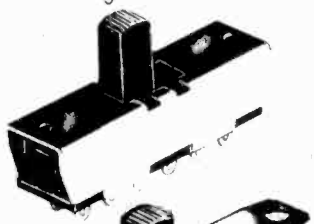
MULTIPOSITION

2 POLE-3 POSITION

5295CS **20p**

2 POLE-4 POSITION

5295CS **20p**



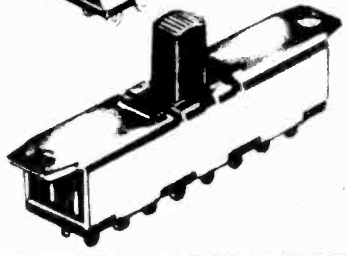
MULTIPOLE

4 POLE-2 POSITION

5289CS **25p**

4 POLE-3 POSITION

5293CS **25p**



PUSH BUTTONS

15p Push to make—Spring off
1A 250V Red, Yellow, Green
DIMS 16 x 6mm (dia)

25p Push to break—as above—Black

50p Push On / Push Off DPDT (6 tags)
DIMS 20 x 12 x 13mm
Red or Black

ALTERNATE ACTION

65p SPST (2 tags) DIMS 11 x 7 x 17mm
Spring loaded Red top

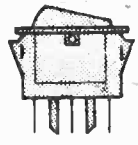
70p SPDT (3 tags) DIMS 11 x 7 x 17mm
Spring loaded Red top

85p DPDT (6 tags) DIMS 11 x 11 x 17mm
Spring loaded Red top latching

15p Push to make—Spring off
1A 250V
DIMS 14 x 6mm Diameter
Red, Yellow, Green, Blue and Black Top

ROCKERS

PRICE EACH



65p SP On-Off (3 tags) 3A 250V
White, See Saw
When on, Neon Lights
DIMS: 29 x 11 x 21

30p On-Off-On 10A 250V
British made, Rocks on-Off-On
DIMS: 29 x 11 x 18

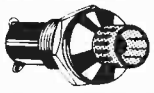
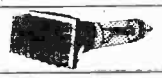
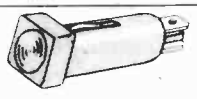
20p SPST (2 tags) 6A 250V
White, miniature
BODY DIMS: 21 x 15 x 13mm

BRISTOL 0272 654201

GLASGOW 041 332 4133

ACCESSORIES

INDICATORS & LAMPS

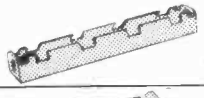
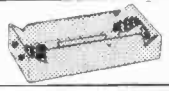
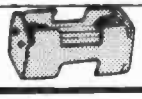
					Price
IN1	M575		RED		
IN2	M575		BLUE		
IN3	M575		GREEN	10mm	20p
IN4	M575		YELLOW	HOLE	
IN5	M575		WHITE		
IN6	B215		RED		
IN7	B215		GREEN	11mm	25p
IN8	B215		BLUE	HOLE	
IN9	B215		YELLOW		
IN10	B218		RED		
IN11	B218		GREEN	11mm	2 8p
IN12	B218		BLUE	HOLE	
IN17	TB31S		GREEN	Neon. 240v.	35p
IN18	JH12R		RED	Neon. 240v	
IN19	JH12R		AMBER	Neon. 240v.	25p
IN20	JH12S		RED	Neon. 240v.	
IN21	JH12S		AMBER	Neon. 240v.	25p

BULBS

To fit Indicators M575, B215 and B218

BU1	12v	12 volt, 0.1 amp. Lilliput screw	8p
BU2	6v	6 volt, 0.2 amp. Lilliput screw	

BATTERY HOLDERS

B1	B205		Moulded. To take four SP11 HP11 batteries in line. Tag terminals	28p
B2	B203		Moulded. To take four SP11, HP11 batteries Two by two. Snap terminals	28p
B3	A302		Moulded. To take four penlight batteries. Two by two. Snap terminals	20p
B4	A303		Moulded. To take four penlight batteries. Side by side. Snap terminals	20p

MAINS KEYNECTOR

Ideal for high speed bench testing, shop demonstrations etc. It can take connections up to 13 amp maximum.

Connects electrical equipment to a mains supply in seconds. No plugs or sockets needed. No dangers from touching a live-wire circuit.

●Built-in safety switch with 13 amp fuse.

PRICE **£5.00** + VAT

Fuse housing shut-keys cannot be depressed—circuit closed complete safety

Neon LIGHT glows—proper connection made

SILICON GREASE

Thermpath 167 — When mounting semiconductors this material improves thermal resistance by up to 40%. The compound is stable over a wide temp. range and maintains insulation.

12gm vial (not illustrated)	**£0.35**
20ml. syringe (46gms)	**£1.00**

ERSIN Multicore 5 CORE SOLDER

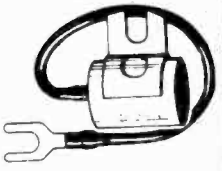
HANDY SOLDER DISPENSER
Size 5 £0.36
Contains 2.3 metres of SAVBIT SOLDER
Postage/Packing 45p on Size 10 & 12

Ref.	Alloy	Daim. mm	Length metres approx.	Use	Price
Size 10	60/40 Tin/Lead	0.7	39.6	For fine wires, small components and printed circuits.	**£1.38**
Size 12	SAVBIT	1.2	13.7	For radio, TV and similar work. Increases copper-bit life tenfold	**£1.38**

SUPPRESSORS

An essential component for dynamo and ignition interference suppression, the following range of suppressor condensers provide most values and fixings required.

Type	Connection	Price
SC1	Space	**£0.35**
SC2	10A Lucas	**£0.35**
SC3	35A Lucas ALL RATED AT 1 F	**£0.35**

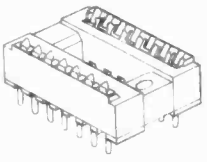


SOCKETS & HOLDERS

			Price
TO18	4 pin holder	A1236/4L	16p
TO5	3 pin holder	A1192	17p
TO18	3 pin holder	A1236	15p
TO99	8 pin holder	A23 2013	40p
TO99	10 pin holder	A23 A2014	45p
TO99	12 pin holder	A1200	£1.20

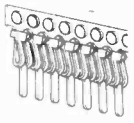
DUAL-IN LINE SOCKETS

8 pin D.I.L.		15p
14 pin D.I.L.		16p
16 pin D.I.L.		18p
18 pin D.I.L.	**NEW LOW PROFILE**	27p
22 pin D.I.L.		30p
24 pin D.I.L.		35p
28 pin D.I.L.		45p
40 pin D.I.L.		55p



TRANSISTOR COVERS

TO3C	Plastic cover	10p
TO66C	Plastic cover	10p



SOLDERCON PINS FOR LOW COST IC SOCKETS £0.55/100 STRIP
Strip of 100 pins for those odd moments you find yourself without a socket

ENAMELLED COPPERWIRE

Available on 2oz Reels in the following guages

20z REELS

SWG	Price	SWG	Price
16	**0.40**	28	**0.50**
18	**0.40**	30	**0.55**
20	**0.40**	32	**0.55**
22	**0.45**	34	**0.60**
24	**0.45**	36	**0.60**
26	**0.50**	38	**0.65**

ETCH RESIST PEN

Etch Resist Pen for Printed Circuit Boards—Simple and Efficient **£1.00**

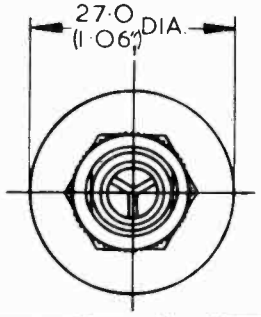
A. MARSHALL (LONDON) LTD. LONDON 01 452 0161

ACCESSORIES

THE MINI-BLEEPTONE 525 £3.75

is an electronic warning device that doubles as a fault indicator or localised warning of fire or intruders. Developed for panel mounting its solid state electronics gives reliability whilst its small size and low current consumption of 3-15mA produce a choice of two signals up to 80dBA. Its wide voltage range ensures operation from almost any transistorised equipment, completing the flexibility of this unit.

Requires 12.7mm (0.5") fixing hole



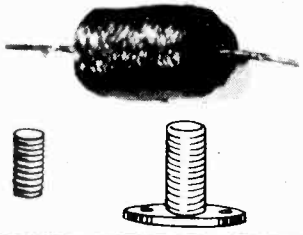
QUARTZ CYRISTALS

Frequency		Tol.	Load	Case	Price
100	Khz	±50ppm	32pf	HC13/U	£3.50
1.0	Mhz	±50ppm	32pf	HC6/U	£3.75
3.2768	Mhz	±20ppm	12pf	HC33/U	£2.75
4.194304	Mhz	±20ppm	12pf	HC18/U	£2.75
5.0	Mhz	±20ppm	30pf	HC18/U	£2.50
10.0	Mhz	±20ppm	30pd	HC/18U	£2.25
10.7	Mhz	±20ppm	30p	HC6/U	£3.40

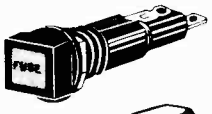
CHOKES

CH1	RF Choke	2.5 mH	**44p**
CH2	RF Choke	5.0 mH	**50p**
CH3	RF Choke	7.5 mH	**50p**
CH4	RF Choke	10 mH	**50p**
CH5	RF Choke	1.5 mH	**44p**

COIL FORMERS
¼" Coil Formers complete
Price £0.15 each



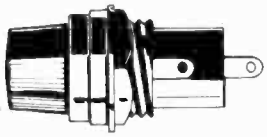
FUSES & FUSEHOLDERS



1) PANEL MOUNTING
For 1¼" (32mm) fuse
Coloured spring-off safety top **£0.35**
Colours available: Red, Blue, White, Yellow

2) PANEL MOUNTING
With see-through cover
For 32mm fuse **£0.20**

3) CAR IN LINE (not illustrated)
Fuse holder takes 1¼" fuses **£0.15**



4) PANEL MOUNTING
Fuse Holders for 20mm or 1¼" fuses
20mm **£0.30**
1¼" **£0.30**

5) PRINTED CIRCUIT MOUNTING FUSE CLIPS for 20mm fuses only **£0.04 pair**

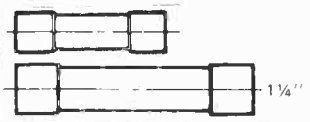
6) CHASSIS MOUNTING FUSE HOLDERS for 20mm fuses on paxoline **£0.07** each

FUSES 1¼"

VALUE	QUICK BLOW	ANTI-SURGE
100mA	£.05	0.20
150mA	.05	.20
250mA	.05	.12
500mA	.05	.12
750mA	.05	.12
1AMP	.05	.12
1.5A	.05	.12
2 AMP	.05	.12
3 AMP	.05	.12
5 AMP	.05	.12
7 AMP	.05	.12
10 AMP	.05	.12
15 AMP	.05	—
20 AMP	.05	—
25 AMP	.05	—

FUSES 20mm

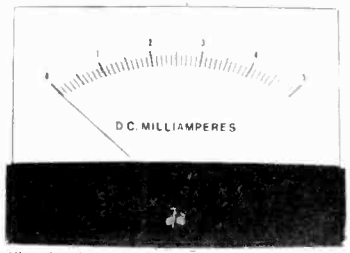
VALUE	QUICK BLOW	ANTI-SURGE
100mA	£.05	£.20
125mA	.05	—
160mA	.05	.20
200mA	.05	—
250mA	.05	.12
315mA	.05	.12
400mA	.05	.12
500mA	.05	.12
630mA	.05	.12
800mA	.05	.12
1 AMP	.05	.12
1.25A	.05	.12
1.6A	.05	.12
2 AMP	.05	.12
3.15	.05	.12
4A	.05	.12
5A	.05	.12
6.3A	.05	.12



Both 20mm and 1¼" fuses are available in quick blow or anti-surge. Please specify

PANEL METERS

REF	CAT	F.S.D.
ME1	T21	0-50 UA
ME2	T22	0-100 UA
ME3	T23	0-500 UA
ME4	T24	0-1 MA
ME5	T25	0-5 MA
ME6	T26	0-10 MA
ME7	T27	0-50 MA
ME8	T28	0-100 MA
ME9	T29	0-500 MA
ME10	T30	0-1 AMP
ME11	T33	0-50v.AC
ME12	T34	0-300v.AC
ME13	T35	"S"
ME14	T36	"VU"
ME15	T40	50-0-50 UA
ME16	T41	100-0-100 UA
ME17	T42	500-0-500 UA



Illuminating Kit
For Above 85p

PRICE	P&P
£4.50	**40p**

DIMS. – 2⅜" x 1⅞" x 1⅜"
REQUIRE 1½" DIA CUT OUT

MULLARD AUDIO MODULES

TYPE	FUNCTION	PRICE
LP1173	Audio Amplifier Module 10 watts	£7.54
LP1181	AM, IF Amplifier Module	£4.50
LP1183/2	Stereo Pre-Amplifier Module	£5.50
LP1184/2	Stereo Pre-Amplifier Module	£8.50
LP1185	FM-IF Amplifier Module	£6.50
LP1186	FM Tuner Module with Diode Tuning	£8.00
LP1400	Stereo Decoder Module	£8.50

All modules built an factory tested
Full data with each module or send 5p + S.A.E.

EXTRAS

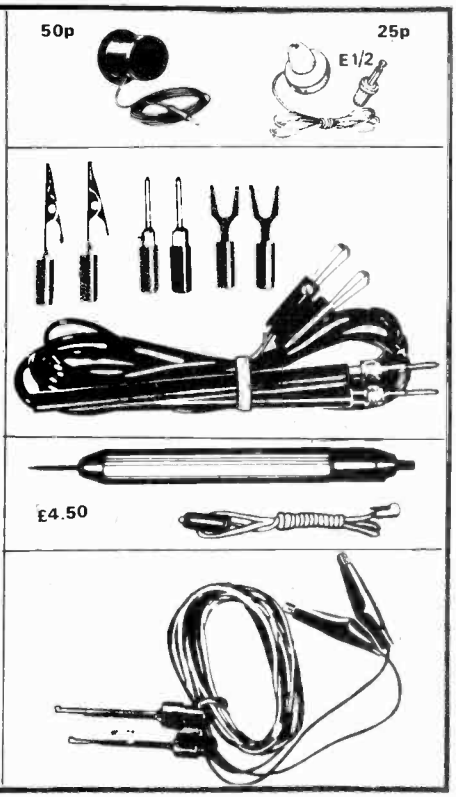
TELEPHONE PICK UP
suction action to phone enables conversation to be recorded (3.5mm plug)

EAR PIECE Crystal **45p**
EAR PIECE
Magnetic **25p**
3.5mm PLUGS

TEST LEAD KIT
Complete with long reach prods - banana plugs, pin plugs, spades and crocodile clips — all push on fittings
PRICE **£1.40**/Set

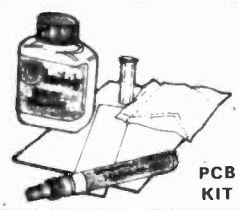
SIGNAL INJECTOR
Model SE250B
Unusually stable trouble-shooter — for checking TV, Radio, amp. etc. One hand operation — penlight battery. Output approx. 1.4v RP. at nom. 1kc/s + harmonics up to VHF measures 7" x 6"

TEST LEADS
P. Circuit-spring loaded push on hooks, joined to insulated crocodile clips at other end.
PRICE **60p**



PRINTED CIRCUIT KIT

ideal PCB kit for the enthusiastic printed circuit board designer.
Contains
Printed Circuit Board
Circuit Marker Pen
Etching Crystals
Solvent
Kit. Price **£3.25** + VAT



BRISTOL 0272 654201 **GLASGOW 041 332 4133**

Mullard TO-92

LOW COST TRANSISTORS

NPN	PNP
BC547	BC557
BC547 A&B	
BC548	BC558
BC548 A&B&C	BC558 A&B
BC549	BC559
BC549 B&C	BC559 A&B
BC337	BC327
BC338	BC328

Mullard

VERY AGGRESSIVE PRICES AVAILABLE

SEE NEXT PAGE

for your general purpose transistor needs

Plastic Low Power Transistors TO-92

NPN	V_{CBO} V	$I_{C(AV)}$ A	Near or Direct Replacements	Characteristics similar (Economic proposition if technically acceptable)
BC547	50	0.1	BC183, BC207, BC171, BC237, BC347, BC385	BC182 BC350
BC547A				
BC547B				
BC548	30	0.1	BC208, BC170, BC172, BC238, BC348, BC386	BC183, BC318, BC351, BC354
BC548A			BC132	
BC548B			BC113	
BC548C				
BC549	30	0.1	BC209, BC173, BC239, BC335, BC333, BC349	BC184, BC319, BC382, BC383
BC549B			BC114	
BC549C				BC413
BC337	50	0.5	BC223, BC232, BC317	BC537, BC255
BC338	30	0.5		
PNP				
BC557	-50	0.1	BC213, BC225, BC204, BC251, BC257, BC307	BC212
BC558	-30	0.1	BC205, BC250, BC252, BC258, BC308, BC357	BC213, BC355
BC558A				
BC558B			BC224	
BC559	-25	0.1	BC206, BC253, BC259, BC309	BC214,
BC559A			BC334, BC336	
BC559B				BC415
BC327	-50	0.5	BC327, BC231, BC320, BC321, BC381	BC322, BC527
BC328	-30	0.5		BC381

INDEX

SESCOSEM power transistors and Zener Diodes

Quality and Reliability

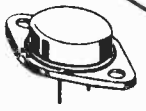
500mW at 25° C **BZX 83C** Sieries

1 WATT at 25° C **IN4728A to IN4764A** Series

TEMPERATURE COMPENSATED IN821 FAMILY

TO3 POWER TRANSISTORS

PLASTIC POWER TRANSISTORS



on the move

THOMSON-CSF

Thomson-CSF United Kingdom Ltd.
Ringway House, Bell Road, Daneshill
Basingstoke RG24 0QG Tel: (0256) 29155

A. MARSHALL (LONDON) LTD. LONDON 01 452 0161

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LISTED BELOW ARE SOME OF THE MORE POPULAR SEMICONDUCTORS WE STOCK FROM OUR PRINCIPLE FRANCHISE SUPPLIERS.

TRANSISTORS

THESE PRICES APPLY FOR ORDERS OF 100 PIECES OR MORE OF ANY ONE ITEM OR 500 MIX MINIMUM 25 PCS PER TYPE

TYPE No	100+ £	TYPE	100+	TYPE	100+	TYPE	100+	TYPE	100+	TYPE	100+	TYPE	100+
2N697	.25	2N5484	.26	BD241A	.29	TIP41C	.67	MC1352P	.90	SN74C174	.80	IN4004	.05
2N699	.33	2N5486	.27	BD241C	.34	TIP42A	.51	MC1495L	4.25	SN74C175	.80	IN4005	.07
2N706	.16	2N6121	.25	BD242A	.30	TIP42C	.67	MC1496G	1.00	SN74C920D	8.39	IN4006	.08
2N708	.17	2N6122	.26	BD242C	.38	TIP2955	.55	MC1553G	6.00	SN74C922	2.62	IN4007	.09
2N914	.31	2N6123	.27	BD243A	.52	TIP3055	.48	MC14553	5.50	SN74C923	2.69	IN4148	.06
2N1131	.21	2N6126	.29	BD243C	.68	TIS43	.22	MM5314	3.65	SN74S262N	8.62	IN4446	.08
2N1132	.24	AC126	.34	BD244A	.57	TIS50	.33	MM5316	3.65	SN76001N	.98	IN4448	.06
2N1613	.24	AC127	.39	BD244C	.75	TIS60	.13	SAJ110	1.23	SN76003N	1.74	IN5400	.12
2N1700	1.30	AC128	.34	BD438	.30	TIS61	.15	SAS560	1.32	SN76008KE	1.05	IN5401	.14
2N1711	.19	AC151	.28	BD439	.30	TIS62	.29	SAS570	1.32	SN76013N	1.15	IN5402	.15
2N1889	.32	AC152	.31	BDX18N	1.20	TIS88A	.26	SAS580	1.38	SN76013ND	.98	IN5404	.16
2N2102	.28	AC153	.38	BDY20	.70	TIS90	.15	SAS590	1.38	SN76018KE	1.05	IN5406	.20
2N2192	.33	AC153K	.42	BDY56	1.36	TIS91	.17	SO41P	72	SN76023N	1.15	IN5407	.24
2N2193	.28	AC176	.39	BF161	.52	TIS92	.27	SO42P	.85	SN76023ND	.98	IN5408	.35
2N2194	.30	AC176K	.42	BF167	.16	TIS93	.27	SN7400N	.14	SN76033N	1.74	IS44	.06
2N2218	.25	AC187K	.41	BF173	.17	AD161	.73	SN7401N	.14	SN76110N	.91	IS920	.06
2N2219	.28	AC188K	.40	BF177	.18	AD162	.77	SN7408N	.20	SN76115N	1.17	IS921	.06
2N2220	.25	ACY22	.35	BF178	.22	AF106	.38	SN7409N	.25	SN76176N	1.28	IS923	.10
2N2221	.18	ACY30	.50	BF179	.28	AF109	.60	SN7410N	.18	SN76131N	.86	IS940	.04
2N2222	.19	BC107A/B	.13	BF180	.22	AF139	.39	SN7413N	.44	SN76226N	1.21	Zener Diodes	
2N2368	.20	BC108/A/B/C	.13	BF181	.22	AF239	.39	SN7414N	1.56	SN76227N	.95	BZX83 400MW	
2N2369	.18	BC109/B/C	.14	BF194	.13	AF240	.90	SN7441AN	.89	SN76228N	1.09	Series	
2N2903	.88	BC115	.17	BF195	.13	AF279	.46	SN7442N	.69	SN76530N	.56	2.7—47v	.06
2N2904	.25	BC116A	.17	BF196	.12	AF280	.48	SN7446N	1.08	SN76532N	.99	IN4728A IW Series	
2N2905	.25	BC136	.16	BF197	.15	CA3018	.80	SN7447AN	1.00	SN76533N	.86	3.3—62v	.14
2N2906	.19	BC140	.26	BF198	.15	CA3028A	.90	SN7448N	1.00	SN76544N	.89	BZY97 1.5w Series	
2N2907	.25	BC141	.28	BF200	.23	CA3046	.80	SN7474N	.37	SN76546N	.99	3.9—33v	.21
2N2926	.10	BC147B	.10	BF224J	.14	CA3080	1.60	SN7475N	.51	SN76550-2	.26	BZX70 2.5w Series	
2N3053	.26	BC148B/C	.10	BF244A	.23	CA3086	.44	SN7486N	.36	SN76552-2	.41	7.5—75V	.40
2N3054	.48	BC149B/C	.10	BF245A	.23	CD4001	.18	SN7489N	1.69	SN76570N	1.28	BZV40 5w Series	
2N3055	.47	BC160	.30	BF255	.15	CD4006	1.02	SN7490AN	.55	SN76620AN	.68	3.3—120v	.45
2N3302	.20	BC161	.33	BF257	.28	CD4011	.18	SN7493N	.55	SN76650N	.87	BZY93 20w Series	
2N3392	.10	BC167A/B	.07	BF258	.30	CD4013	.41	SN7496N	.92	SN76660N	.40	6.8—75v	.75
2N3394	.10	BC168A/B/C	.07	BF259	.34	CD4016	.41	SN74107N	.37	SN76666N	.60	IN821	.18
2N3439	.85	BC169B/C	.08	BF271	.15	CD4017	1.57	SN74121N	.44	TAA370A	1.71	IN823	.28
2N3440	.60	BC177A/B	.16	BF336	.26	CD4029	.99	SN74123N	.51	TAA550	.35	IN825	.44
2N3441	.75	BC178A/B	.16	BF337	.30	CD4049	.49	SN74141N	.89	TAA630	2.33	TIC44	.24
2N3442	1.15	BC179A/B	.16	BF338	.35	CD4060	1.10	SN74147N	2.14	TAAB61A		TIC46	.36
2N3566	.12	BC182A/B	.08	BF457	.32	CD4511	1.58	SN74148N	1.33	TAA960	1.34	TIC47	.52
2N3663	.13	BC182LA/B	08	BF458	.34	CD4518	1.38	SN74166N	1.49	TAA970	1.50	C106A	.27
2N3702	.10	BC183A/B/C	.08	BF459	.37	LM114H	1.72	SN74173N	1.76	TAA120	.47	C106B	.30
2N3704	.12	BC183LA/B/C	.08	BFR39	.19	LM301-8	.44	SN74187N	.86	TBA120	.47	C106D	.40
2N3706	.10	BC184B/C	.08	BFR40	.19	LM380-3	.58	SN74LS00	.17	TBA480	1.10	C116A	.34
2N3708	.09	BC184LB/C	08	BFR41	.19	LM308N	.67	SN74LS02	.17	TBA500Q	1.37	C116B	.38
2N3711	.11	BC212A/B	.08	BFR79	.19	LM309K	1.24	SN74LS04	.20	TBA520Q	1.37	C116C	.42
2N3771	1.40	BC212LA/B	.08	BFR80	.19	LM317K	2.07	SN74LS08	.17	TBA540Q	1.37	C116D	.47
2N3772	1.50	BC213A/B/C	.08	BFR81	.19	LM379S	2.59	SN74LS10	.17	TBA560Q	1.92	C126B	.50
2N3773	1.95	BC213LA/B/C	.08	BFX29	.39	LM380-9	.58	SN74LS13	.44	TBA641B	2.20	C126D	.60
2N3789	2.63	BC214B/C	.08	BFX30	.39	LM380-14	.65	SN74LS32	.19	TBA800	.90	C126M	.75
2N3794	.11	BC2144B/C	.08	BFX84	.30	LM381AN	1.65	SN74LS42	.73	TBA810S	.87	K005	1.75
2N3819	.25	BC237B	.08	BFXB5	.30	LM3B1N	1.03	SN74LS74	.27	TCA105	.84	K01	1.95
2N3820	.25	BC238A/B	.08	BFX86	.30	LM382N	.79	SN74LS75	.44	TCA440	.94	K04	2.75
2N3823	.53	BC239B	.08	BFXB7	.30	LM389N	.62	SN74LS76	.27	TCA640	1.49	PW005	.75
2N3855	.23	BC257A	.07	BFX88	.23	LM555CH	.59	SN74LS85	1.15	TCA650	1.49	PW01	.78
2N3904	.10	BC258A	.08	BFY50	.25	LM556CN	.66	SN74LS86	.31	TCA660	1.74	PW04	.90
2N3905	.09	BC259B	.08	BFY51	.25	LM723C	.62	SN74LS90	.70	TCA730	1.92	S005	.32
2N3906	.10	BC300	.26	BFY52	.25	LM723-14	.51	SN74LS92	.65	TCA740	1.64	S01	.35
2N4036	.39	BC301	.26	BFY90	.85	LM725CN	1.65	SN74LS107	.30	TCAB20	1.78	S04	.50
2N4037	.34	BC302	.26	BSX21	.19	LM741C	.44	SN74LS138	.86	TCA980	1.56	W005	.27
2N4058	.12	BC303	.33	BSY28	.32	LM741C-8	.29	SN74LS151	.79	TDA1002	.96	W01	.29
2N4059	.11	BC307A/B	.08	8SY65	.32	LM741C-14	.37	SN74LS157	.79	TDA1004	1.48	W04	.35
2N4060	.10	BC308A/B	.08	BU104	1.24	LM747CN	.65	SN74LS160	1.00	TDA1022	4.15	TIC206D	.41
2N4122	.22	BC309A/B/C	.08	BU105	2.06	LM748-8	.44	SN74LS161	1.00	TDA1024	.59	TIC226D	.46
2N4124	.10	BC327	.11	BU126	1.24	LM748-14	.44	SN74LS162	1.00	TDA1034	1.64	TIC236D	.62
2N4126	.10	BC328	.11	BU204	1.25	LM1303	.69	SN74LS163	.100	TDA2540	1.78	TIC246D	.80
2N4286	.11	BC413	.10	BU205	1.30	LM1304	.93	SN74LS164	.97	UUA170	1.52	TIC253D	1.23
2N4289	.12	BC414	.11	BU206	1.50	LM1316	.55	SN74LS175	.89	UUA180	1.52	TIC263D	1.31
2N4303	.20	BC415	.11	MJ481	1.40	LM1458CP1	.81	SN74C00	.18	BA102	.14	LD30A	.14
2N4304	.17	BC547A/B	.07	MJE340	.47	LM1496N	.55	SN74C02	.18	BA154	.10	LD35A	.18
2N4347	1.40	BC548	.07	MJE370	.40	LM1812	3.72	SN74C04	.18	BA155	.10	LD37A	.18
2N434B	1.70	BC549B/C	.09	MJE371	.49	LM3018	.80	SN74C08	.18	BA156	.13	LD41A	.16
2N4904	1.30	BC557	.08	MJE520	.34	LM3900	.51	SN74C10	.18	BA1B2	.09	LD55A	.20
2N4918	.45	BC55B	.08	MJE521	.47	LM3905	1.03	SN74C20	.18	8AX13	.04	LD57A	.20
2N4919	.54	BC559	.08	MPF102	.28	LM320T		SN74C30	.18	8AX16	.06	LD57C	.50
2N4920	.64	BCY58	.19	MPF103	.30	5/12/15/24	1.90	SN74C32	.18	BB103	.18	LD261	.70
2N4921	.38	BCY70	.23	MPF104	.30	LM320MP		SN74C42	.18	BB104	.29	LD460	2.35
2N4922	.46	8CY71	.28	MPF105	.32	5/12/15/24	.86	SN74C48	1.58	8B105A/B	.21	LD470	3.00
2N4923	.54	BCY72	.14	MPSA05	.17	LM323K	4.31	SN74C73	.49	BB105G	.15	LD480	3.00
2N5086	.13	BCY78	.37	MPSA06	.17	LM340T		SN74C74	.41	BY126	.23	TIL209	.12
2N5190	.44	BD115	.40	MPSA12	.27	5/12/15/24	.86	SN74C76	.49	BY127	.26	TIL210	.14
2N5192	.64	BD131	.40	MPSA55	.17	LM341P		SN74C85	1.31	BY164	.55	TIL212	.13
2N5194	.59	BD132	.43	MPSA56	.17	5/12/15/24	.72	SN74C86	.46	BY206	.15	NSN373	2.63
2N5245	.26	BD135	.25	OC42	.42	LM78LO		SN74C90	.61	OA47	.9	NSN374	2.63
2N5294	.25	BD136	.25	TIP29A	.22	5/12/15/24CH	.58	SN74C107	.87	OA90	.06	NSN583	2.78
2N5296	.25	BD137	.26	TIP29C	.27	LM78LO		SN74C151	1.75	OA91	.06	NSN584	2.78
2N5298	.25	BD138	.26	TIP30A	.24	5/12/15/24CK	1.2(	SN74C157	1.57	OA200	.06	BPX29	1.30
2N5447	.11	BD139	.27	TIP30C	.30	LM7BLO		SN74C160	.99	OA202	.06	BPW34	1.50
2N5448	.10	BD140	.27	TIP31A	.25	5/12/15/24CZ	.27	SN74C161	.99	IN914	.08	ORP1	.71
2N5449	.11	BD239A	.30	TIP31C	.31	MC846P	.60	SN74C162	.99	IN916	.05	BP100	.69
2N5457	.22	BD239C	.33	TIP32A	.27	MC1312P	1.75	SN74C163	.99	IN4001	.04	BPX79	2.84
2N5458	.22	BD240A	.29	TIP32C	.33	MC1327P	1.35	SN74C164	.87	IN4002	.04	TIL138	1.67
2N5459	.22	BD240C	.36	TIP41A	.51	MC1350P	.70	SN74C173	.80	IN4003	.04	TIL139	1.67

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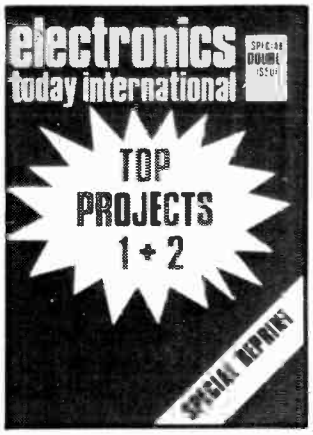

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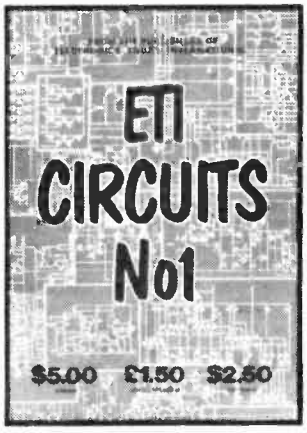

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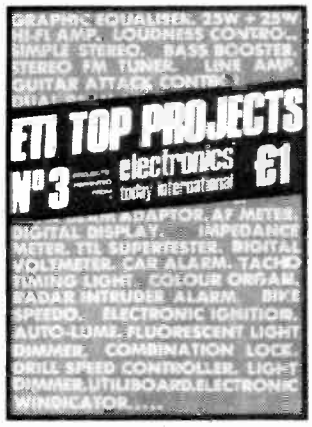

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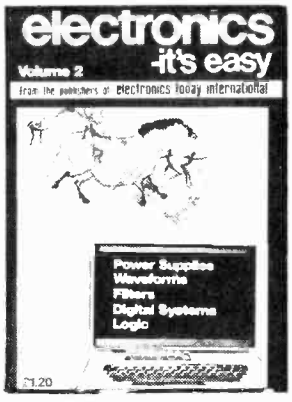

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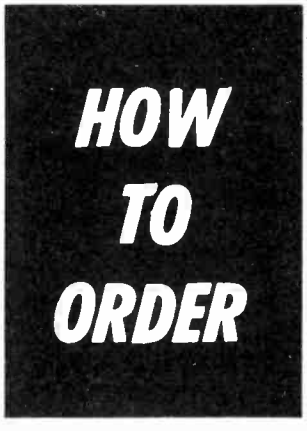

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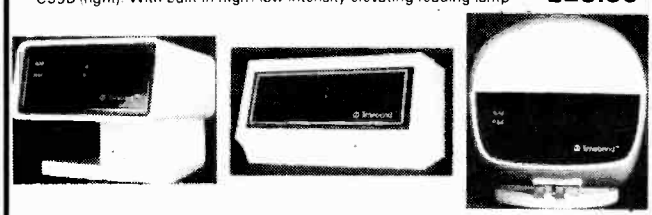

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SYSTEM BUS & VDU INTERFACING

Described by John Miller-Kirkpatrick

THERE ARE SEVERAL "standard" methods of interconnecting PCBs in an MPU system, these are known as different 'Bus Structures'. Probably the first of these is the one now known as the 'IMSAI' or S-100 Bus, developed for use with the Altair and Imsai computer systems which were the first popular 8080 microcomputer systems in the USA.

Most of the semiconductor manufacturers have chosen to ignore this standard in producing development kits and as other kit manufacturers copy or base their designs on the development kits so the hopes of a real standard dwindle. There are several groups now trying to set up another set of bus structures for the UK. Apart from the IMSAI BUS, SWTC BUS, etc, most of the others are based on the idea of using the DIN standard 'Eurocard' format of card size. This allows the smallest card to be 100 x 160 mm with double and quad Eurocards being multiples of the basic size. In System 68 we have decided to adopt the small single Eurocard as the basic card size, thus allowing the use of standard casing and connector systems.

The connector which we intend to use whenever possible is a 31-way DIN standard plug and socket system. There is no fixed parallel bus structure as 31-way severely limits the number of signal lines which can be included on every card.

The basic System 68 is based on a 4K block which most people will want to extend not long after getting the basic system operational. The logical extension to make is to add on more program memory in the form of PROM or RAM, a logical size to allow for in each expansion card is 4K. A 4K RAM card would require 2 or perhaps 3 power supply lines, 8 data lines, 12 address lines, read and write strobes and a "CARD ENABLE" line. Thus we have already allocated 26 of our possible 31 ways leaving 5 lines uncommitted, we could of course parallel the top 4 address bits as well as the lower 12 but this would leave only a couple of lines spare (CARD ENABLE would not be required).

From our definition of the requirements for a 4K RAM card we can lay down a 'preferred' bus structure on which System 68 cards should be designed wherever possible. Now the eagle-eyed amongst you will notice that the VDU cards do not fit this 'preferred' structure and the reason is that the VDU is an example of available space being a more important consideration than conforming to the 'preferred' bus. As the card sockets have to be wired to each other it is a simple matter to change from one layout to another. This makes System 68 a lot more flexible than most of the other micros on the market.

When wiring up the backplane connectors be neat, using different coloured wires for each signal and connecting them with as little excess wire as possible will help you and the MPU.

System 68 backplane connections

PIN No.	VDU CARD	PREFERRED FORMAT
1	+5v	GND
2	GND	U/C
3	U/C	U/C
4	NWDS	U/C
5	Address bit 9	NWDS
6	Address bit 8	NRDS
7	Address bit 7	U/C
8	Address bit 6	U/C
9	Address bit 5	U/C
10	Address bit 4	Data bit 7
11	Address bit 3	Data bit 6
12	Address bit 2	Data bit 5
13	Address bit 1	Data bit 4
14	Address bit 0	Data bit 3
15	VDU ENABLE	Data bit 2
16	KBD ENABLE	Data bit 1
17	NRDS	Data bit 0
18	Data bit 0	Address bit 11
19	Data bit 1	Address bit 10
20	Data bit 2	Address bit 9
21	Data bit 3	Address bit 8
22	Data bit 4	Address bit 7
23	Data bit 5	Address bit 6
24	Data bit 6	Address bit 5
25	Data bit 7	Address bit 4
26	--12V	Address bit 3
27	INT/KBD STROBE	Address bit 2
28	RESET	Address bit 1
29	U/C	Address bit 0
30	U/C	--12V
31	U/C	+5V

U/C = Uncommitted

Note. On the PCB layout for VDU board B the pin numbers are marked from the wrong end.

Using the VDU

The VDU system described in the past two months is of the 'Direct Access' type of VDU rather than the 'Serial' or pseudo-teletype type. The main advantages of the System 68 VDU over the TTY compatible units are speed and Read/Write facilities. Speed is very different because the direct access VDU has RAM which is shared with the MPU and thus the speed of writing a character or page of characters relies only on the speed of the MPU and the efficiency of the program.

Carriage Return?

The term Carriage Return / Line Feed otherwise known as CR / LF comes from TTY printer systems where at the logical or physical end of each line the printer carriage which holds the paper must be returned to its start position and the paper advanced one line by a line feed instruction.

In the case of the TTY VDUs the hardware is worked out to reset the character counter per line to zero (CR) and to cause the VDU to address the next line down (LF).

In the case of the System 68 VDU we do not have any hardware commands whatsoever and so all commands of this type must be decoded by a software routine which is driven by the main program and which in turn is solely in command of the VDU.

Carriage Routine

In its simplest form this routine will be passed the character to be output by the main program via a register, a stack or Working Storage RAM. The routine will test the character and decide whether it is an ASCII control character or a printable character. If the character is to be 'printed' then it is placed in the next available VDU RAM location and will thus be displayed by the VDU on the next page scan, as this happens every 20mS the change on the VDU can be considered to be instant. The routine will now increment the 'next available VDU location' register and store this address in RAM and then pass control back to the main calling program.

If the output character is found to be an ASCII control character the routine must go through a sequence of operations which will have the same effect as the control character would have on a TTY printer.

If it is a CR then what we need the MPU to do is to write spaces up to the end of the current line and then jump back into the normal end of routine which will update the 'next location' register and store it. Thus next time the main program wishes to output a character that character will be placed in the location following the previous end of line which just happens to be the first location on the next line. The interesting thing is that in most MPUs which I have looked at this simple form of VDU control takes up about the same amount of software

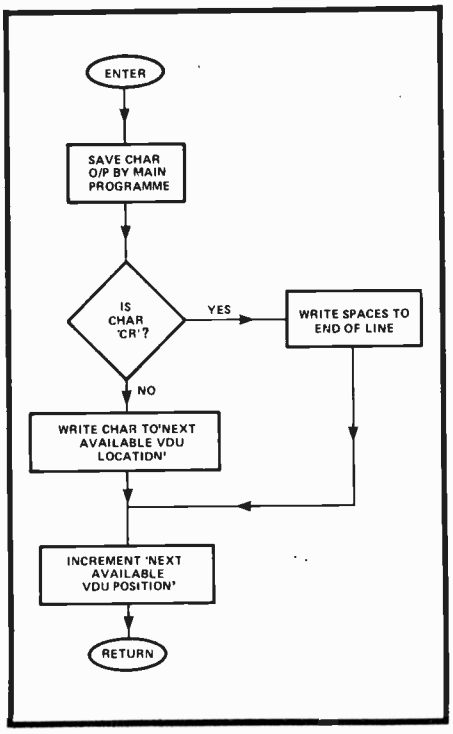


Fig. 1 Flow chart showing routine to implement writing to VDU. With this routine the only allowable ASCII control character is CR.

(program) as a software TTY routine, about 40-50 bytes. An example of this will be given when we discuss the software for System 68 in a couple of months' time, in the meantime those of you with MPUs who want to use System 68 VDU should be able to grasp the basic program requirements.

MPU + VDU = AOK

Connecting the System 68 VDU to an MPU is a reasonably simple matter as the shared RAM concept makes it almost as easy as adding RAM. For a start the 8 bit data bus from the VDU is connected to the MPU data bus (with buffering if required), similarly the basic 10 bit VDU address bus is connected to the lower 10 bits of the MPU address bus.

Ignoring the keyboard control signals for the time being we are left with only three signal lines — VDU ENABLE, NWDS and NRDS. The VDU ENABLE line is effectively the same as the chip select line on a 1K RAM, it must be taken to a logical low status at the same time as the address is set up on the bus. It is hardware decoded from the upper bits of the MPU address bus to define a 1K byte block starting address, in a small 4K system this might well be X'800' and thus the VDU ENABLE line will go low if the upper address bus indicates an address in the range X'800' to X'BFF' inclusive. As far as the MPU is concerned this RAM is now available for it to use as it wishes and it is the job of the VDU sub-routine to use it as a VDU.

The two other signals are NWDS (Not Write Data Strobe) and NRDS (Not Read Data Strobe), NWDS goes low whenever data is available on the data bus and a valid address is available on the address bus and a WRITE to RAM condition is required. NRDS is similar except that it is available if a READ operation is required, these are standard signals which must be available in any MPU system which uses RAM. By studying last month's circuit you should be able to see the effects of these signals on the VDU RAM and thus on the screen.

Key to Success

The keyboard control signals on the System 68 VDU board B are similar to the controls for the VDU and thus the DATA, and NRDS strobes are shared with those of the VDU (NWDS makes no sense with

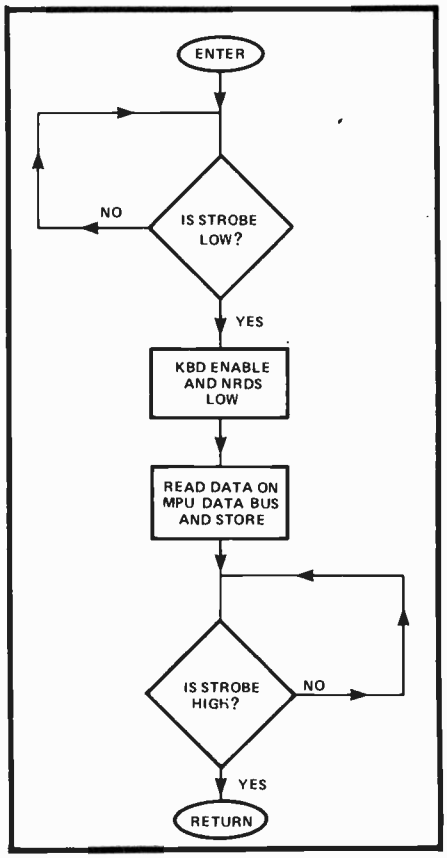


Fig. 2 Flow chart showing routine to implement a read from keyboard operation.

most keyboards). The additional control signals are 'INT' or strobe, RESET and three reserves. 'INT' is the negative going strobe signal produced by most ASCII keyboards and can be connected to the MPU interrupt or other sense input or can be connected as the eighth input bit from the keyboard. RESET is to be connected to allow resetting of the MPU from the keyboard rather than or in addition to the front panel, it should be connected to the MPU RESET pin. The three Reserves are intended for user applications for keyboard option switches or to allow the MPU to drive lamps, buzzers, relays, etc, on the keyboard, note that although only three lines are available these could be encoded or decoded by a 3 to 8 multiplexing chip.

Key to the Sub

The software required for examining the keyboard is very simple and again let us assume that it is a sub-routine called by the main program. The subroutine could have been called by the interrupt system in which case we know that the strobe line is already low and thus valid data is available at the keyboard buffer. Alternatively we have to enter a loop which continually tests the strobe signal and branch out of the loop when this signal goes low. In both cases we can now put the KBD ENABLE line low in a manner similar to that used for VDU ENABLE. At the same time we must put NRDS low to indicate that we wish to read the data at that location and the combination of both signals will enable the outputs of the KBD buffer and place the keyboard data on the MPU data bus. Our subroutine does all of this by executing a READ instruction and then saves the character data input in RAM. In order to fully debounce the keyboard the routine will now enter another loop to await the release of a key and thus the change to logic '1' of the strobe pulse. Command is now passed back to the main calling program with the input character in RAM or a register.

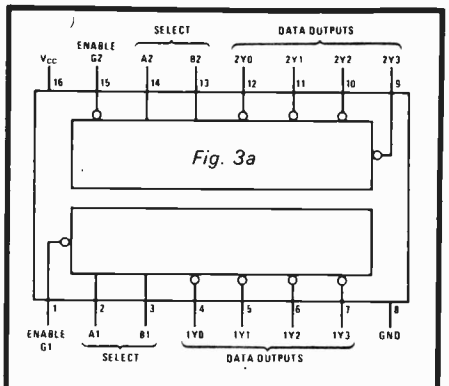
Device address decoding

This concept can be one of the most daunting to new MPU users -- but have no fear, System 68 is here! Most MPUs claim to be able to access 64Kilobytes (65,536 bytes) but do not say what they are accessing. Others claim to have bolt-on goodies like I/O PORTS or PIAs and ACIAs, these are all ways of kidding the MPU that it is addressing one of the 64K locations available to it.

In the case of the 6800 the first instruction (effectively) is fetched from location X'FFFE' after a RESET or Power-up. The data in this location cannot be random and thus it has to be previously defined as ROM or switches and then has to be uniquely accessed by the MPU address bus so that the data at that location *only* can be loaded onto the MPU data bus.

Consider the standard (not ITT) 74LS139, this is a dual 2 to 4 line decoder in a sixteen pin package. If we wish to break up our 4K into four 1K blocks we can ignore the lower 10 bits of the address bus and use the next two as inputs to one of the 2 to 4 line decoders. These two address lines can be in any of 4 live (ie not TRI-STATE) states defined by logic levels 00, 01, 10, 11. The 74LS139 uses these to enable one of four outputs which can then in turn be used to enable a block of 1K bytes (eg VDU ENABLE). Similarly we can break down one of these blocks into four 256 byte blocks by using the other half of the 74LS139 and use one of the outputs as KBD ENABLE We can also use another output from the 74LS139 (second half) to define an area of 256 bytes of RAM for use as a stack or Working Storage RAM. A RAM chip such as the 2112 is presented as 256 locations each with 4 bits, thus two of these chips would give 256 x 8 bits or 256 bytes. These chips are internally decoded to access each of the 256 locations uniquely and all they require is the lower 8 bits of the address bus plus a device address (usually called CHIP ENABLE) which in our example is output from the 74LS139.

By using further similar decoding techniques it is not difficult to work out how to access X''FFFE' uniquely without having to use a ton of TTL decoders.



INPUTS			OUTPUTS			
ENABLE	SELECT					
G	B	A	Y0	Y1	Y2	Y3
H	X	X	H	H	H	H
L	L	L	L	H	H	H
L	L	H	H	L	H	H
L	H	L	H	H	L	H
L	H	H	H	H	H	L

H = high level, L = low level, X = don't care

Fig. 3b

Fig. 3 Chip pin-out for 74139 is shown in (a) above; (b) shows the truth table for this IC.

Tri-State Buffers, etc

MPUs introduced a new concept to digital electronics, that of a third output state of a logic gate. This can be very difficult to comprehend especially as most explanations are in the form of technical language.

We can however consider a TRI-STATE thus as two lots of 8 two position switches so that the first 8 switches are either open circuit or connected to the wipers of the other 8 switches and in turn these switches are connected to either logic '1' or '0'. It is assumed that all of the second batch of switches are preselected with the required logic states and that the first set of switches are all in the open circuit state. By closing all 8 of these switches at once the 8 outputs will change from open circuit to the preselected logic states. If you control all 8 of the output switches with a solenoid driven from a relay which in turn is driven by a logic '0' signal then you have just built an 8 bit TRI-STATE port! Most IC manufacturers have put all of this into ICs in the form of 4, 6 or 8 bit buffers, for example the 8095,6,7,8 6 bit buffers or the 8195,6,7,8 8 bit buffers as used in System 68 VDU.

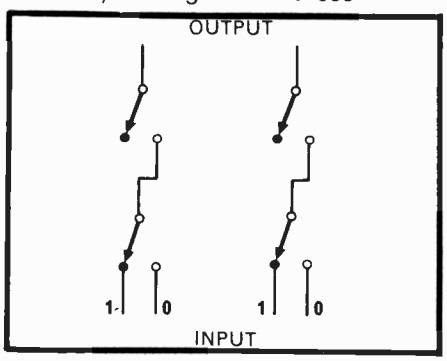


Fig. 4 A TRI-STATE gate may be represented by switches as shown above.

Next month

The 6800 MPU board.

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4006	1.31	4030	0.60	4054	1.29	4086	0.80
4007	0.20	4031	2.46	4055	1.46	4089	1.74
4008	1.07	4032	1.19	4056	1.46	4093	0.89
4009	0.60	4033	1.55	4057	29.81	4094	2.08
4010	0.60	4034	2.11	4059	6.20	4095	1.16
4011	0.20	4035	1.31	4060	1.24	4096	1.16
4012	02.0	4036	3.09	4061	25.60	4097	4.13
4013	0.60	4037	1.06	4062	10.10	4098	1.22
4014	1.12	4038	1.20	4063	1.22	4099	2.03
4015	1.12	4039	3.09	4066	0.69	40101	1.76
4016	0.60	4040	1.19	4067	4.13	40102	2.16
4017	1.12	4041	0.93	4068	0.24	40103	2.16
4018	1.12	4042	0.93	4069	0.24	40104	2.26
4019	0.60	4043	1.12	4070	0.65	40107	0.66
4020	1.24	4044	1.04	4071	0.24	40108	6.18
4021	1.12	4045	1.56	4072	0.24	40109	2.21
4022	1.07	4046	1.48	4073	0.24	40181	4.30
4023	0.20	4047	1.01	4075	0.24	40182	1.73
4024	0.87	4048	0.60	4076	1.71	40194	2.26
4025	0.20	4049	0.60	4077	0.65	40257	2.26
4026	1.92	4050	0.60	4078	0.24		

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14505	4.38	14521	2.77	14543	1.82	14568	3.15
14506	0.57	14522	2.15	14549	4.10	14569	3.72
14507	0.60	14526	2.15	14552	10.50	14572	0.27
14508	3.08	14527	1.76	14553	4.66	14580	8.35
14510	1.51	14528	1.22	14554	1.67	14581	4.30
14511	1.74	14529	1.72	14555	1.01	14582	1.64
14512	1.03	14530	0.95	14556	1.01	14583	0.84
14514	3.47	14531	1.74	14557	4.65	14584	0.71
14515	3.47	14532	1.39	14558	1.25	14585	1.10
14516	1.51	14534	8.15	14559	4.10		
14517	4.02	14536	4.00	14560	2.17		

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74C04	0.26	74C90	0.92	74C192	1.49	74C918	2.90
74C08	0.26	74C93	0.92	74C193	1.49	74C920	9.84
74C10	0.26	74C95	1.31	74C195	1.31	74C921	9.84
74C14	1.51	74C107	1.31	74C200	7.20	74C925	8.28
74C20	0.26	74C150	4.17	74C221	1.50	74C926	8.28
74C30	0.26	74C151	2.63	74C901	0.74	74C927	8.28
74C32	0.26	74C154	3.93	74C902	0.74	74C928	8.28
74C42	1.20	74C157	2.36	74C903	0.74	80C95	1.20
74C48	2.37	74C160	1.49	74C904	0.74	80C96	0.92
74C73	0.74	74C161	1.49	74C905	7.71	80C97	0.87
74C74	0.63	74C162	1.49	74C906	0.74	80C98	0.92
74C76	0.74	74C163	1.49	74C907	0.74	88C29	6.21
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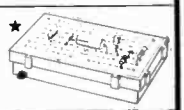

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MICROFILE

Our micro man, Gary Evans, takes a look at a new system of large scale software distribution and at some new items of hardware.

THE PATTERNS THAT are shown at the top of this page are beginning to appear on a wide range of products, from paperback books to tins of baked beans. They are typical of the optical bar codes that can be used to record digitally encoded information.

The advantage of storing information in this way is that the data may be quickly and accurately read into a POS (Point Of Sale) terminal, stock control computer etc., thus making sophisticated stock control procedures and easy handling of invoices possible.

An example of use would be at a supermarket checkout. Each product would have a code printed on its label which would be read with the aid of a simple bar code reader. The POS terminal would decode the product information and access a "look up" table to determine the unit price. This amount would then be added to the invoice total. The terminal could also modify the stock level of that product enabling accurate, up to the minute stock levels to be maintained.

The increased flexibility of systems such as this together with the falling costs of the hardware involved means that many people are beginning to adopt systems based on these bar codes.

More Bars Please

Let's turn now to a problem faced in the home computer field — namely that of low cost software distribution on a large scale.

Software, be it in the form of high level language statements, assembly language statements or as an object code, can be stored and transported in a wide variety of forms. In this country at the moment it seems that there is no standard method of software exchange media, instead, the first method that comes to mind is used.

These methods include dumping the program to PROM, to paper or cassette tape, or indeed, as a teletype print out.

None of the above methods meet the ideal requirements of a software exchange medium, namely that it be of low cost and of high reliability.

These two requirements should be met by both the encoding and decoding operations. Thus while a paper tape reader may be cheap to produce, the production of paper tape requires a large amount of mechanical devices, slowing the process and adding to the cost. On the other hand, while software trading via a paper print out is cheap it does not meet the requirement of high reliability, depending as it does on manual loading into a system.

It's about now that the relevance of our first few paragraphs becomes apparent. Why not encode our software in the form of a bar code?

Software in this form could be produced reasonably cheaply on high speed printing machines, perhaps as part of a magazine. The data may also be easily loaded into a home computer system. With a simple light per reader, consisting of a light source and photo-sensitive element, not costing a great deal, this system meets our two basic requirements.

It may not surprise you to know that this has already been done in America. A number of software packages have been published, including a nice 4K Assembler for any M6800 based system.

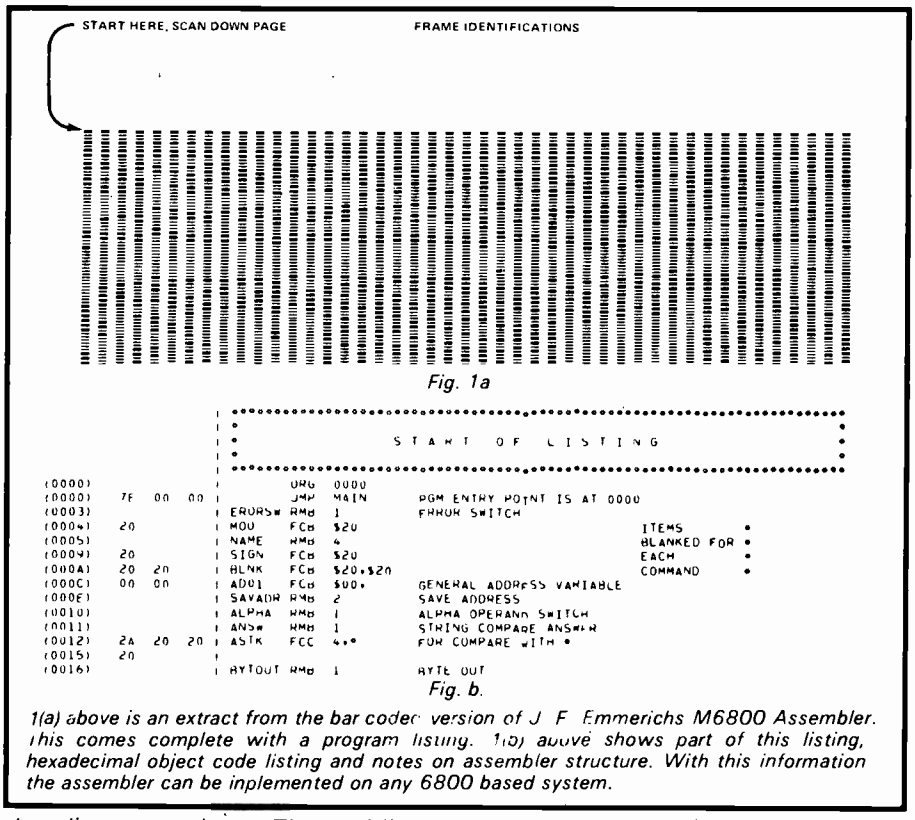

Fig. 1a

```
                    *****************************************************
                    *                                                   *
                    *                  START OF LISTING                 *
                    *                                                   *
                    *****************************************************
(0000)                      ORG  0000
(0000)  7E  00  00          JMP  MAIN       PGM ENTRY POINT IS AT 0000
(0003)              ERORSW  RMB  1          ERROR SWITCH
(0004)  20                  FCB  $20                          ITEMS     *
(0005)              NAME    RMB  4                            BLANKED FOR *
(0009)  20                  FCB  $20                          EACH      *
(000A)  20  20              BLNK FCB  $20,$20                 COMMAND   *
(000C)  00  00              ADD1 FCB  $00,   GENERAL ADDRESS VARIABLE
(000E)              SAVADR  RMB  2          SAVE ADDRESS
(0010)              ALPHA   RMB  1          ALPHA OPERAND SWITCH
(0011)              ANSW    RMB  1          STRING COMPARE ANSWER
(0012)  2A  20  20  ASTK    FCC  '*'        FOR COMPARE WITH *
(0015)  20
(0016)
                    BYTOUT  RMB  1          BYTE OUT
```

Fig. b.

1(a) above is an extract from the bar coder version of J F Emmerichs M6800 Assembler. This comes complete with a program listing. 1(b) above shows part of this listing, hexadecimal object code listing and notes on assembler structure. With this information the assembler can be inplemented on any 6800 based system.

Hard Time For Soft Pirates

The low cost of distributing software by means such as bar coding also has an incidental advantage. It kills off the "Software Pirates" that were begining to operate in this area.

These "pirates" would operate in much the same fashion as record bootleggers. They would produce low grade copies of any new software offered on the market, usually in the form of a CUTS encoded tape.

These copies being of very inferior quality, contained many bugs. They were supplied without any documentation i.e. source listing, flow charts, and so often proved impossible to debug (Have you ever tried to debug an object code program without good documentation and retained your sanity?)

With the major suppliers able to offer software cheaply and with adequate additional information it is

MICROFILE

hoped that the "pirates" will find no room in our lobby as they benefit nobody but themselves.

2716 Is FAMOS

Intel have recently developed a 16K EPROM which has a number of new features which make it one of the easiest to use EPROMS that we have come across. Apart from being the largest device of this type commercially available, the 2716 has programming requirements that are far easier to meet than many of the earlier types.

When programming the 2716, the 26V supply required does not have to be externally switched during the program cycle. Instead the necessary switching is incorporated on the chip enabling each address to be selected and programmed with a single pulse.

The chip uses FAMOS transistors as the storage elements and makes use of passive oxide isolation to reduce the space between the transistors of the memory array.

It is interesting to compare the 2716 with the 2708 (at 8K the largest EPROM to date).

The 2716 is four times as dense as the 2708, consumes 20% less power while retaining the same access time. It also incorporates a low power standby mode which does not degrade its access time.

While not for the amateur yet, it will not be long before we are able to get our hands on goodies like this.

National COPS Out

National Semiconductor recently launched their COPS (Calculator Orientated Processor Systems) family of 4-bit microprocessors. They are aimed at filling the gap between general-purpose micros, which are often too powerful, and dedicated systems which take too long to develop.

The range consists of the MM 5781 and MM5782, a two chip set, together with two single chip controllers, the MM5799 and the MM57140. Each chip has the same basic architecture but they differ in the amount of ROM, RAM and number and type of I/O ports they provide.

These chips should prove ideal for applications from basic industrial control situations to sophisticated POS (Point Of Sale) terminals. The MM5799 has already found a home in Sinclair's new Programmable Calculator.

COPS chips should also be able to provide a nice fast "number cruncher" board for your microcomputer system.

Daz-ling Chip

Glancing through an ITT semiconductor catalogue the other day, we came across a device which we found quite interesting.

The pin-out of the 28 pin package is quite different from those that we usually see. Pins marked -- 15V and OV are familiar enough, but pins marked BIO, RINSE HOLD and FAST WASH?

The chip is in fact the ITT7150 which is typical of the dedicated micros that are beginning to appear in consumer goods. The 7150 spends its life controlling washing machines, hence the pin designations above. It provides a comprehensive range of control functions, and when used with a few interface circuits, it can replace the mechanical wonders that have appeared in washing machines until now.

With micros finding their way into dish washers, microwave overs and freezing systems in the near future we wonder what chip pin-outs of the future will look like. ●

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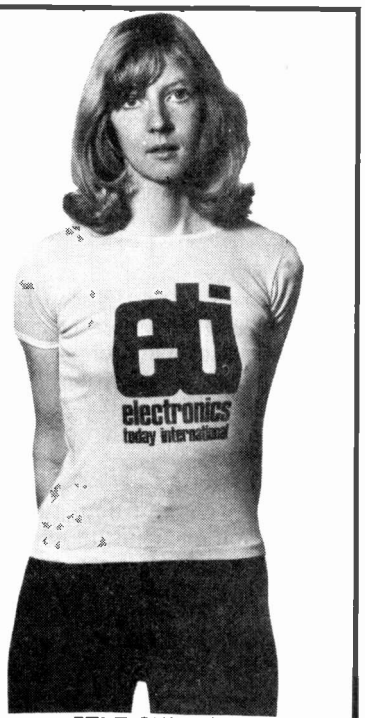

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POTENTIOMETERS

PART 12 OF OUR COMPONENT SERIES LOOKS AT THE VARIOUS POTENTIOMETER TYPES THAT ARE IN COMMON USE TODAY

POTENTIOMETERS ARE MADE in such a bewildering array of sizes, shapes, styles, and combinations that it is difficult to sort out what best suits a particular situation and what alternatives there may be. Apart from that, they come in a variety of wattage ratings, voltage ratings, resistance variation 'laws', etc – and how are you going to sort through that lot?

Potentiometers perform some control function by varying a resistance element or by tapping off a voltage from a fixed resistance. The variable resistor may need to be varied continuously so that some control function is performed, or it may be a 'preset' control which is only required for some calibrating or 'trimming' function. Preset potentiometers are generally called 'trimpots'.

So, potentiometers are generally split into two broad categories – **continuously variable** types, which are equipped with a shaft for the attachment of a knob, and **trimpots** which are generally equipped with a screwdriver slot.

Types

There are five basic types of potentiometer, classified according to the type of resistance element employed:

(1) Carbon composition
(2) Carbon Film
(3) Hot-Moulded Carbon
(4) Cermet
(5) Wirewound

Carbon composition pots have a composition element moulded to the required size and shape and generally employ a metallic spring-wiper. They are generally quite inexpensive but have the disadvantage that they become noisy after use. Carbon film pots consist of a resistive film that is sprayed or screened onto a phenolic former of the required size and shape. A metallic spring-wiper is also generally used in this type of pot, and the element will withstand many more rotations than a composition type before noise problems. Carbon film pots are also inexpensive and are the commonest types in use, along with Hot Moulded Carbon types. Carbon film pots have a good degree of resolution whereas the composition types are poor in this respect.

Hot Moulded Carbon potentiometers are manufactured by a process wherein the resistive element, insulating base, and terminations are moulded into one integral part. A carbon wiper contact is usually employed. They have a high wattage rating on a size-to-size basis and a high degree of conformity between units. This factor, together with their very high resolution, has led them to be increasingly used as precision controls. They exhibit low noise levels in operation compared with carbon film and wirewound types.

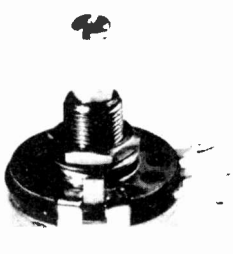

Fig. 1. The common, basic style of potentiometer. It has a threaded bushing and nut for panel mounting through a single hole and standard solder lug terminals.

Cermet potentiometers find wide application in precision controls, as trimpots and in many stringent applications (the element is rugged, exhibits low noise levels in use, and has good resolution). Wattage ratings are similar to those for hot moulded carbon pots of a similar size. They are generally somewhat more expensive. A metallic wiper is usually employed.

Wirewound potentiometers consist of a resistance wire would on a former with a metallic wiper, although a graphite wiper contact is sometimes used on low value, high wattage types. They have the disadvantage of being noisy, the resistance changes in small 'steps' as the wiper passes over the turns of wire, and they are usually more bulky than other types of equivalent value. However, they can be made in very low resistance values and they are able to dissipate much more power than other types of equivalent value.

Styles

The most common, basic style of potentiometer is illustrated in Figure 1.

In some applications, 'Tandem' or 'Ganged' potentiometers are required (for example for stereo tone and balance controls). They consist of several potentiometers all connected to the one shaft and stacked one behind the other, as illustrated in Figure 2. 'Dual-Concentric' potentiometers appear similar to the dual-ganged pot on the left in Figure 2. However, in this case, each pot is separately controlled by means of two concentric shafts. Dual-concentric pots are often used where there is limited space (e.g., for the RF and audio gain controls on a communications receiver).

The assembly illustrated in Figure 3 consists of four potentiometers mounted on the four sides of a metal box and connected by means of a special linkage to the lever which may be moved in any direction. These assemblies are used for complex control functions such as quadrophonic 'balance' controls, radio controlled models etc.

Switches are often mounted on the rear of potentiometer assemblies and connected (mechanically) to the control shaft so that the one control knob may serve several functions. There are three basic types of switches generally used: the rotary type, the push-pull type and push-push type. A rotary style of switch is often employed as a mains-power switch on a control, such as a volume control. It has the advantage that when the switch is moved to the ON position the control is at minimum. But, it has the disadvantage that anything up to the first 15% or 20% of the control cannot be used. On many controls this is of

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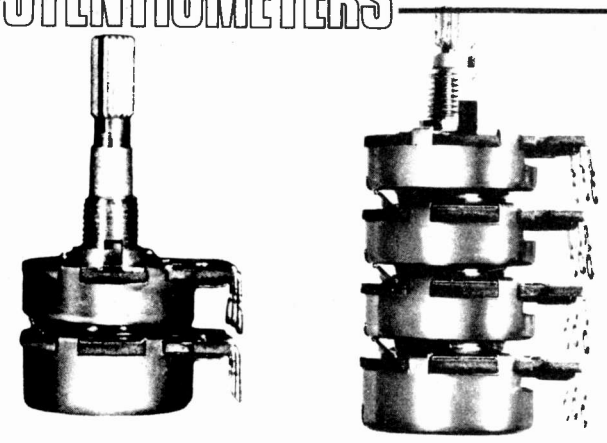


Fig. 2 'Tandem' or 'ganged' potentiometers consist of several potentiometers controlled by one shaft. 'Dual-concentric' type are similar to the one on the left except that they are separately controlled by concentric shafts, one inside the other – the inner, shaft controlling the 'back' pot and the outer shaft controlling the 'front' pot.

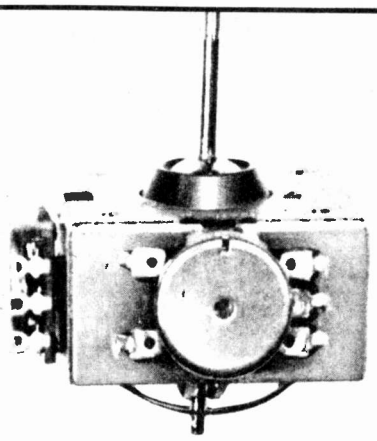


Fig. 3 Lever-controlled 'quad' pot assembly. These assemblies are used for complex control functions such as quadrophonic sound 'balance' and in model control applications etc.

little consequence. Push-Push and push-pull switches have the advantage that the control may be left in a certain position and switch operation does not disturb it. With a volume control however, this may be disastrous as the equipment may be turned on while the volume control is at a high setting, or worse still, full on!

While solder-lug terminals are commonly found, potentiometers are also manufactured with terminals suitable for printed circuit board mounting,

Power Ratings

With the exception of wirewound types the majority of standard potentiometers are obtainable in ratings of 0.1, 0.2, 0.25, 0.5 and 1 watt. Potentiometers are derated in much the same manner as fixed resistors. If this information is desired it is best to consult the manufacturer's literature.

Wirewound potentiometers are obtainable in ratings up to 100 watts (!!) but more usually they are available in ratings (depending somewhat on their resistance value) of 0.5, 1, 2, 5, 10, 15 and 20 watts. The higher power ones are usually quite bulky. Cermet and hot moulded carbon types are generally the smallest size for a given rating.

Resistance Law

The resistance 'law' of a potentiometer refers to the manner in which the resistance changes (as measured between as end terminal and the wiper terminal) with rotation of the shaft. There are a considerable number of different 'laws' in common use. The main ones however are: linear, logarithmic, and 'S' law. These are illustrated in Figure 4. Note that various log laws are used, the 20% log law is the more common one however. The laws for both clockwise (CW) and counter-clockwise (CCW) log are illustrated, as the potentiometer may be connected to operate in reverse fashion if desired. The various common laws are given a letter code which is stamped or marked on the body of the assembly along with the resistance value. The code is quite straightforward, as follows:

A = linear law
B = logarithmic law
C = reverse logarithmic (or anti-log)
S = 'S' law.

A pot may be marked 25kA, which is a 25k ohm, linear law potentiometer. Another may be marked 1M/C, which is a one megohm, reverse logarithmic pot.

The linear law control varies resistance in direct proportion to the rotation of the shaft. This type of pot is commonly used in voltage control applications, on tone controls and other applications which require a straightforward resistance variation.

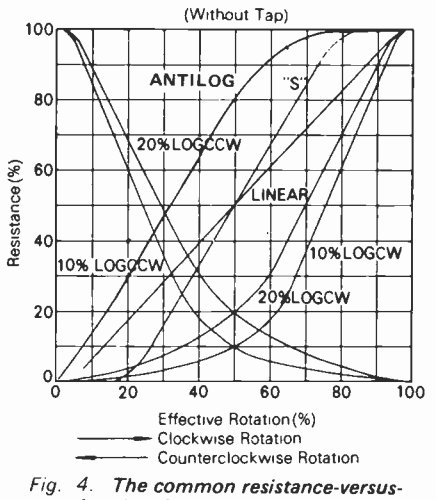


Fig. 4. The common resistance-versus-rotation 'laws' as 'tapers' for potentiometers.

With a log law control, the resistance increases very gradually during the initial rotation of the shaft, most of the resistance change occurring in the last 20-30% of the rotation. This type of law approximates the natural sensation of loudness as our ears follow a logarithmic law in their sensitivity to sound amplitude. Consequently, such controls are frequently used as volume controls so that they produce an apparent linear increase in sound output as the shaft is rotated. If a linear control were used, the greatest change in perceived volume would occur within the first 10-20° of shaft rotation.

Anti-log laws provide the reverse the greatest change in resistance takes place in the early portion of the shaft rotation, the least change occurs in the last 30-40% of shaft rotation.

The 'S' law provides only a small change in resistance for the initial and final 20% of shaft rotation and provides a linear variation between these extremes.

Other laws include semi-log and linear-tapered. These have curves that lie between the log and linear curves on the graph in Figure 4. The semi-log law provides a somewhat greater change of resistance-versus rotation over the first 40% of shaft rotation than with the log curve. The linear-taper provides a nearly logarithmic variation over the first 50% of shaft rotation and a linear variation thereafter.

Resistance Ranges

Most types of carbon element potentiometers are made in values ranging from 50 ohms up to 2 M. Some older types were made in values as high as 500 M. Cermet potentiometers are made in values ranging from 10 ohms to 10 M.

Some manufacturers make their pots to values in the standard E6 (20%) series (i.e.: 47 ohms to 2 M for carbon types). However, many pots are made with values according to the following decade series: 10,15,20,25,50 & 100. i.e: 2 k5, 5 k, 10 k, 15 k, 20 k, 25 k, 50 k, 100 k etc . . .
Some (typically of US make) include 75 in the value range.

Wirewound potentiometers are made in values ranging from 10 Ω to 100 k.

Slide Pots

These are pots having a linear element rather than a circular element as in standard pots. They are available generally with a carbon element having slider ranges of typically 50 mm, 75 mm, and 100 mm in the various laws as previously illustrated.

Slide pots have particular advantages of their own. One being that it is easier to see the proportional position of the control at a glance than with standard potentiometers. In some circumstances the slide pot provides a much more convenient form of control, for example in multi-channel audio mixer applications.

Trimpots

Trimpots are usually 'preset' controls. That is, they are only adjusted occasionally to set certain circuit parameters or conditions, for calibration purposes etc. Consequently they are generally adjustable by means of a screwdriver slot on the control shaft, although some have an integral knob to allow finger adjustment.

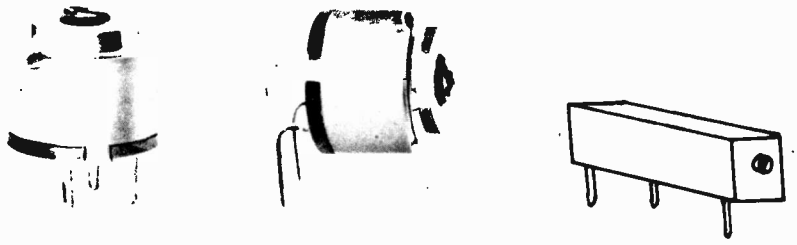
Trimpots are made in a wide variety of styles and sizes, as illustrated in Figure 5. Some types are enclosed to prevent the ingress of dust etc which can cause the control to become noisy in operation. Many types are only single-turn controls with the wiper covering only 180° in some cases, while others cover the more conventional 270-280° of rotation. Other trimpots are made for more critical applications and have a multi-turn control which allows a much finer and more accurate adjustment.

Manufacturers make trimpots in values ranging from 50 ohms to 5 M for carbon element types, and typically up to 30 M for Cermet types. Wirewound types are made in values typically ranging from 100 ohms to 5 k. Wattage ratings for the various types are typically 0.1, 0.2, 0.25, 0.5 up to 1 W. Trimpots are available in the same range of laws as are standard potentiometers, although most common styles have a linear law. Other characteristics are the same as for the type of element employed.

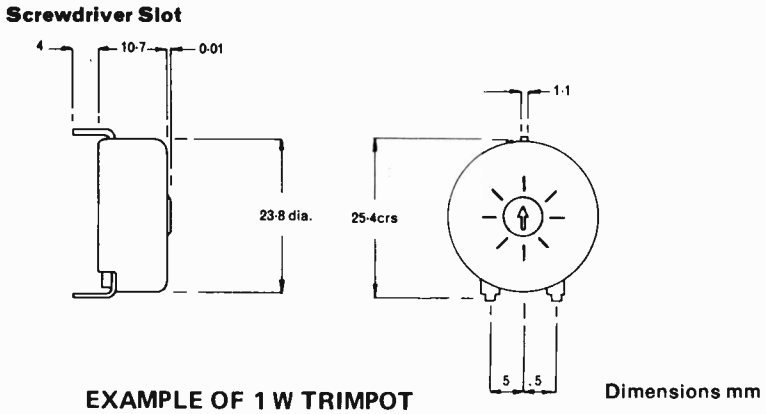
Open Style Circular Trimpots

VERTICAL MOUNT | HORIZONTAL MOUNT | HORIZONTAL MOUNT WITH INTEGRAL KNOB

Enclosed Types



VERTICAL MOUNT | HORIZONTAL MOUNT | MULTI-TURN TRIMPOT



EXAMPLE OF 1 W TRIMPOT

Dimensions mm

Fig. 5. Examples of various styles of trimpots.

Connecting Potentiometers

One thing that baffles electronic project constructors is the 'correct' way to connect a potentiometer.

The best way to illustrate how to do it is by example. The most common application of a potentiometer is that where it is required to vary a quantity (signal, voltage, etc) so that an increase occurs when the control shaft is rotated *clockwise*. The best example of this is a volume control.

In Figure 6 a pot is illustrated typically as you would see it when you come to make the connections. The arrow indicates the direction in which the control shaft will be turned to increase the output. THE TERMINAL IN THE CENTRE IS ALWAYS THE WIPER CONNECTION. So, terminal 1 (on the left as you view it to wire it up), connects to 'ground' or minimum. Terminal 2 (the wiper) connects to the output (in some cases it can also be the

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input terminal; operation of the pot still remains the same). Terminal 3 (the one on the right) connects to the input (or the output if the input is connected to the wiper).

Try it out for yourself. Get a 1 k (linear is best) pot and a battery (anything from 1.5 V to 9 V will do), hook up the battery with the positive to terminal 3, and the negative, to terminal 1. Connect a voltmeter with the negative to terminal 1 and the positive lead to terminal 2. Commence with the control shaft at the fully anti-clockwise position (hard left!). As you slowly rotate the shaft clockwise, the reading on the voltmeter will rise. True! It's easier to do it than it is to read about it. The wiper, in this case, commences at terminal 1 and moves towards terminal 3.

Some applications require the pot to work in the reverse fashion. For example, as a frequency or pulse rate control in an oscillator or multivibrator. In such cases, an increasing effect occurs as the wiper traverses towards the 'minimum resistance' end of the control. The pot is simply connected so that terminal 1 is the 'maximum resistance' end of the control and terminal 3 the minimum.

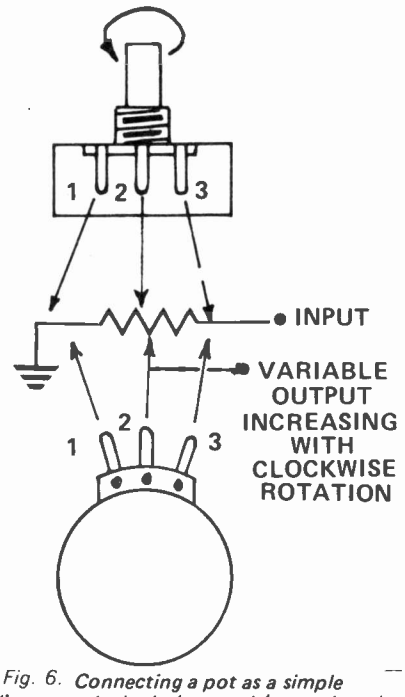


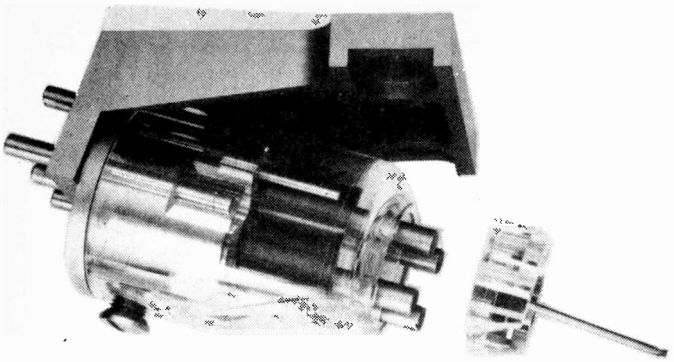
Fig. 6. Connecting a pot as a simple 'increase clockwise' control (e.g. volume).

Fig. 7. Pots in some applications require only a variation in resistance. Which terminals are connected together depends on the circuit effect.

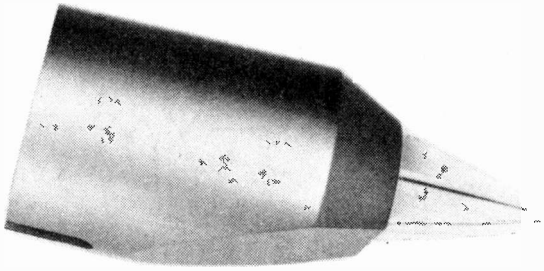
In some applications the circuit shows that the wiper is shorted to one of the 'end' terminals. But which one? Terminal 1, or 3? In such cases it depends on whether the 'maximum effect' occurs at minimum or maximum resistance. Look at Figure 7. The circuit shows that as the wiper traverses the element it shorts out the section of the track it has just traversed, decreasing the resistance as it moves towards the terminal which is not connected to the wiper. Leaving one 'end' terminal unconnected achieves the same purpose.

If the *maximum* effect (from the circuit in which the pot is to be connected) occurs at *minimum* resistance then terminals 1 and 2 are connected together. Maximum resistance (and thus minimum effect) occur at fully anti-clockwise rotation (hard left!). The effect increases as the control is rotated clockwise.

On the other hand, if the *maximum* effect occurs at *maximum* resistance then terminals 2 and 3 are connected together. Thus, as the control is rotated clockwise from the fully anti-clockwise position the resistance, and thus the effect, increases.



PICKUP PRINCIPLES



Ron Harris explains the workings of Hi-Fi's smallest black box

FOR ALL THE continuing sophisti-cation within the electronics of the hi-fi chain, no viable method has been offered up to extract the mechanical information from the good old L.P. other than the trusty electro-mechanical cartridge.

This in itself generates an order of magnitude more distortion than any hi-fi component, but for some as yet unexplained reason, people seem more ready to accept some quite quirky behaviour from cartridges than from anything else.

After all if a particular brand of amplifier needed its wires cleaning before every usage, its sales would remain nicely static at zero.

The term electro-mechanical can be seen to excuse a multitude of sins.

INDUCTION

Most pickups owe thier existance to Mr Faraday and his laws of induction. If you move a wire relative to a magnet within its field, you will generate an emf across that wire. It matters little whether you move the magnet or the coil of wire.

Various methods and variations have of course been evolved to utilise this principle to obtain an amplifiable voltage from the ups and downs of the vinyl.

Not all cartridges operate on this principle, just 90% of them!Ceramic devices are the main exception but these have completely faded from hi-fi usage, as the quality is no longer of comparitively high enough standard for the enthusiast.

The most common types are;

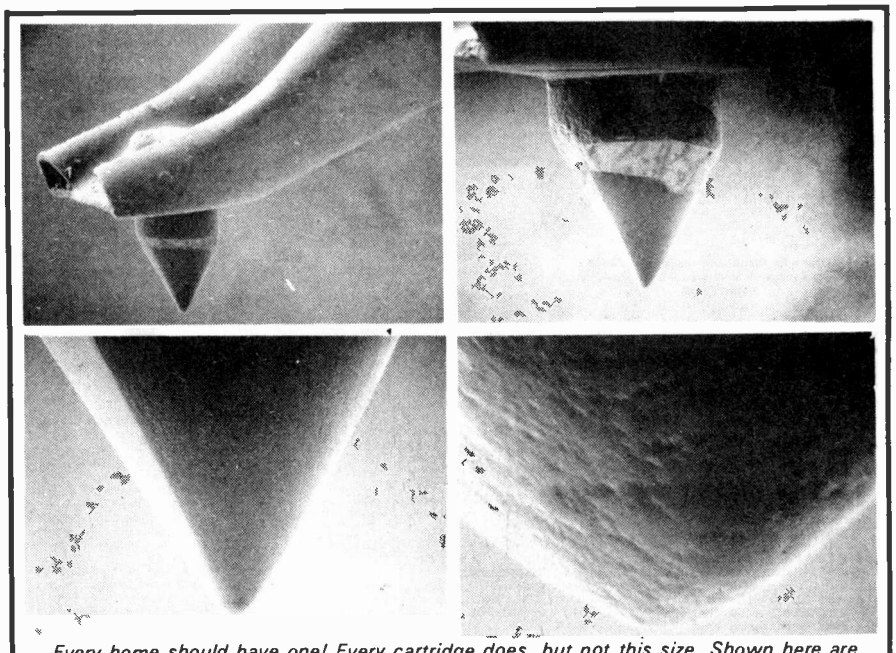
(i) Moving magnet
(ii) Moving coil
(iii) Moving iron Induced magnet
(iv) Electret

We shall be considering each type in turn.

No reference is made in this article to such universal parameters as tip mass compliance of cantilever, arm resonance, output level etc etc

Such things are of paramount importance, but have little to do with the operating principles behind the cartridges themselves.

We mention them lest you think we had forgotten, or worse still were ignorant of them!



Every home should have one! Every cartridge does, but not this size. Shown here are four extreme magnification shots of a Stanton stylus. From top, left to right, 50X, 100X, and on the bottom 400X and 2000X.
And you thought that diamond was smooth eh?

MOVING MAGNET

By far the most common method. Fig I shows the basic operation of a Phillips 412 super M pickup, which can be considered typical of the bar magnet variety.

The pole pieces PL and PR are composed of mu-metal. When the stylus moves following the groove wall at say the left channel signal, the magnet will follow a similar path such that movement takes place parallel to PR, varying the distance relative to PL. This causes an emf to be set up across the left channel coils. Since that movement takes place parallel to the right channel coil, no emf is generated across that coil.

Since the coils are detecting minute changes in flux, sheilding from external influences must be good so that these are not registered as signals. Transformers must be kept well away from all pickup cartridges, which is why your deck will invariably work better on one side of your amplifier than on another!

A variation on this theme has been penned by Audio Technica, who use one magnet for each channel, set at 45o to the record surface which makes them perpendicular to the groove walls. This does imitate the return of the cutting head pretty closely. The magnets are much smaller than usual, being around 25% of the mass normally utilised.

Since each channel was a totally separate motor assembly, stereo separation cannot help but be enhansed. Perhaps the most famous sons of the moving magnet are Shure, led by the VI5 111. This flagship design uses a laminated core structure, increasing the efficiency.

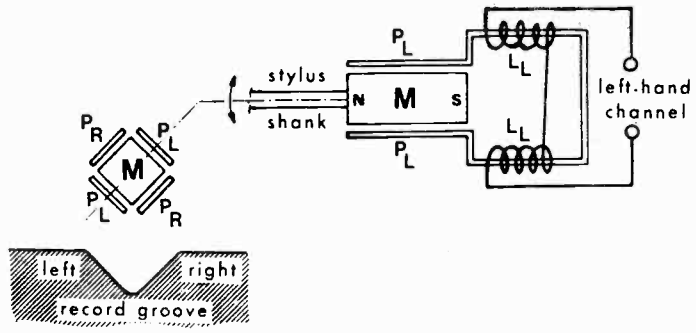
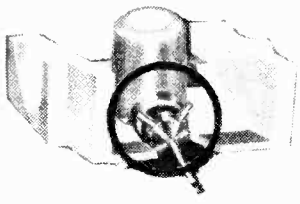
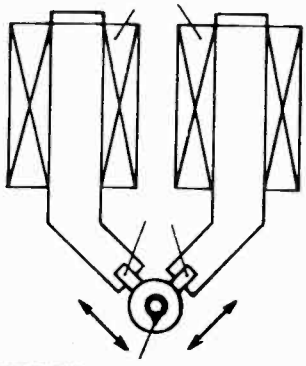
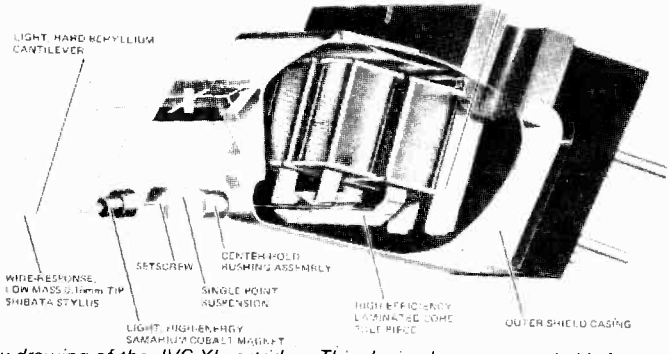


Figure 1. The workings of a moving magnet cartridge, which in this case is a Philips 412. The bar magnet is marked 'M', and PL and PR are the pole pieces for each channel.



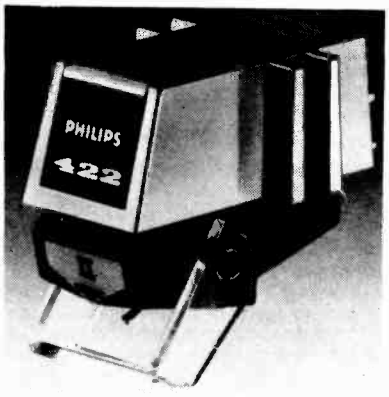


Audio Technica's dual magnet system. On the left an actual stylus assembly, and on the right how that bit in the circle operates, copying the cutting head movements.



A cutaway drawing of the JVC XI cartridge. This device has an extended h.f. response to allow it to produce CD4 records, a task for which it has become the standard machine!

Surely this needs no introduction? The Shure V15 Mk3, probably the most famous moving magnet cartridge and arguably the most transparent in reproduction.



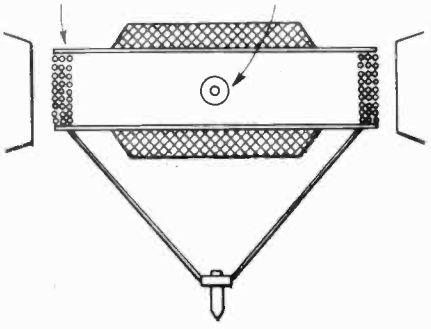
A Philips 422 Super M. Very under-rated device this, people tend to only use them in Philips decks! The diagram in Fig 1 refers to this cartridge.

MOVING COIL

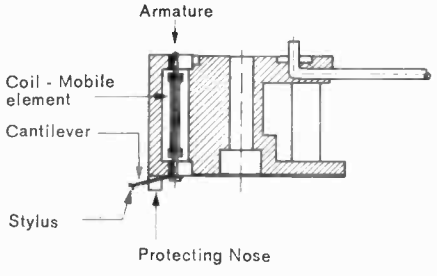
The oldest form of pickup cartridge. Originally developed by Ortofon, and now carried on by such adherents as Satin, Fidelity Research (and even Sony!).

The principle is extremely simple. The magnets are held in a fixed position within the cartridge body, and the coils for each channel are attached to the stylus assembly. The basic design is shown below. As the stylus follows the groove, the coils are forced to move next to the relevant magnets, thus inducing an emf in each.

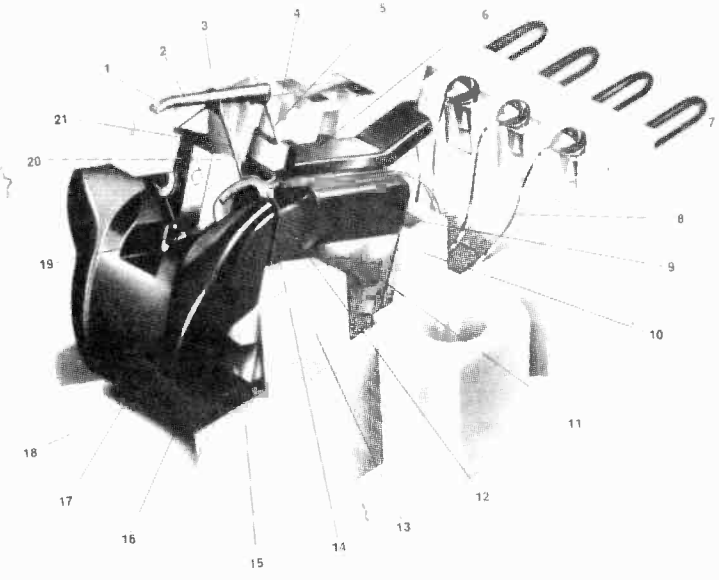
The main drawback is the low output, roughly 0.5 mV, as compared to 2 - 5 mV for the moving magnet designs. There are exceptions, notably Satin and Ultimo which produce outputs around 2mV. In order to raise this low level to one which can be fed to a normal input, a transformer or booster amp is required between cartridge and amplifier. However a tiny, but increasing number of amplifiers are now incorporating moving coil input to negate this requirement.



A highly simplified model of how a moving coil cartridge works. The blocks to either side represent the magnets, and the little flocks of circles are the coils.



Cutaway drawing of an early Ortofon moving coil device. An interesting feature is the vertical armature mounting. Note the protective nose mounted to safeguard the stylus!

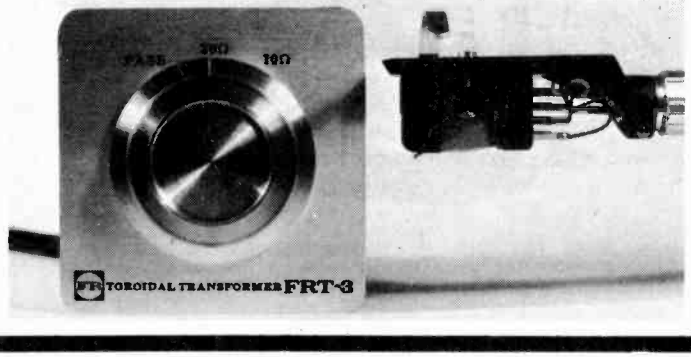


1. Stylus tip
2. Cantilever
3. Stylus housing
4. Tension wire
5. Plate spring
6. Stylus mounting magnet
7. Output terminals
8. Connecting wire
9. Oscillating block resonance damper
10. Oscillating block restriction wall
11. Magnet
12. Pole piece
13. Oscillating block restriction wall
14. Magnetic gap
15. Gap spacer
16. Yoke
17. Moving coil
18. Cartridge main housing
19. Armature positioning pin
20. Armature support
21. Pantograph-type armature

Above is an internal peek at a Satin moving coil pickup. This is one of the high-output cartridges which does not need a transformer or booster amp to be used with normal amplifiers.

If you're setting up a hi-fi system based on a moving coil cartridge, check out the Yamaha 1010 amplifier, it already possesses a high quality moving coil pre amp!

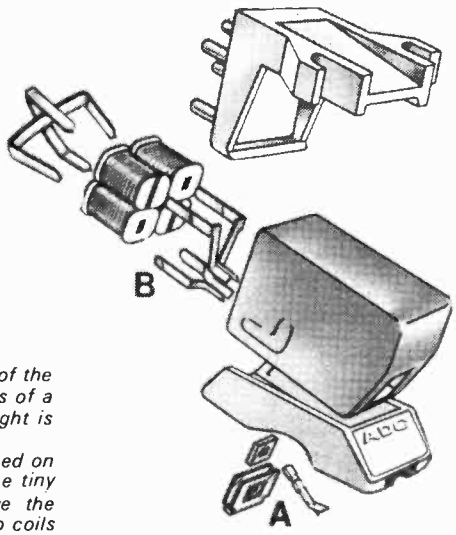
And in the right corner . . . a Fidelity Research device with its booster transformer. This Japanese device has picked up quite a few followers in its short but glorious career in Britain.

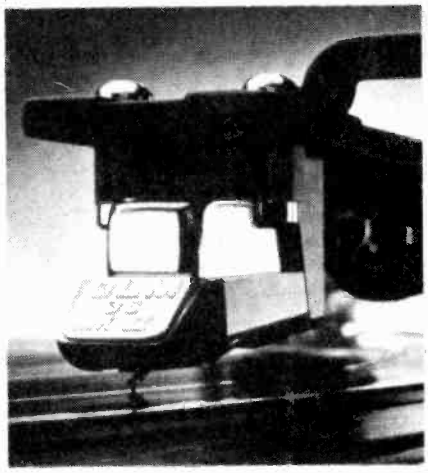


INDUCED MAGNET OR MOVING IRON

Replacing the moving magnets is a single high permeability armature which itself moves with the stylus within the field of the (fixed) magnets. As there is no mechanical linkage the mass of the stylus is reduced. ADC are the prophets of this system.

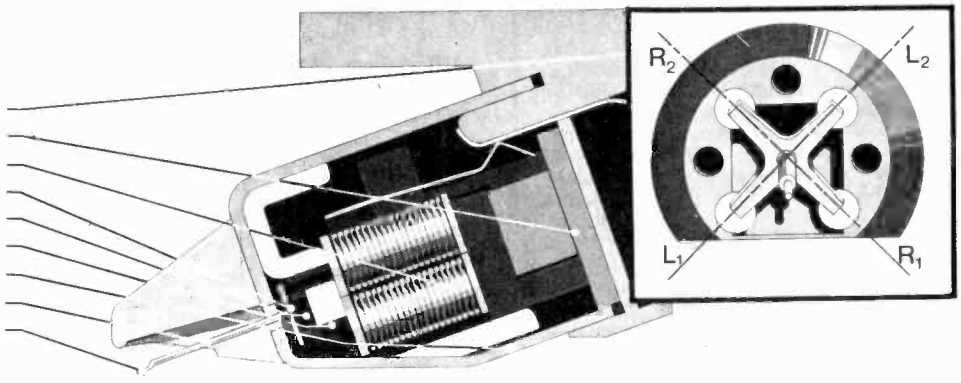
Bang and Olufsen have an innovation on the market in the form of the MMC range. Here a small 'cross' is attached to the armature and this influences the 4 induction coils, to obtain that emf.





Right: ADC are the main exponents of the art of the induced magnet. The drawing shows the vitals of a Q36 pickup following this doctrine. Further right is how it looks when in use and in one piece.
Below: Bang and Olufsen MMC is heavily based on the moving iron principle, but incorporates the tiny little cross (shown as an insert) to improve the transfer from armature to coils. Note that two coils per channel are used.

½" mounting bracket
Hycomax magnet
Induction coil (4 in total)
Moving micro-cross (MMC patent)
Block suspension
Pole piece (4 in total)
Mu metal screen
Ultra light cantilever
Stylus

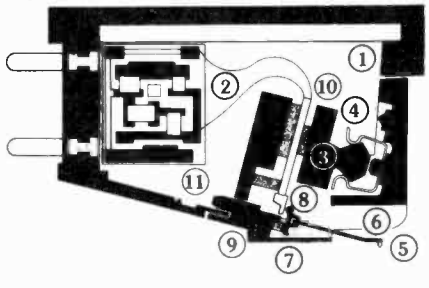


ELECTRET

Just as a quartz crystal is capable of producing an output under stress so are some semiconductor substances. An 'electret' is a permanently polarized block of material which, when stressed, produces an output voltage directly proportional to the force causing the stress.

In the Micro-Acoustics QDC 1E cartridge, a conventional stylus assembly joins with a pyramid shaped chunk of material which is pivoted in the centre of the base, and supported by two elastomer blocks, at each corner, where the actual electret contacts the pyramid.

Output impedence is around 8K, which shunts the usual 47K of amplifier inputs down. Micro claim this engenders their cartridges with lower noise figures. Phase shift characteristics should certainly be good, since the output impedence will be almost pure resistance, with very little capacitance present, and no inductance. The signs are that this system will be used increasingly as time goes on.



The drawing shows the insides of a Micro Acoustics 2002 electret cartridge. This is the cheaper version of the QDC 1E referred to in the text. To explain the numbers: 1, Total device possesses a mass of 4.0 grams; 2, Internal connecting wires to the matching circuit; 3, Dampers (mechanical); 4, Retainer spring for the stylus assembly; 5, Stylus assembly; 6, Beryllium cantilever; 7, Bearings and resolver; 8, Stylus to electret coupling; 9, User replaceable stylus assembly; 10, The actual electret transducer; 11, Passive matching circuit (matching to phono inputs).

ETI DATA SHEET

LM 2907, LM 2917 FREQUENCY TO VOLTAGE CONVERTORS — NATIONAL

The LM2907, LM2917 series are monolithic frequency to voltage converters with a high gain op amp/comparator designed to operate a relay, lamp, or other load when the input frequency reaches or exceeds a selected rate. The tachometer uses a charge pump technique and offers frequency doubling for low ripple, full input protection in two versions (LM2907-8, LM2917-8) and its output swings to ground for a zero frequency input.

Features

The op amp/comparator is fully compatible with the tachometer and has a floating transistor as its output. This feature allows either a ground or supply referred load of up to 50 mA. The collector may be taken above V_{CC} up to a maximum V_{CE} of 28V.

The two basic configurations offered include an 8-pin device with a *ground referenced tachometer* input and an internal connection between the tachometer output and the op and amp non-inverting input. This version is well suited for single speed or frequency switching or fully buffered frequency to voltage conversion applications.

The more versatile configurations provide differential tachometer input and uncommitted op amp inputs. With this version the tachometer input may be floated and the op amp becomes suitable for active filter conditioning of the tachometer output.

Both of these configurations are available with an active shunt regulator connected across the power leads. The regulator clamps the supply such that stable frequency to voltage and frequently to current operations are possible with any supply voltage and a suitable resistor.

Applications

The LM2907 series of tachometer circuits is designed for minimum external part count applications and maximum versatility. In order to fully exploit its features and advantages let's examine its theory of operation. The first stage of operation is a differential amplifier driving a positive feedback flip-flop circuit.

The input threshold voltage is the amount of differential input voltage at which the output of this stage changes state. Two options (LM2907-8, LM2917-8) have one input internally grounded so that an input signal must swing above and below ground and exceed the input thresholds to produce an output. This is offered specifically for magnetic variable reluctance pickups which typically provide a single-ended ac output. This single output is also fully protected against voltage swings to ±28V, which are easily attained with these types of pickups.

Following the input stage is the charge pump where the input frequency is converted to a dc voltage. To do this requires one timing capacitor, one output resistor, and an integrating or filter capacitor. When the input stage changes state (due to a suitable zero crossing or differential voltage on the input) the timing capacitor is either charged or discharged linearily between two voltages whose difference is $V_{CC}/2$. Then in one half cycle of the input frequency or a time equal to $1/2\ f_{IN}$ the change in charge on the timing capacitor is equal to $V_{CC}/2 \times C1$. The average amount of current pumped into or out of the capacitor then is: $= V_{cc} \times f_{IN}$

The output circuit mirrors this current very accurately into the load resistor R1, connected to ground, such that if the pulses of current are integrated with a filter capacitor, then $V_o = i_c \times R1$, and the total conversion equation becomes:

$$V_O = V_{CC} \times f_{IN} \times C1 \times R1 \times K$$

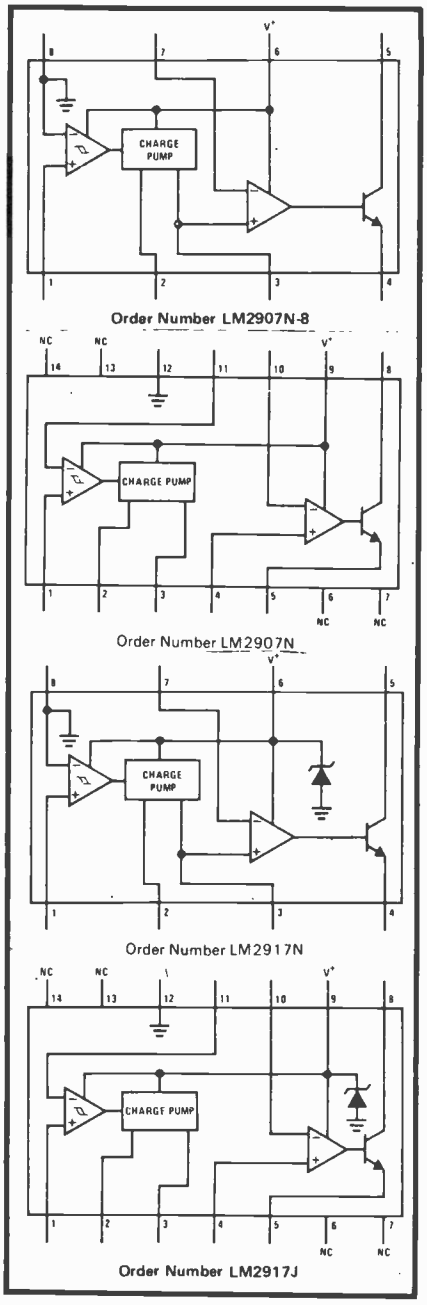
Where K is the gain constant — typically 1.0.

Applications

- Over/under speed sensing
- Frequency to voltage conversion (tachometer)
- Speedometers
- Breaker point dwell meters
- Hand-held tachometer
- Speed governors
- Cruise control
- Automotive door lock control
- Clutch control
- Horn control
- Touch or sound switches

Absolute Maximum Ratings

Supply Voltage	28V
Supply Current (Zener Options)	25 mA
Collector Voltage	28V
Differential Input Voltage	
Tachometer	28V
Op Amp/Comparator	28V
Input Voltage Range	
Tachometer	LM2907-8, LM2917-8 ±28V
LM2907, LM2917	0.0V to +28V
Op Amp/Comparator	0.0V to +28V
Power Dissipation	500 mW



Choosing R1 and C1

There are some limitations on the choice of R1 and C1 which should be considered for optimum performance. The timing capacitor also provides internal compensation for the charge pump and should be kept larger than 100 pF for very accurate operation. Smaller values can cause an error current on R1, especially at low temperatures. Several considerations must be met when choosing R1. The output current at pin 3 is internally fixed and therefore $V_o/R1$ must be less than or equal to this value. If R1 is too large, it can become a significant fraction of the output impedance at pin 3 which degrades linearity.

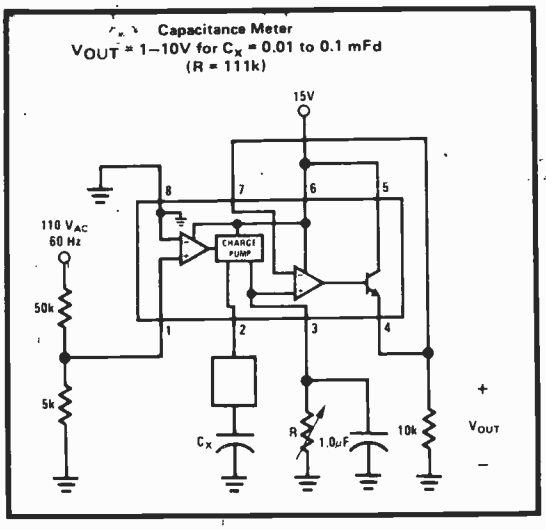
It appears R1 can be chosen independent of ripple, however response time, or the time it takes V_{OUT} to stabilize at a new voltage increases as the size of C2 increases so a compromise between ripple, response time, and linearity must be chosen carefully.

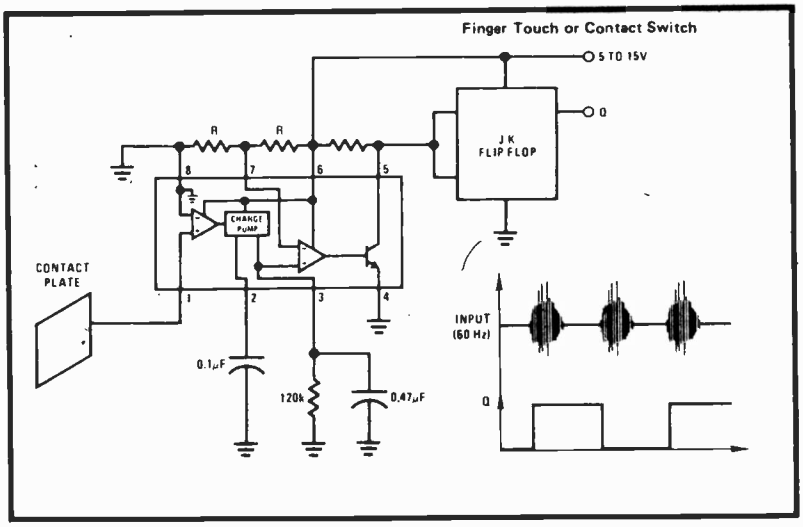
As a final consideration, the maximum attainable input frequency is determined by V_{CC}, C1 and I_2:

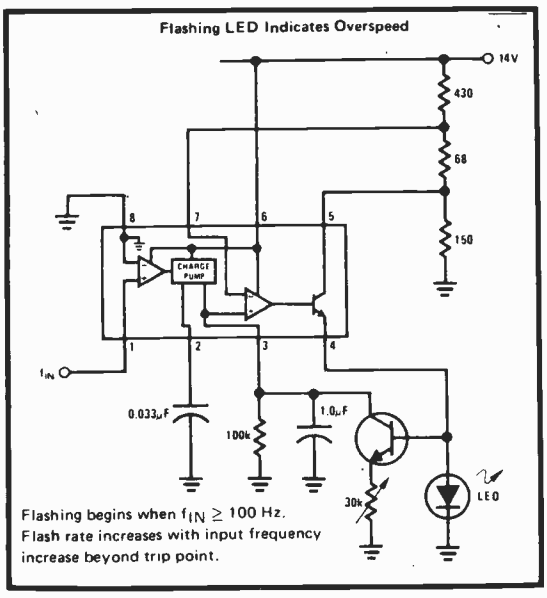
$$f_{MAX} = \frac{I_2}{C1 \times V_{CC}}$$

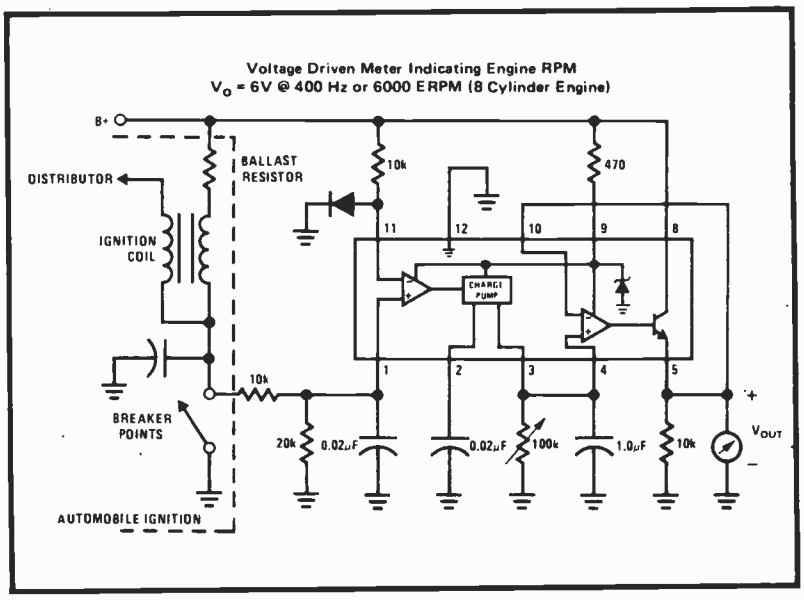
Using Zener Options

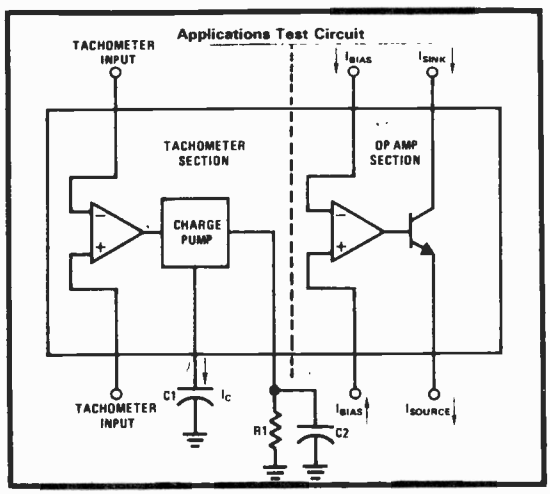
For those applications where an output voltage or current must be obtained independent of supply voltage variations, the

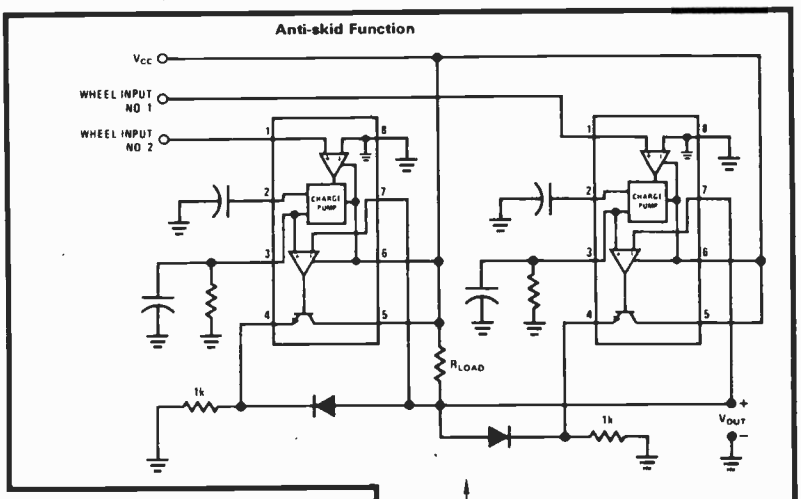




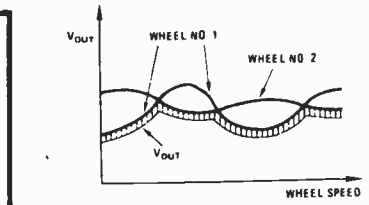








LM2917 is offered. The most important consideration in choosing a dropping resistor from the unregulated supply to the device is that the tachometer and op amp circuitry alone require about 3 mA at the voltage level provided by the zener. At low supply voltages there must be some current flowing in the resistor above the 3 mA circuit current to operate the regulator. As an example, if the raw supply varies from 9 to 16V, a resistance of 470Ω will minimize the zener voltage variation to 160 mV. If the resistance goes under 400Ω or over 600Ω the zener variation quickly rises above 200 mV for the same input variation.



VOUT is proportional to the lower of the two input wheel speeds.

The LM 1830 is a monolithic bipolar integrated circuit designed for use in fluid detection systems. The circuit is ideal for detecting the presence, absence or level of water, or other polar liquids. An AC signal is passed through two probes within the fluid. A detector determines the presence or absence of the fluid by comparing the resistance of the fluid between the probes with the resistance internal to the integrated circuit. An AC signal is used to overcome plating problems incurred by using a DC source. A pin is available for connecting an external resistance in cases where the fluid impedance is of a different magnitude than that of the internal resistor. When the probe resistance increases above the preset value, the oscillator signal is coupled to the base of the open-collector output transistor. In a typical application, the output could be used to drive a LED, loud speaker or a low current relay.

Features

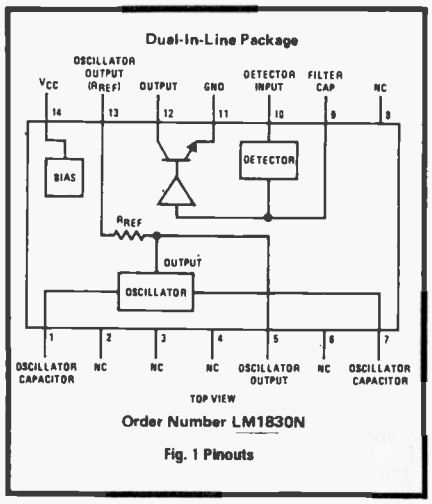
- Low external parts count
- Wide supply operating range
- One side of probe input can be grounded
- AC coupling to probe to prevent plating
- Internally regulated supply
- AC or DC output

Applications

- Beverage dispensers
- Water softeners
- Irrigation
- Sump pumps
- Aquaria
- Radiators
- Washing machines
- Reservoirs
- Boilers

Absolute Maximum Ratings

Supply Voltage	28V
Power Dissipation	300mW
Output Sink Current	20mA



Order Number LM1830N

Fig. 1 Pinouts

Applications

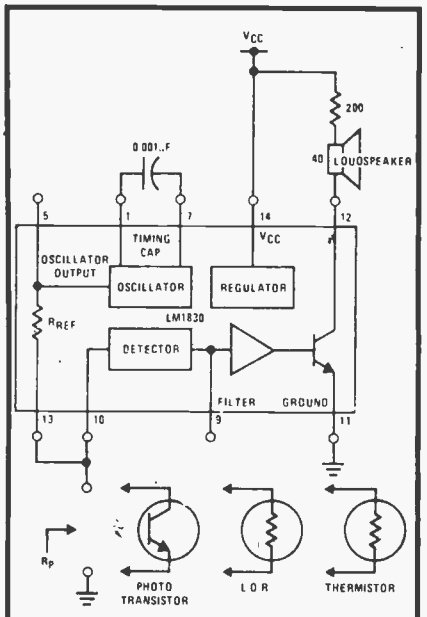
The LM 1830 requires only an external capacitor to complete the oscillator circuit. The frequency of oscillation is inversely proportional to the external capacitor value. Using 0.001 μF capacitor, the output frequency is approximately 6 kHz. The output from the oscillator is available at pin 5. In normal applications, the output is taken from pin 13 so that the internal 13k resistor can be used to compare with the probe resistance. Pin 13 is coupled to the probe by a blocking capacitor so that there is no net DC on the probe.

Since the output amplitude from the oscillator is approximately 4 V_{BE}, the detector (which is an emitter base junction) will be turned "ON" when the probe resistance to ground is equal to the internal 13kΩ resistor. An internal diode across the detector emitter base junction provides symmetrical limiting of the detector input signal so that the probe is excited with ± 2 V_{BE} from a 13k source. In cases where the 13k resistor is not compatible with the probe resistance range, an external resistor may be added by coupling the probe to pin 5 through the external resistor as shown in Fig. 2. The collector of the detecting transistor is brought out to pin 9 enabling a filter capacitor to be connected so that the output will switch "ON" or "OFF" depending on the probe resistance. If this capacitor is omitted, the output will be switched at approximately 50% duty cycle when the probe resistance exceeds the reference resistance. This can be useful when an audio output is required and the output transistor can be used to directly drive a loud speaker. In addition, LED indicators do not require DC excitation. Therefore, the cost of a capacitor for filtering can be saved.

Probes

In a typical application where the device is employed for sensing low water level in a tank, a simple steel probe may be inserted in the top of the tank with the tank grounded. Then when the water level drops below the tip of the probe, the resistance will rise between the probe and the tank and the alarm will be operated. This is illustrated in Fig. 3. In situations where a non-conductive container is used, the probe may be designed in a number of ways. In some cases a simple phono plug can be employed. Other probe designs include conductive parallel strips on printed circuit boards.

In automotive and other applications where the power source is known to contain significant transient voltages, the internal regulator on the LM 1830 allows protection to be provided by the simple means of using a series resistor in the power supply line as illustrated in Fig 4. If the output load is required to be returned directly to the power supply because of the high current required, it will be necessary to provide protection for the output transistor if the voltages are expected to exceed the data sheet limits.



Output is activated when $R_p \gtrsim 1/3\ R_{REF}$

FIGURE 4. Direct Coupled Applications

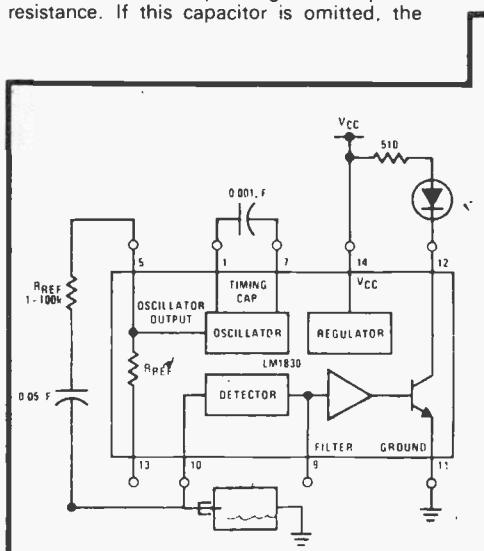


FIGURE 2. Application Using External Reference Resistor

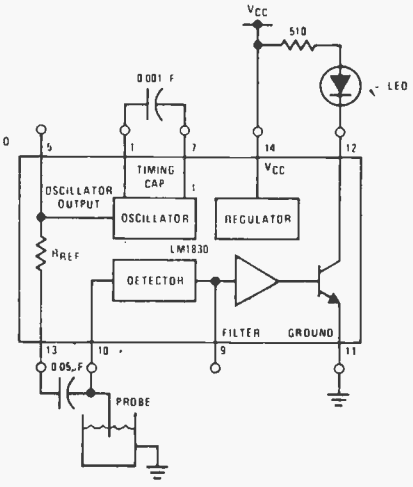


FIGURE 3. Basic Low Level Warning Device

Although the LM 1830 is designed primarily for use in sensing conductive fluids, it can be used with any variable resistance device, such as light dependent resistor or thermistor or resistor or resistive position transducer.

The LM 1830 is available from **A. Marshall (London) Ltd., 42 Cricklewood Broadway, London NW2 3ET.** Price for one off is **£1.86** plus **30p** per order post and packing.

ELECTRONICS —it's easy! PART 42

Chart recorders

IN GENERAL, chart recorders are designed to accept electrical voltage signals as these constitute the majority of signals produced by sensing equipment. Occasionally the chart recorder is more appropriately connected to a mechanical output without electrical signals being involved: in some circumstances there is no need for electrical circuitry.

Chart recorders are, therefore, electronic system units which accept a voltage signal converting it to an equivalent graphical representation on paper. The recorder can be put to use in any application where an electrical signal is produced. Examples are measurement of fluctuations of the power mains voltage, records of body currents in medical diagnosis and changes in temperature in a process plant. The earliest chart recorder was probably Lord Kelvin's 19th century paper-tape siphon-recorder used to record electric telegraph signals. Because of the large and varied demand for chart recorders, manufacturers have developed numerous alternatives. Figure 1 shows a number of recorders installed to monitor an oil rig.

In fundamental terms chart-recorders are electro-mechanical converters — electrical signals are changed into equivalent mechanical ones which are used to make a permanent record on a paper-chart. For this reason there are two aspects to a chart recorder — its mechanical design and its electrical design. For convenience we look at each more or less separately but in designing and operating the recorder the two are so closely related that the response depends on adjustment of both disciplines of thought.

Fig. 1. Chart recorders are used in many varied applications. The panels of this control room contain a number that are used by the operators to see how the process is behaving.

Chart Recorder Formats:— Chart recorders are designed to display a signal in a graphical form that is convenient to the user. There are two basic types: those which record one or more variables with respect to time (commonly called x-t recorders) and those which plot one variable against the other (x-y recorders).

Strip-chart:— In these recorders a continuous roll of suitably scaled paper is motor driven at constant speed past the marking head. The paper drive is usually driven by a synchronous or stepping motor as this ensures accurate paper-speed. Where mains supply is not available dc governed-motors and clockwork alternatives can be used. Chart speed changes are commonly obtained by altering gear ratios. Figure 2 shows the construction of a typical panel mounted strip-chart x-t recorder. The module shown withdrawn from the housing is the paper drive unit, the housing contains the electronic amplifier driving the pen which contacts the top of the paper when the drive unit is plugged in.

Strip chart recorders for bench top use are also common - Figure 3. Some strip chart recorders take up the used paper by rolling it or by folding it in a concertina. The latter, known as z-fold, is very convenient when the need to refer to the record arises.

Chart speeds vary widely - from metres per second in fast-writing recorders used to capture kilohertz bandwidth transients, down to millimetres per hour for industrial process and slow-scientific phenomenon recording. It is not usual, however, to find a range as wide as this in the one unit.

Process industry strip-chart recorders generally run at one speed only; units for scientific use usually have switched speed capability. The choice is decided by matching the resolution required with the amount of paper consumed.

Paper sheet:— The flat-bed style lends

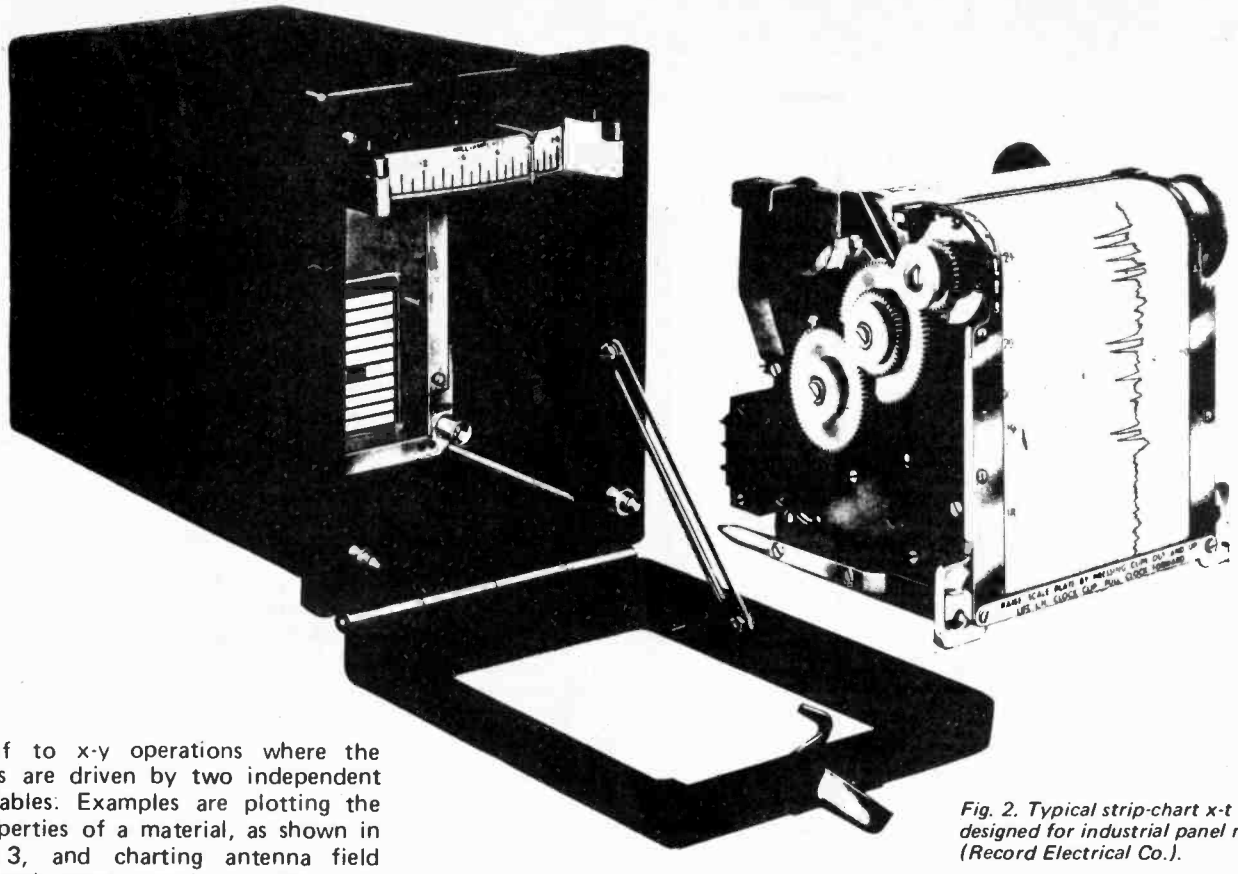


Fig. 2. Typical strip-chart x-t recorder designed for industrial panel mounting. (Record Electrical Co.).

itself to x-y operations where the axes are driven by two independent variables. Examples are plotting the properties of a material, as shown in Fig. 3, and charting antenna field strength versus position. In this style the recording paper is a single sheet which is attached to the platen. The pen moves both in the x and y directions. The paper may be held by clips or by electrostatic attraction. If the x axis input (horizontal) is fed with voltage that rises linearly with time (a ramp function) the x axis will move across the chart with time making the unit an x-t format recorder. Plug-ins generating appropriate ramps are often provided as an accessory – one is illustrated in Fig. 4

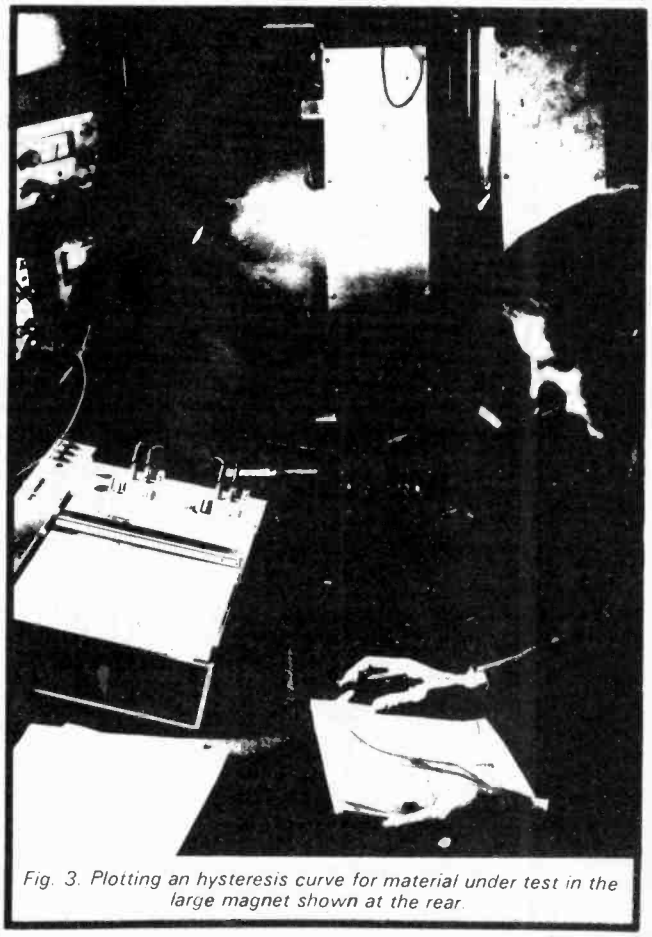


Fig. 3. Plotting an hysteresis curve for material under test in the large magnet shown at the rear.

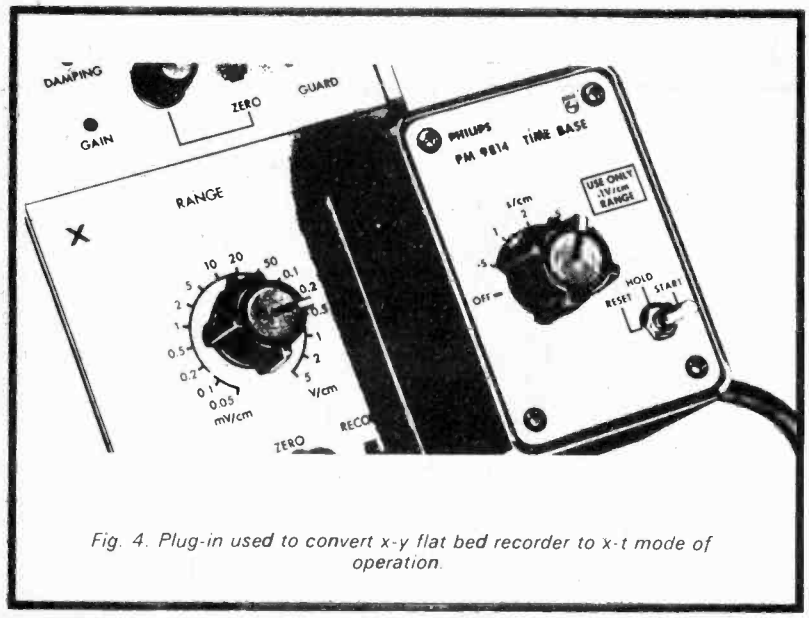


Fig. 4. Plug-in used to convert x-y flat bed recorder to x-t mode of operation.

Circular:– Where the Geometry of the measurement task is circular, such as recording out-of-roundness of a ground shaft, or where the measure has a cyclic time function, such as daily temperature changes, a circular form of chart is easier to use. The chart rotates under the marking device at a rotational velocity locked to the geometrical position or the appropriate sub-unit of time – hours, days, weeks and months. An example of a circular-chart recorder is given in Fig. 5.

The size of chart papers varies greatly from recorder to recorder. Strip charts are used from 50 mm width to around 800 mm with lengths as much as 150 m. The duration of the maximum record that can be taken on a roll is decided by the chart length and the chart speed. Flat bed units begin in paper size at about 200 by 300 mm ranging to huge computer-controlled automatic-draughting units with beds as much as 6 m x 4 m. Circular charts rarely exceed 300 mm diameter.

Supply of chart papers can be difficult at times because stockists find difficulty in holding large stocks of the numerous options available. It is wise for the operator to hold a generous supply in hand at all times.

When reading values from paper charts care must be exercised in ensuring that inaccuracies caused by paper size changes, paper wander across its platen and marking mechanism offsets are allowed for. Good quality charts are a necessity with high-quality measurements.

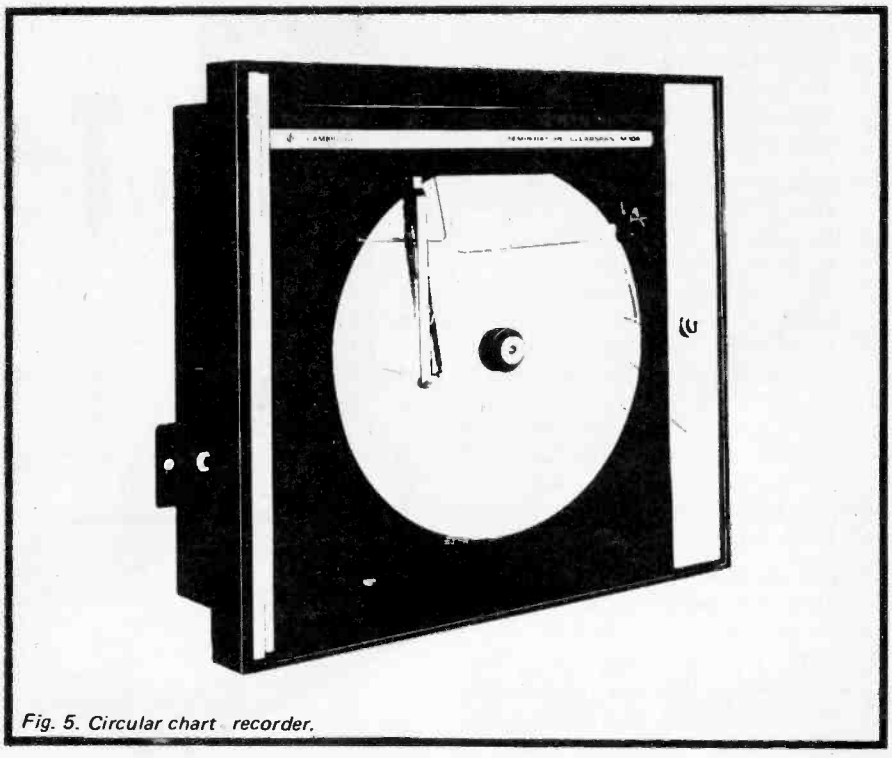


Fig. 5. Circular chart recorder.

PAPER MARKING TECHNIQUES

In these units an electronic amplifier coupled to a mechanical drive moves a mechanical point across the chart. It is then necessary to mark the paper in order to show where the point has travelled. Five commonly used techniques will be encountered.

Ink pen-- Samuel Morse's telegraph recorder used a pencil to mark the paper strip. A limitation is that the lead wears away making a feed mechanism necessary. Ink can flow from a reservoir continuously: Kelvin introduced the siphon system in 1873. This system is used extensively today in one form or other. Ink feed rate is a factor of the pen, paper absorbency and ink viscosity. Figure 6a shows pen details.

A second ink feed method uses a combination of gravity feed and capillary action through small bores. These are the ballpoint and fibre-tip pens. A third ink method pressurizes the ink, recording being performed by a very fine ink jet. This method is suitable for fast writing speeds (as high as 60 metres per second compared with around 1 m per second for unpressurized ink feeds). There is no mechanical contact with the paper in pressurized systems, the fast writing rate arising because of the very small size of nozzle built into the deflecting system. Figure 6b shows the schematic of such a recorder. The pressure is automatically adjusted to suit the chart speed set.

The correct choice of ink and paper for the speed of operation is essential.

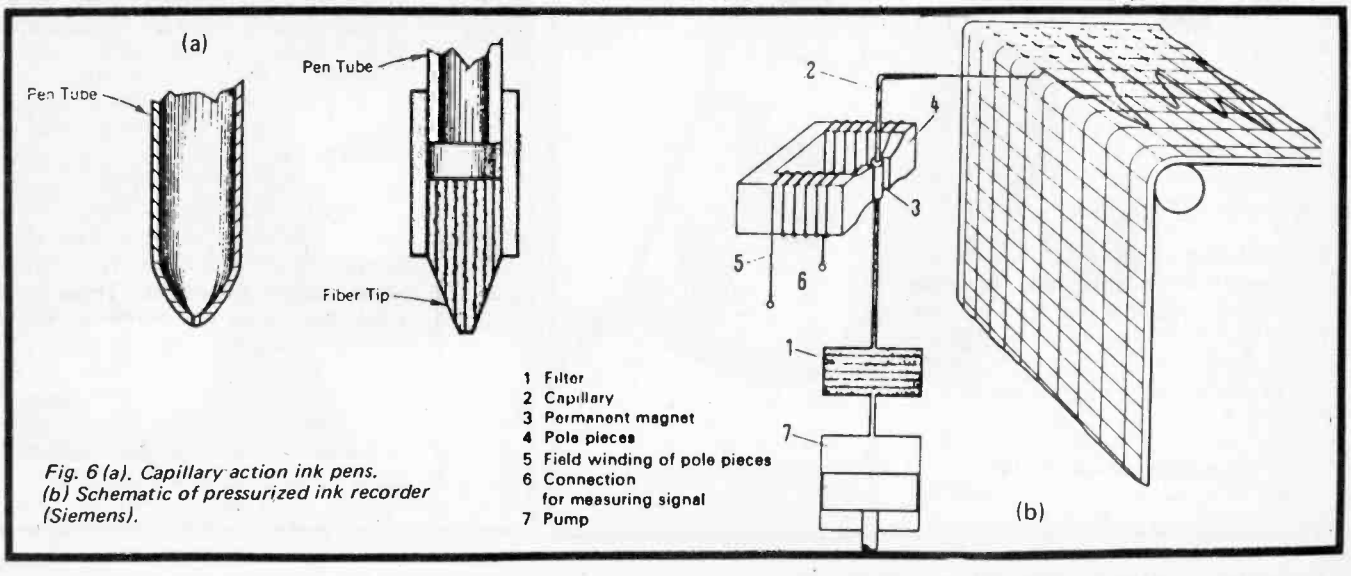


Fig. 6 (a). Capillary action ink pens. (b) Schematic of pressurized ink recorder (Siemens).

Water-based inks are to be avoided as the record can be destroyed by accident. Fast drying inks are needed or else the trace may be rolled-up before the ink is dry. In short, although the alternatives to ink offer certain advantages we are still forced to use ink as the best all-round choice in many applications.

Pressure sensitive papers-- Black paper treated with tiny wax beads appears white until the beads are flattened to form a transparent cover window thereby exposing the black. Pressure sensitive papers are marked by the action of a gentle pressure exerted by the stylus. The relatively high contact-force needed restricts these to slow response application. Pressure-sensitive papers are more usually used with marking mechanisms that are periodically pressed against the paper to form a dot.

Electro-sensitive papers: Some recorders use paper which is marked when an electric current is passed through it. The earliest was carbon impregnated; dielectric breakdown producing the mark by applying a high voltage between the stylus and the platen.

Another method electroplates onto the surface of paper made conductive by saturation with salts. It requires wet paper use but will operate with lower voltage levels than the above carbon paper method.

Zinc oxide reduced to free zinc is the process used in another kind of recording system. Metallized papers in which the metal film is fused to its paper backing are another. Yet another is based on providing a change in the paper surface which takes up toner (similar to the Xerox process) — it is fine for very fast systems but not those that occur slowly.

Heat senstitive papers: Yet another method of making the record is to use a heated stylus melting a wax-like coating on black paper. These papers can be manufactured with greater resistance to marking (during handling) than the pressure sensitive papers. Stylus temperature can also be varied with ease to suit the writing speed concerned.

Photographic paper: The earliest photographic systems used negative film. Such systems are still in use today but the majority of the highest speed recorders (30 kHz is possible) use ultraviolet light to expose specially treated paper. Exposure produces a latent (invisible) image which needs further exposure to form the visible image. This is shown in Fig. 7: the fluorescent lamp intensifies the traces.

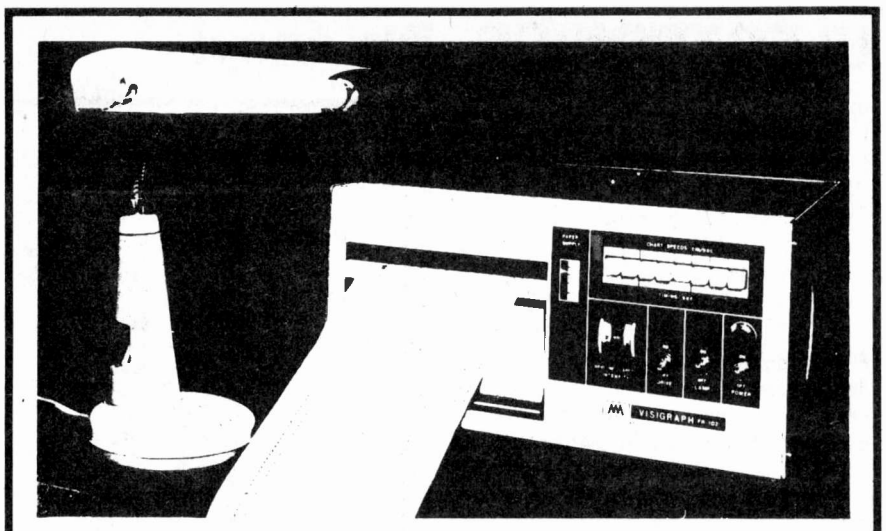


Fig. 7. UV recorders provide traces by exposure of photographic paper. Further exposure is needed to bring the latent image into view.

Continuous versus dotting mechanisms: Fast writing speeds require continuous marking and for these the writing mechanism functions continuously. For very slow speed needs, as are found in process plant monitoring an alternative, in which a dot is produced on the paper at regular periods, has certain advantages. Figure 8 shows one form of mechanical arrangement. A separate motor, or pick-off from the chart drive causes a point to periodically press on the paper, marking it by the appropriate method used. By incorporating a geneva mechanism (one that rotates a shaft in steps) the input signal can be switched sequentially over a number of different signal channels (six and twelve are usual). Also synchronised to the channel changing action is an inking system that steps from colour to colour to provide a different coloured dot for each channel. Inking may be as shown (different ribbons) or may be provided as individual pads each soaked with ink. A multipoint dotting head wipes through this ink. One maker uses a multicolour single ribbon, akin to a typewriter ribbon.

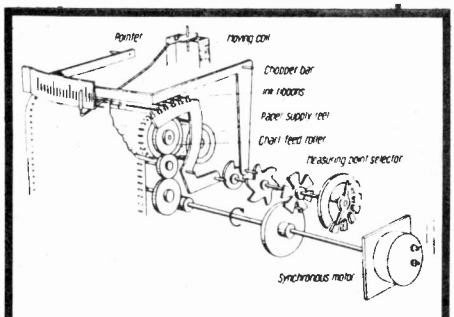


Fig. 8. Dotting recorders offer the advantages in slow-speed applications of being suitable for multi-channel multiplexing.

Multi-channel operation is also provided in some continuous trace recorders. This is almost always achieved by incorporating separate. Multi-trace recorders in which each trace has the full paper width capability are also available. Mechanical drives have the disadvantage in that the traces must be slightly out of phase so that the pens can pass one another without fouling. Optical recorders do not suffer from this drawback.

RECORDING MOVEMENTS

We now look at the methods used to transduce the electrical input signal into an equivalent mechanical movement.

Moving coil mechanisms: Basically these use modified moving coil and pointer. The end of the pointer carries an ink pen or acts as a marking point when forced onto the chart paper in dotting styles (see Fig. 8). Simple systems trace an arc across the chart giving a non-linear record. (curved markings on the paper overcome this but complicate the platen design). This can be linearized to provide better accuracy by various means such as that shown in Fig. 9.

Optical recorders also use a moving coil unit on which a mirror is mounted to reflect a high intensity focussed beam across the paper. These units have their origin in practical oscillographs designed by Duddell (to Blondel's ideas) at the turn of the century. The choice of galvanometer unit largely decides the frequency response. Today they are supplied as robust plug-in units like that shown in Fig. 10. The application, in many units, decides which galvanometer is

used and the optimum terminating resistance value in order to know the deflection and sensitivity for a given frequency of signal. These recorders offer the ability to modulate the trace intensity producing 2-D half-tone chart records.

Potentiometric recorders: Around 1898 Professor Callendar devised his recording resistance pyrometer and in doing so, provided instrumentation with the potentiometric or self-balancing recorder. This method makes use of a closed-loop system that causes the pointer to follow input signals. Referring to Fig. 11 the recorder has a drive motor mechanism which translates the pointer in one direction or the other depending upon the polarity of the signal driving the motor. Attached to the shaft driving the pen is a rotary resistance balancing potentiometer, as shown in Fig. 11a. Schematically this can be shown as a linear equivalent (the more recent design style used) as shown in Fig. 11b. The potentiometer wiper moves across in unison with the pen and generates a changing value signal. The potentiometric system circuit layout is represented in Fig. 11c. A reference voltage is supplied across the potentiometer. Voltage from the wiper is compared with the input signal voltage to be recorded. If a difference exists this constitutes an error which causes the drive motor to move accordingly to correct the error. The input signal and reference signals are suitably attenuated to provide the sensitivity needed at full-scale deflection.

The advantages of recorders such as those described above are that the mechanism plots a linear scale, and there is considerable power available to move the pen against frictional forces. The system, being potentiometric, draws little current once the unit has achieved balance and, as considerable drive power is available under closed-loop control, the pen response can be made tighter than for the open-loop pointer-type moving coil units. Sensitivity is decided more by the amplifier gain than mechanical constants. The majority of flat-bed recorders use this principle: at full trace movement their writing speeds can reach several metres per second. The method also overcomes the restriction on traverse length suffered by rotationally driven recorder mechanisms. Although a simple dc servo control is shown, potentiometric recorders, especially those built before around 1970 more usually used ac control systems.

CRT — Fibre Optic Recorders: A recent design concept couples a CRT linear sweep trace to photosensitive paper via an optical fibre connection. This provides the highest response of all chart recorders so far available — dc to 1 MHz.

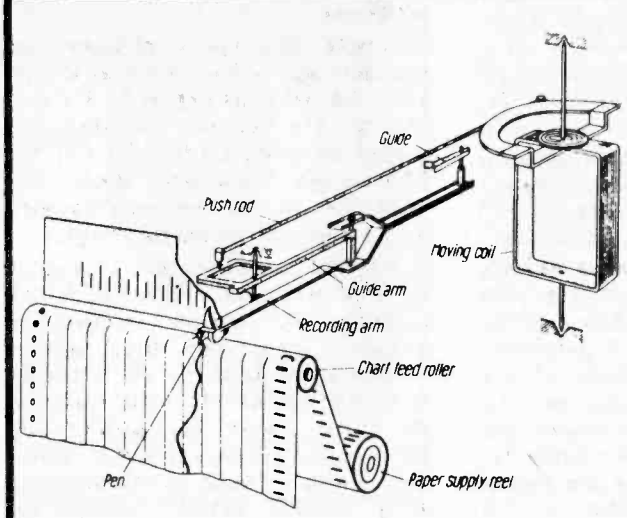


Fig. 9. Special linkages are used to linearize the non-uniform movement produced by a moving coil pen drive.

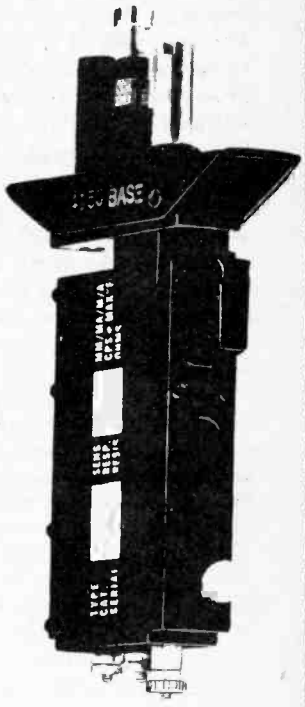


Fig. 10. Galvanometer unit for UV recorder (Hathaway Instruments).

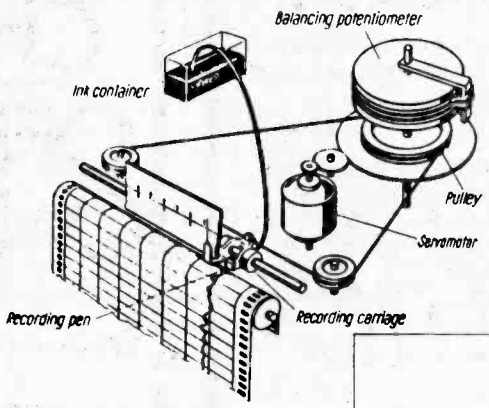
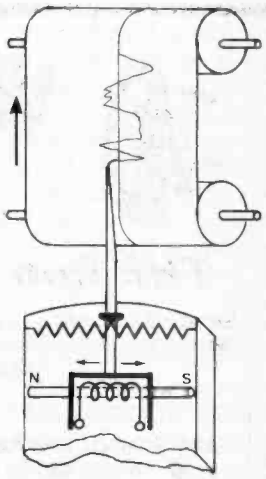
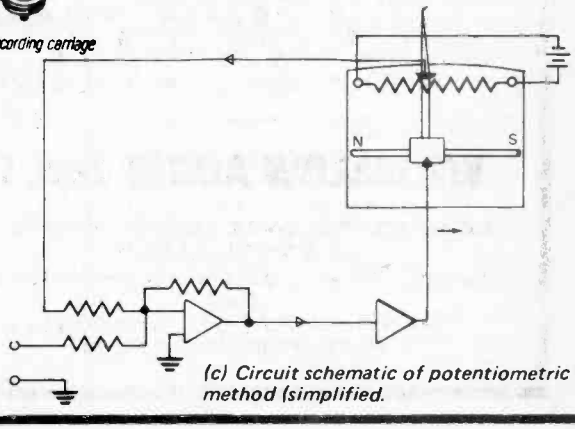


Fig. 11 (a). Arrangement of motor form of potentiometric recorder.



(b) Schematic using linear motor.



(c) Circuit schematic of potentiometric method (simplified.

DYNAMIC RESPONSE

A point commonly overlooked is that chart recorders have a certain dynamic response and are effectively low-pass filters of the input signal. The response of a recorder to a sine signal, that is, the recorded trace, will look like the original but will lack adequate amplitude if the pen cannot follow fast enough. When quoting response rates it is therefore necessary to state amplitude as well as frequency. For example, moving-coil recorders with short pen arms have a typical response that is flat from dc to 100 Hz at 10 mm peak-to-peak deflection for a sinewave. If the frequency is increased the recorder will still operate but the amplitude of a sinewave record falls off. Plots of complex waveforms may be severely distorted for the fundamental may be recorded at full amplitude with harmonics attenuated progressively. A square-wave input may be recorded as a near sine-wave if the response is inadequate. It is better to use a smaller signal amplitude in such cases.

Simple moving-coil chopper-type recorders will roll off from as low as 1 Hz. Ink jet units extend to 800 Hz: beyond that optical recorders are needed providing up to 1 MHz in the CRT design. Frequencies above this must be viewed by oscilloscopes using cameras to record the image.

Faithful response is also a function of amplifier characteristics. With the exception of simple moving-coil recorders most units have built-in amplification because the majority of signals to be recorded, have insufficient power to provide an adequate response. Recorder sensitivities may be fixed in manufacture, as in process industry dotting recorders, or have adjustable ranges. The manufacturers of recorders usually provide the amplifiers as part of the recorder, the purchaser only has to make the selection.

Event-marking recorders: In many recording applications the variable remains constant for more of the time than it varies. An example might be recording rainfall in dry areas. If the record must provide fine time-resolution the chart must run fast which means using immense lengths of paper for little data recorded. An approach, slowly finding acceptance, is to use a time/date printer which prints a value each time an increment of event occurs. Each increment print-out causes the chart to advance a unit. The result is a record chart completely filled with non-zero data. It is harder to interpret but much more efficient for spasmodic data situations. At present, however, this form of equipment is hard to procure commercially. ●

ELECTRONICS TOMORROW

by John Miller-Kirkpatrick

Hear No Evil . . .

FOR ABOUT £3,500 you can buy a microcomputer system complete with VDU, Printer, Multi-cassette system, 18KRAM, software, etc — all you need to be up and running is a mains plug. The most likely add-on to this sort of system is a floppy disk, more RAM or telecommunications facilities to be able to use it with a telephone to talk to a mainframe computer.

One problem with the idea of communicating with a mainframe from a micro is that the micro could possibly be more intelligent than the mainframe. For example I used the word "talk" earlier and I was not kidding. A company called Heuristics Inc, 900 N San Antonio Rd, Los Altos, California is now offering a product called "Speechlab" which adds to an S-100 bus to enable you to talk to your micro via a microphone. The signal from the microphone is amplified and then passed into three filtering networks with time averagers following each. The filter outputs are digitised by using a standard A/D converter and multiplexer, the resulting digital voltage levels are stored in RAM and another microphone sample taken. As each spoken word can be analysed into sections of high, medium or low frequencies sustained for different times the micro can build up a digital "picture" of the word. This "picture" can then be compared to word pictures already stored for comparison and hopefully a match found.

An interesting side application of this unit is for handicapped persons, even those with a serious speech handicap. Speechlab can recognise repetitions of sound patterns which do not necessarily need to be from a spoken language. Thus a slightly extended version of the Speechlab program could give a handicapped person the ablity to operate household or office equipment, including a typewriter, simply with a set of sound commands. The really remarkable thing about this MPU add-on kit is its relative simplicity and its price of $250, with the hopeful or perhaps inevitable advent of the Speechchip in a few months time we might well be able to look forward to micros with a vocabulary in excess of 1,000 words — well above that of a lot of adults!

Speak No Evil

Of course the 1000+ word vocabulary mentioned above is only the number of spoken words that the micro can understand. A microprocessor will never be able to produce anything like human speech with a level of vocabulary of anything near 1000 words. Unless, of course, you happen to have something like the Al Cybernetic Model 1000 speech synthesiser from Al Cybernetic, Box 4691, University Pk, NM88003, USA. Again this unit plugs on to an S-100 bus at one end and an audio amplifier at the other, to give, according to reports, an understandable if slightly robotic speech output. The output sounds are made up from a conversion of a phonetic interpretation of the ASCII character set, supplied as a string of characters. Essentially the Model 1000 is a hardwired analogue of the human vocal tract with various parts of the circuit emulating the vocal chords, the lungs, mouth, tongue, lips and teeth.

See No Evil . . .?

Just to complete the trio, I should mention the digital camera seen recently at the Build Your Own Computer Exhibition. I can't recollect which company were showing it or exactly what it was capable of doing but it is enough to recognise that we can now build a machine with ears, mouth and eyes. With RAM and PROM now being designed in 64KByte packages and mass production leading to low prices how long will it be before machine intelligence becomes an everyday fact of life? Perhaps one of the first applications is in a telephone answering system that is able to answer an unattended phone, take a message, give a message, ring you at another number and pass on any important messages. Connect up a digital camera and TV screen to it before 1984 and you get a free Big Brother thrown in!

Green Fields and Blue Water.

If you already have or are considering building one of the TV games kits using the General Instruments AY-3-8500 then the fact that GI have just released the pin compatible AY-3-8550 may interest you. The 8550 plays the same six games as the 8500 but allows for changes in colour of the background, ball and players. The colour coding of the players allows one player to be "Blue" and the other player to be "Red", thus making their pieces on the screen easy to identify.

With the ability to encode the background according to the type of game you can produce new games from the existing logic. Changing the football background from green grass to blue water changes the game from football to water polo — same type of game but different rules.

The main physical differences between the 8500 and the 8550 are changes at pins —

1, 14 and 15 allow the bats to be moved horizontally as well as vertically by use of two more variable controls.

6, now Black/white bat select, allows payer colour coding.

28 is now a composite output being the sum of the signals for bats, ball, field and score and can be used in lieu of the data on pins 9, 10 and 24.

Data on the 8550 and other GI TV games is available from GIM, 57/61 Mortimer St, London W1N 7TD ●

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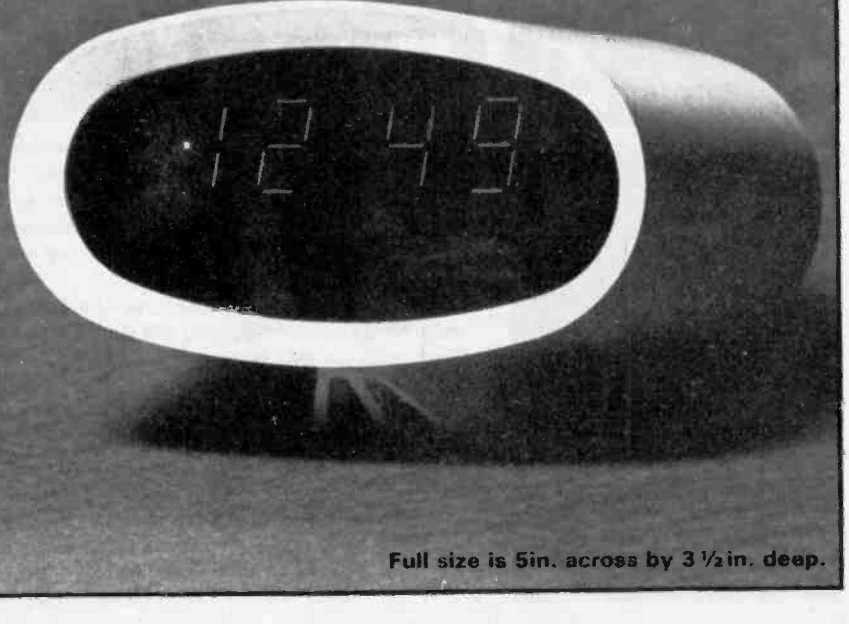

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Maximum Input	10V r m s
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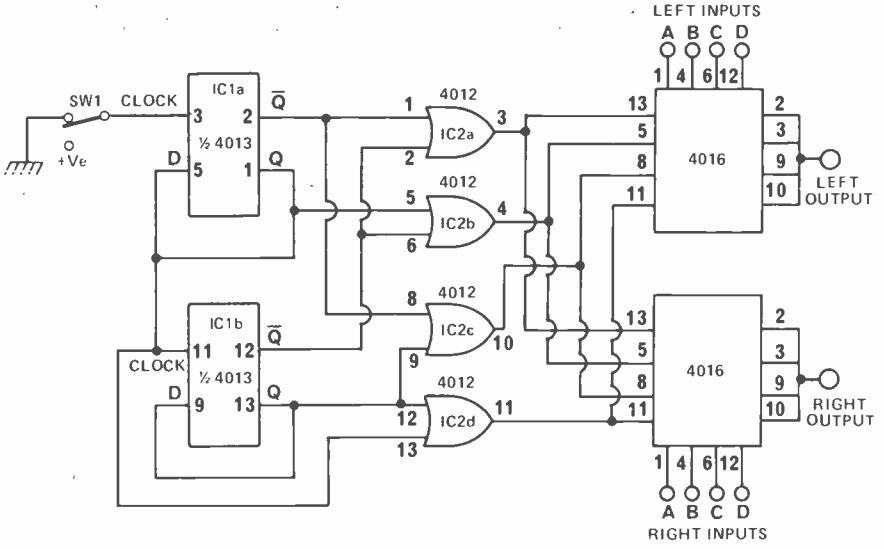
Stereo Input Selector

T. E. Huffinley

Four different inputs can be switched through by the continual pressing of SW1. IC1 is a dual 'D' type flip flop. The Q outputs are connected to the D inputs so that the clock inputs are divided by two. The two flip-flops are connected in series, giving a two stage binary counter.

IC2 is a quad OR gate. This is used to decode the four states of the counter. The outputs are used to control the quad switches of IC3 and IC4 (4016AE).

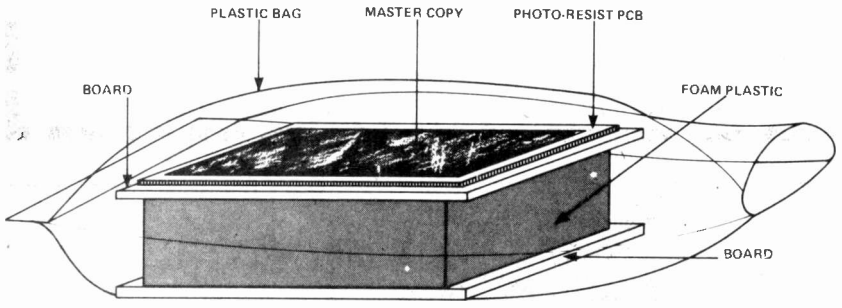


PCB Bag

L. Rink

A piece of foam plastic is placed between two boards of about the same size as the PCB being printed, on top of this is placed the Photo-resist PCB with the master copy transparency in position on top. The whole of this is put inside a plastic bag and then sqaushed flat.

The end of the plastic bag is then sealed by folding over, and then when the pressure is released, and the plastic foam tries to expand, air pressure presses the transparency tight against the PCB and usually can hold it for several minutes.

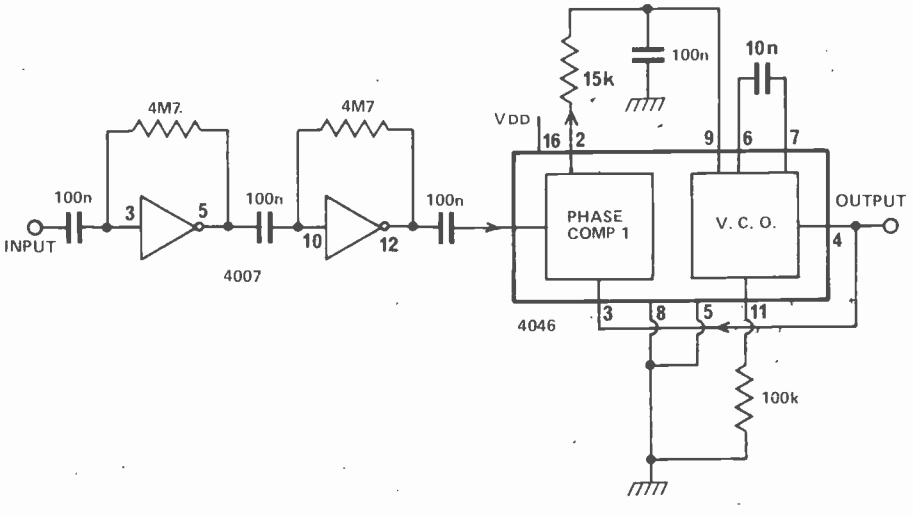


Guitar Synthesiser

R. Barnett

This circuit uses a CMOS Phase Locked Loop, the 4046, to produce a very unusual sound from a guitar, which sounds something like a syntheiser.

The signal from the guitar is amplified by two of the amplifiers in the 4007. The amplified signal is used by the phase comparator to lock the VCO to the frequency of the note played. The VCO does not oscillate until a note is played, when using the low pass filter shown (i.e. the 15 k resistor and 100 n capacitor). If the value of the resistor is increased, the VCO oscillates continuously at about 1 kHz (with no input signal). This gives very smooth note changes. The basic frequency may be changed by varying the 100 k resistor.



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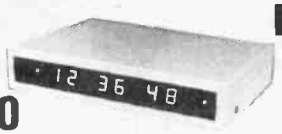

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tech-tips

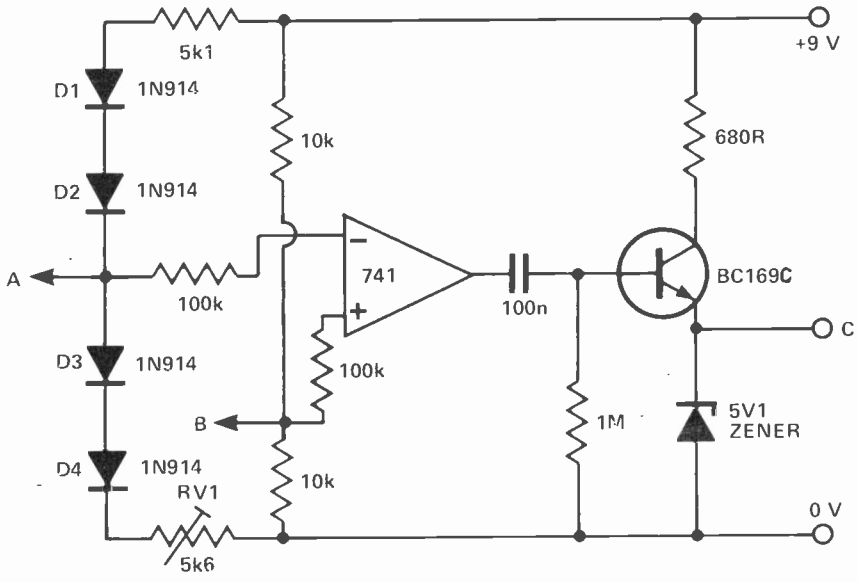
Thermo Touch Switch

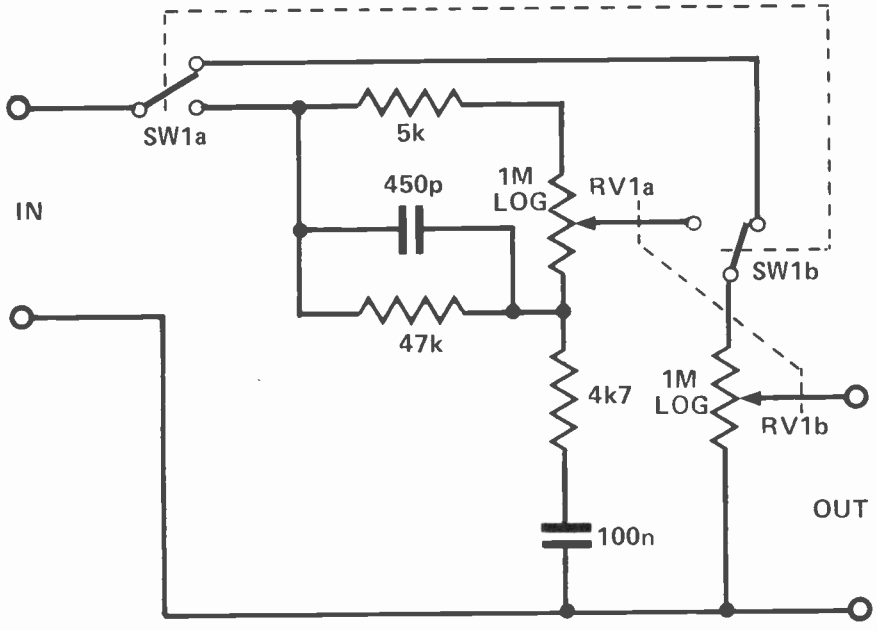
S. B. Dick

The following touch switch works on the temperature dependence of the forward voltage of silicon diodes. At 0 °C this is about 650mV, but drops by 2mV per °C increase in temperature.

When a finger is placed on D3 and D4 the voltage at A will drop below that at B and the O/P of the Op-Amp will go high, causing a TTL compatible pulse to appear at C. D1 and D2 provide compensation against ambient temperature changes. VR1 is initially set so that VA is greater than VB by about 10mV.

The system has the intrinsic advantage that it may be used in moisture-prone conditions in which ordinary touch switches would be most unsatisfactory due to their principle of operation.





Loudness Control

David Chivers

This loudness control works with the volume control to provide a more even listening contour. Since the human ear can hear sound in the middle of the audio spectrum better than at the extremities, it is desirable to attenuate high and low frequencies less than the middle frequencies as the volume is cut.

With SW1 on, bass and treble are boosted relative to middle frequencies. RV1a is ganged to the volume control, this varies the strength of loudness control so that at low volume the effect is more noticeable. This unit will replace the volume control in a present system, coming between the preamp and power amplifier. It a stereo unit is to be made, SW1 should be four pole two way, and it is best to have separate volume / loudness controls for each channel since four way potentiometers are hard to find.

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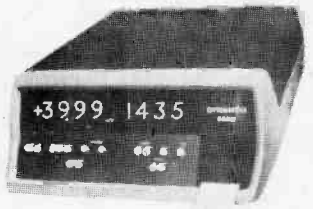

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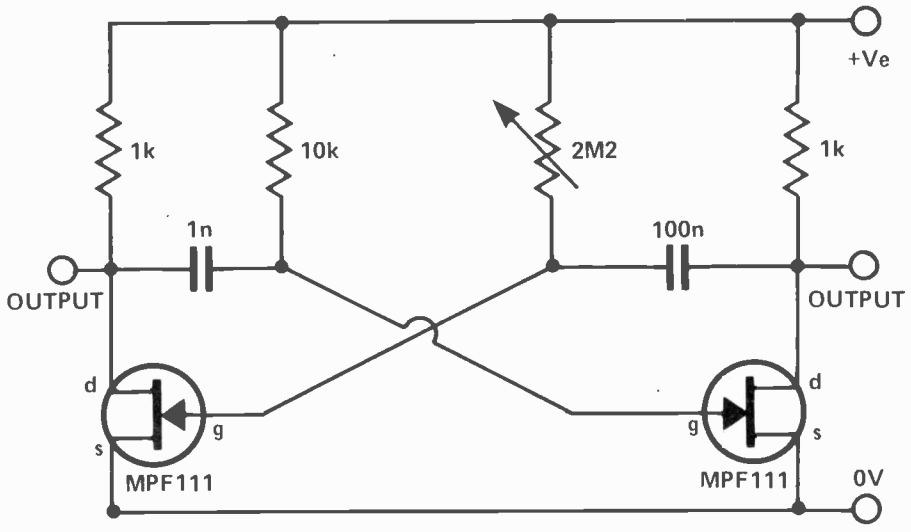


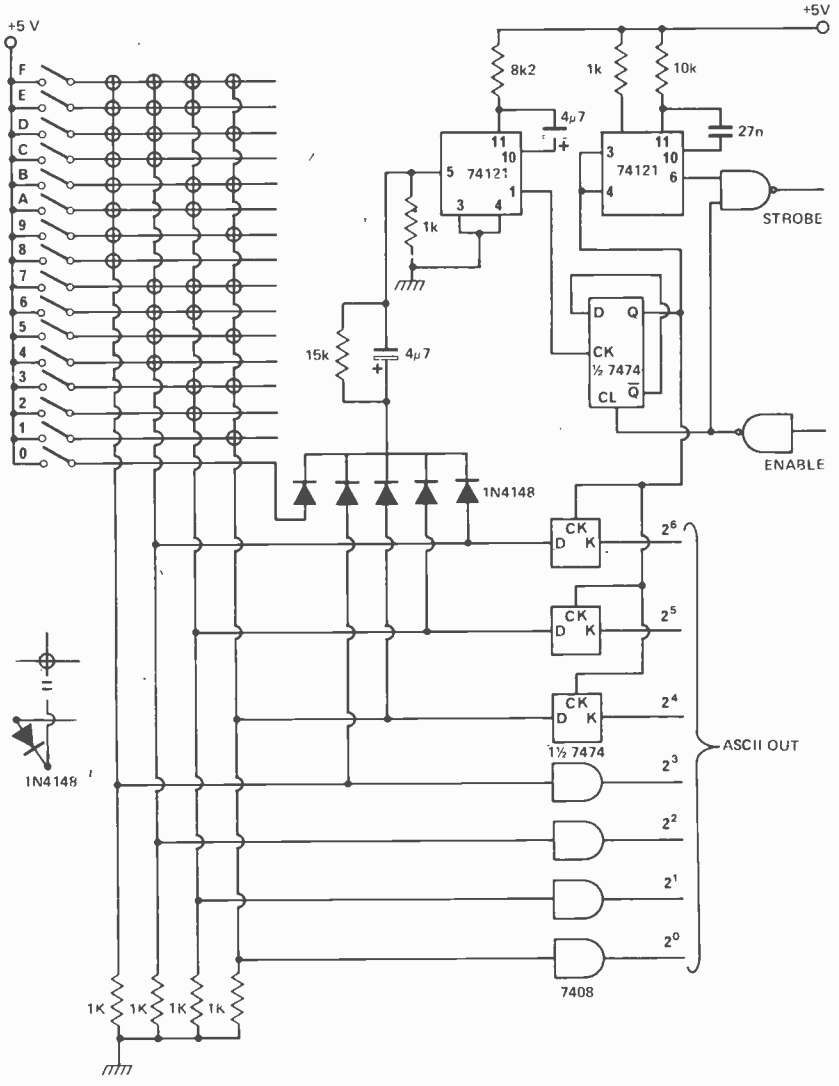
Wide Range Astable

P. D. Maddinson

In a conventional astable, the bipolar transistors take a significant amount of base current, which limits the use of high value timing resistors. By replacing bipolar transistors with FET's, which consume a much smaller 'gate' current, we can use much higher values of timing resistor and hence get a much wider range.

N-channel FET's were chosen, so that a positive Vcc rail could be used, and with a 5V supply the circuit was able to drive TTL without trouble.

With the component values given one time constant was approx. 5 μS, and the other was variable from 5 μS to approx. 2mS; a range of 400:1.



ASCII Keyboard

R. Barnett

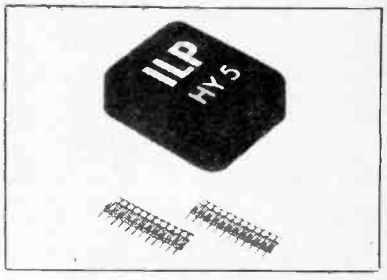
This circuit uses a 16 key calculator keyboard to generate the 7 bit ASCII code, using two hex numbers to define ASCII character.

If, for example, the code for A (41 hex) is required, '4' is pressed first. After 10mS (to avoid switch bounce) the binary code from the diode matrix is latched into three D-type flip-flops. '1' is now entered. This time, after the 10mS delay, a 200uS pulse is produced by the second 74121. If the ENABLE input is low, a negative pulse appears on the STROBE output, while the ASCII code for A appears on the other outputs. If the enable input is high, the circuit remains in its initial state with the strobe pulse disabled.

15—240 Watts!

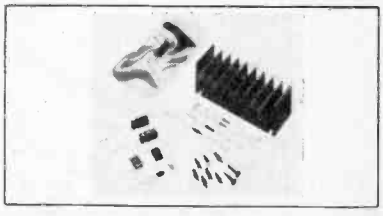
HY5
Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag. Cartridge, tuner, etc.) are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.
FEATURES: Complete pre-amplifier in single pack — Multi-function equalization — Low noise — Low distortion — High overload — two simply combined for stereo.
APPLICATIONS: Hi-Fi — Mixers — Disco — Guitar and Organ — Public address.
SPECIFICATIONS:
INPUTS: Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; input impedance 47kΩ at 1kHz.
OUTPUTS: Tape 100mV; Main output 500mV R.M.S.
ACTIVE TONE CONTROLS: Treble ± 12dB at 10kHz; Bass ± at 100Hz.
DISTORTION: 0.1% at 1kHz; Signal/Noise Ratio 68dB.
OVERLOAD: 38dB on Magnetic Pick-up; SUPPLY VOLTAGE ± 16-50V.
Price £5.22 + 65p VAT P&P free.
HY5 mounting board B1 48p + 6p VAT P&P free.



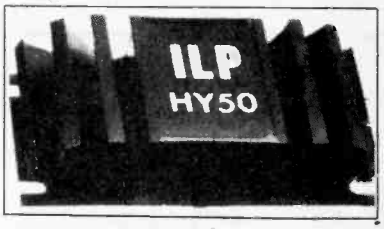
HY30
15 Watts into 8Ω

The HY30 is an exciting New kit from I.L.P., it features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.
FEATURES: Complete kit — Low Distortion — Short, Open and Thermal Protection — Easy to Build.
APPLICATIONS: Updating audio equipment — Guitar practice amplifier — Test amplifier — Audio oscillator.
SPECIFICATIONS:
OUTPUT POWER 15W R.M.S. into 8Ω. DISTORTION 0.1% at 15W.
INPUT SENSITIVITY 500mV. FREQUENCY RESPONSE 10Hz-16kHz — 3dB.
SUPPLY VOLTAGE ±18V.
Price £5.22 + 65p VAT P&P free.



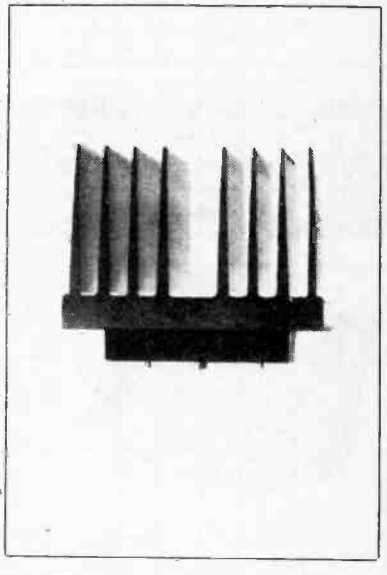
HY50
25 Watts into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.
FEATURES: Low Distortion — Integral Heatsink — Only five connections — 7 Amp output transistors — No external components.
APPLICATIONS: Medium Power Hi-Fi systems — Low power disco — Guitar amplifier.
SPECIFICATIONS: INPUT SENSITIVITY 500mV.
OUTPUT POWER 25W RMS in 8Ω LOAD IMPEDANCE 4-16Ω. DISTORTION 0.04% at 25W at 1kHz.
SIGNAL/NOISE RATIO 75dB. FREQUENCY RESPONSE 10Hz-45kHz — 3dB.
SUPPLY VOLTAGE ± 25V. SIZE 105.50.25mm.
Price £6.82 + 85p VAT P&P free



HY120
60 Watts into 8Ω

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection, this amplifier sets a new standard in modular design.
FEATURES: Very low distortion — Integral Heatsink — Load-line protection — Thermal protection — Five connections — No external components.
APPLICATIONS: Hi-Fi — High quality disco — Public address — Monitor amplifier — Guitar and organ.
SPECIFICATIONS:
INPUT SENSITIVITY 500mV.
OUTPUT POWER 60W RMS into 8Ω. LOAD IMPEDANCE 4-16Ω. DISTORTION 0.04% at 60W at 1 kHz.
SIGNAL/NOISE RATIO 90dB. FREQUENCY RESPONSE 10Hz-45kHz —3dB. SUPPLY VOLTAGE ±35V.
Size: 114 x 50 x 85mm.
Price £15.84 + £1.27 VAT P&P free.

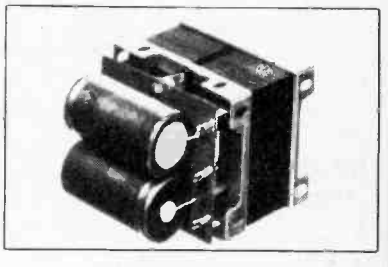


HY200
120 Watts into 8Ω

The HY200, now improved to give an output of 120 Watts, has been designed to stand the most rugged conditions, such as disco or group while still retaining true Hi-Fi performance.
FEATURES: Thermal shutdown — Very low distortion — Load-line protection — Integral Heatsink No external components.
APPLICATIONS: Hi-Fi — Disco. — Monitor — Power Slave — Industrial — Public address.
SPECIFICATIONS:
INPUT SENSITIVITY 500mV.
OUTPUT POWER 120W RMS into 8Ω. LOAD IMPEDANCE 4-16Ω. DISTORTION 0.05% at 100W at 1kHz.
SIGNAL/NOISE RATIO 96dB. FREQUENCY RESPONSE 10Hz-45kHz — 3dB. SUPPLY VOLTAGE ±45V.
SIZE 114 x 100 x 85mm.
Price £23.32 + £1.87 VAT P&P free.

HY400
240 Watts into 4Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.
FEATURES: Thermal shutdown — Very low distortion — Load line protection — No external components.
APPLICATIONS: Public address — Disco — Power slave — Industrial.
SPECIFICATIONS:
OUTPUT POWER 240W RMS into 4Ω. LOAD IMPEDANCE 4-16Ω. DISTORTION 0.1% at 240W at 1 kHz.
SIGNAL/NOISE RATIO 94dB. FREQUENCY RESPONSE 10Hz-45kHz — 3dB. SUPPLY VOLTAGE ±45V.
INPUT SENSITIVITY 500mV. SIZE 114 x 100 x 85mm.
Price £32.17 + £2.57 VAT P&P free.



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SYSTEM 68

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Due to the steady pressure on our back numbers department, and the dwindling number of issues available, we have set up a photocopying service. This involves our staff in considerable time consuming endeavour, so we hope our readers understand our decision to apply a flat charge of 50p inclusive. This covers any article, regardless of the number of pages involved, from any ONE issue of ETI.
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ETI Book Service sells books to our readers by mail order. The prices advertised in the magazine including postage and packing. SEND ORDERS to ETI BOOK SERVICE, P.O. Box 79, Maidenhead, Berks.

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We cannot solve the problems faced by individual readers building our projects unless they are concerning interpretation of our articles. When we know of any error we print a correction as soon as possible at the end of News Digest. Any useful addenda to a project will be similarly dealt with. We cannot advise readers on modifications to our projects.

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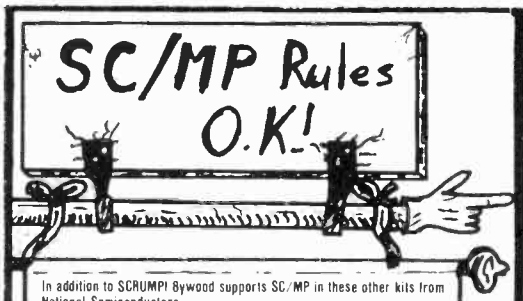

In addition to SCRUMPI Bywood supports SC/MP in these other kits from National Semiconductors—

INTROKIT: Eurocard PCB with SC/MP chip, 256x8 RAM,512x8 PROM (with KIT8UG monitor), Xtal, TTY interface, etc. Requires +5,–12v supply. If you have access to a TTY machine then this kit is a great start in microprocessors. If you do not have access to a TTY then you may consider using NS's new K8DKIT, replace the KITBUG PROM in an INTROKIT with the PROM supplied, add a few other components (supplied) and you have a portable microprocessor.

INTROKIT £66.33. K8DKIT £66.50

LCDS. National's Low Cost Development Kit for SC/MP. Uses a Hex keyboard and digital display or a TTY to communicate with the 2K monitor programs in PROM. The CPU application card supplied plugs into one of the sockets on the main mother PCB. Additional PROM and RAM application cards are available to allow expansion up to its full 64K capacity. RUN/STEP/HALT run modes allow for simple debugging.

Low Cost Development System £349.30

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MM2112-2 256x4 RAM	£4.30
MM2102-2 1Kx1 RAM	£2.95
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DS8833 4 bit buffer (Bi-Di)	£2.10
SC/MP Microprocessor chip	£14.50

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Power Supply P297 (+5,–5, –12) Kit form £11.50

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BOOKS AND DATA

SC/MP Technical Description	£1.95
SC/MP Programmers Guide	£6.30
SC/MP Applications Guide	£2.95
SCRUMPI Data Sheets	£0.75
F8 Data (Xerox)	£0.75

All prices exclude VAT at 8%

SYSTEM 8

BYWOOD ELECTRONICS is supporting ETI System 68 with a range of MPU kits, VDU kit, Case kit and many add-ons. An expanding range of compatible products building up to a complete home or small business computer system from about £300 upwards.

VDU KIT

At last! A high speed VDU controller to connect virtually any MPU to virtually any TV set! The full 8 bit x 1K RAM is fully decoded to give a maximum of 256 possible different characters displayed in any of 64 positions on each of 16 rows. The two Eurocard system includes Tri-State 8 bit keyboard input port and Screen Read facilities. Probably one of the most advanced MPU-VDU designs available.

Kit of all ICs, IC sockets, PCBs, capacitors, resistors, etc. **£83.34.**

N.B. PCB-B to be released when available.

CASE KIT

Complete VEROCASE kit for System 68. A versatile case system taking 100 x 160mm Eurocards in a 19" rack with an attractive case. The 4" module is used for a power supply and the six 2" front panels allows for future expansion. The 31-way plug and socket pairs allow each unit to be unplugged and removed as required.

Unit	Description	Qty. per kit	Price each
71-3841L	Frame: Case	1	17.26
71-3842F	End Angles	2	0.70 (pair)
71-3844G	4" Module	1	2.55
71-3845B	2" Panel	6	0.90
17-0267H	31-way Plug	7	0.90
17-0268C	31-way Socket	7	1.00
		Post & Packing on each kit	1.10
		Complete kit	39.92

6800 CPU CARD

To be released when published.

SC/MP CPU CARD

SC/MP MPU, 256 bytes RAM, 512 bytes PROM (VDUBUG), address decoding chips, IC sockets, PCB, etc. Interfaces to System 68 VDU and fits case, connector system. VDUBUG program uses ASCII keyboard input to allow SC/MP programs to be written, displayed and executed.

SC/MP Control Card SC1 **£60.19.**

Introkit owners write to us for special conversion offer!

CLOCK CHIPS & KITS

TYPE	SPECIAL FEATURES	£CHIP	£KIT
MM5309	7seg+BCD RESET ZERO	4.26	8.00
MM5311	7seg+BCD	4.26	8.00
MM5312	7seg+BCD 4 DIGIT ONLY	5.65	
MM5313	7 seg+BCD	6.50	
MM5314	7seg+BASIC CLOCK	4.26	7.00
MM5315	7 seg+BCD REST ZERO	6.50	
MM5316	Non-mpx ALARM	7.50	
MM5318	7seg+BCD External digit select	4.93	8.00
MM5371	ALARM 50Hz	12.19	
MM5377	CAR clock. Crystal control. LCD	10.56	
MM5378	CAR clock. Crystal control. LED	9.86	14.00
MM5379	CAR clock. Crystal control. Gas discharge	9.86	
MK5025	ALARM. SNOOZE	5.60	9.00
MK50395	UP/DOWN Counter — 6 Decade	12.10	15.10
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CT7003	ALARM. SNZ. CALENDER. Gas discharge	9.00	
FCM7004	ALARM. SNZ. CALENDER. 7seg	9.00	12.50
AY5 1202	7seg. 4 digit	4.76	
AY5 1230	7seg. ON and OFF ALARM	5.25	TBA

All above clock kits include clock PC board, clock chip, socket and CA3081 driver IC. MH15378 also includes crystal and trimmers. When ordering kit, please use prefix MHI, e.g. MHI 5309.

OLDE CLOCKS

In kit form or built these clocks are based on designs hundreds of years old. Wood stone and iron are used to reproduce authentic "olde worlde" wall clocks in full detail. The kits contain all you need including glue, screws, etc. and very comprehensive instructions. Stones for weights are excluded.

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Rotating Dial	Diam 6"	23.50	39.50
Wrought Iron	Diam 5½"	54.25	79.95
Wooden Wheel	Diam 6½"	36.95	52.00
Knight Clock	7½"	48.50	77.50
Oak Foliot	Diam 14"	123.95	145.00

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DISPLAYS

		Litronix class 2 product	
DL707, 704, 701 0.3"	1.48	DL707E	0.70
DL727, 728, 721 0.5" (2 dig.)	3.75	DL727E (2 dig)	1.80
DL747, 750, 746 0.6"	2.45	DL747E	1.50

MHI DISPLAY KITS

MHI707/4 digit 0.3"	6.60	MHI707E/4	3.50
MHI707/6	9.50	MHI707E/6	4.50
MHI727/4 0.5"	8.50	MHI727E/4	4.50
MHI727/6	12.00	MHI727E/6	6.00
MHI747/4 0.6"	9.80	MHI747E/4	6.00
MHI747/6	14.70	MHI747E/6	8.10

Any one or two of the above MHI display kits will interface directly with any of the MHI clock kits.

CASES (with perspex screen)

VERO 1. 8" x 5½"x3"	3.00
VERO 2. 6"x3¼"x2¼"	3.00

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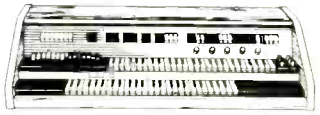

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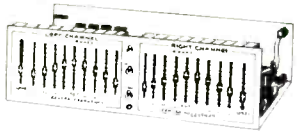

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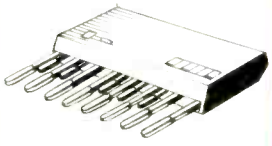

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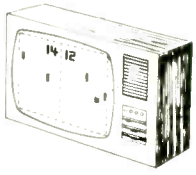

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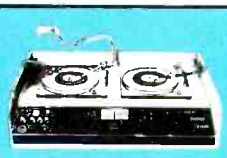

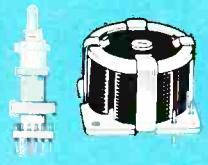

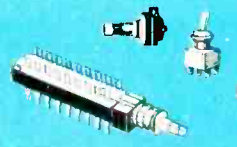

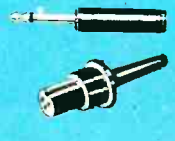

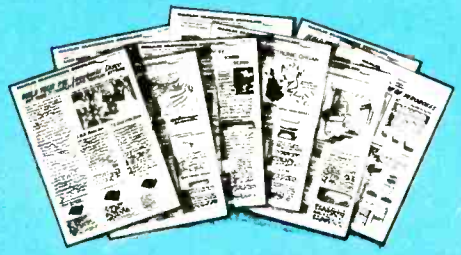

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