electronics today

INTERNATIONAL

JULY 1980 60p

STEREO IMAGE CO-ORDINATOR
Move Your Sound Around

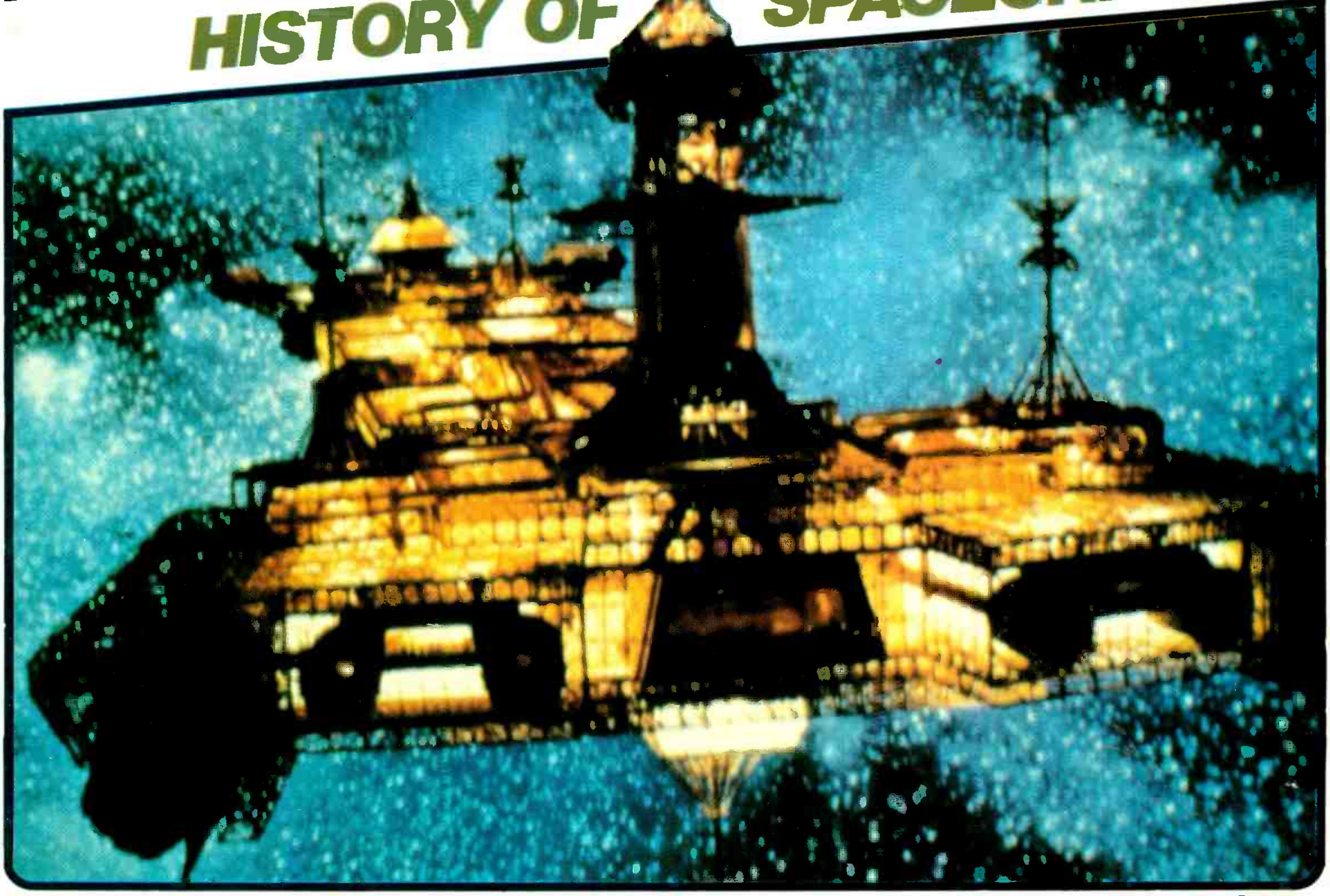
DESIGNING ACTIVE FILTERS

LOUDSPEAKER PROTECTION UNIT

FREQUENCY METER

TIME CONSTANTS?

HISTORY OF SPACECRAFT



...NEWS....PROJECTS....MICROPROCESSORS....AUDIO...

TRANSCENDENT 2000
SINGLE BOARD SYNTHESIZER

All kits also available as separate packs (e.g P C B , component sets, hardware sets, etc.). Prices in FREE CATALOGUE

LIVE PERFORMANCE SYNTHESIZER DESIGNED BY CONSULTANT TIM ORR (FORMERLY SYNTHESIZER DESIGNER FOR EMS LIMITED) AND FEATURED AS A CONSTRUCTIONAL ARTICLE IN ELECTRONICS TODAY INTERNATIONAL.

The TRANSCENDENT 2000 is a 3 octave instrument transposable 2 octaves up or down giving an affective 7 octave range. There is portamento, pitch bending, a VCO with shape and pitch modulation, a VCF with both low and high pass outputs and a separate dynamic sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features

The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal trim!) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibreglass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready-built units selling for many times the price!

Cabinet size 24.6" × 15.7" × 4.8" (rear) 3.4" (front)

COMPLETE KIT ONLY £168.50 + VAT!

Comprehensive handbook supplied with all complete kits! This fully describes construction and tells you how to set up your synthesizer with nothing more elaborate than a multi-meter and a pair of ears!

WE'VE MOVED! NEW FACTORY UP! PRICES DOWN!

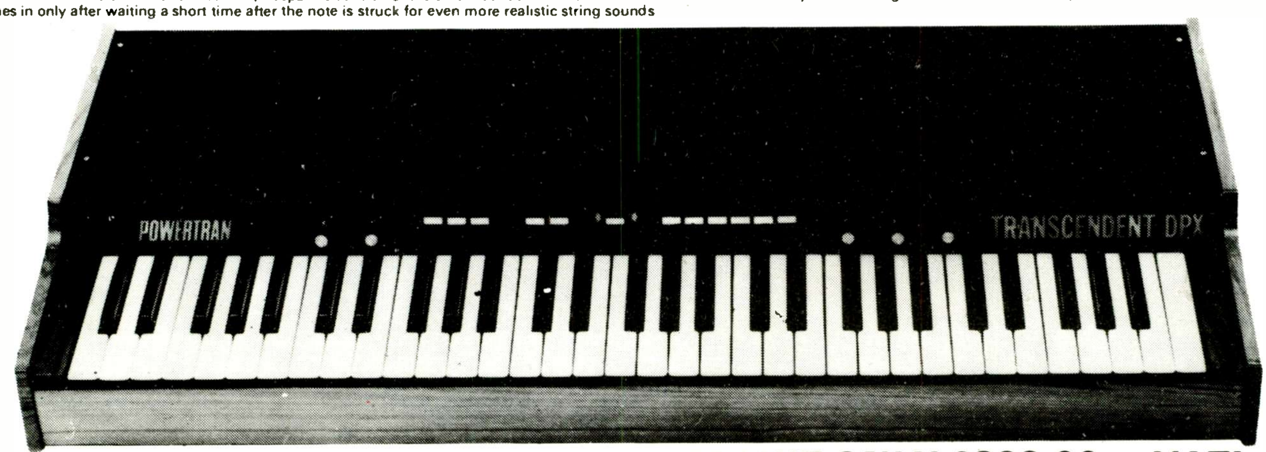
INCREASED CAPACITY AT OUR BIG NEW FACTORY MEANS MANY PRICES DOWN! ALL OTHERS FROZEN!

TRANSCENDENT DPX

DIGITALLY CONTROLLED, TOUCH SENSITIVE, POLYPHONIC, MULTI-VOICE SYNTHESIZER

ANOTHER SUPERB DESIGN BY SYNTHESIZER EXPERT TIM ORR — PUBLISHED IN ETI

The Transcendent DPX is a really versatile new 5 octave keyboard instrument There are two audio outputs which can be used simultaneously On the first there is a beautiful harpsichord or reed sound — fully polyphonic, i.e. you can play chords with as many notes as you like. On the second output there is a wide range of different voices, still fully polyphonic It can be a straightforward piano or a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or brass over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass at the lower end (the keyboard is electronically split after the first two octaves) or vice versa or even a combination of strings and brass sounds simultaneously And on all voices you can switch in circuitry to make the keyboard touch sensitive! The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical touch sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrato comes in only after waiting a short time after the note is struck for even more realistic string sounds



Cabinet size 36.3" × 15.0" × 5.0" (rear) 3.3" (front)

COMPLETE KIT ONLY £299.00 + VAT!

To add interest to the sounds and make them more natural there is a chorus/ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects.

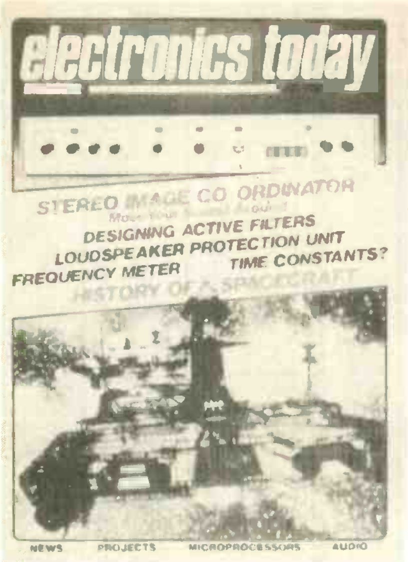
As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing etc., etc.)

Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet.

The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc , even a 13A plug — you need buy absolutely no more parts before plugging in and making great music! When finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1,200!

POWERTRAN

ORDERING INFORMATION AND MORE KITS INCLUDING THE BLACK HOLE ON PAGE 9



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JULY 1980 VOL 9 NO 7

FEATURES

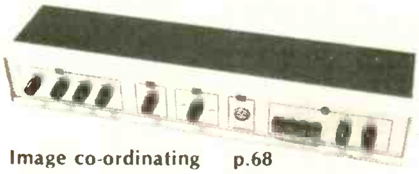
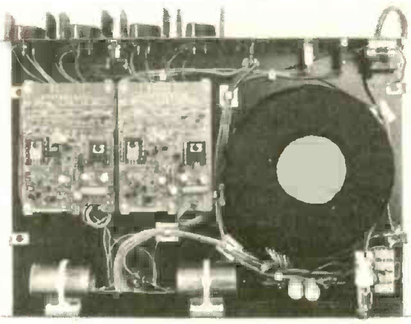


Image co-ordinating p.68

PROJECTS


Quantum sounding off p.43

INFORMATION

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POLYESTER CAPACITORS: Axial lead type. **400V**: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n **9p**; 18n **10p**; 22n, 33n **11p**; 47n, 68n **14p**; 100n **17p**; 150n, 220n **24p**; 330n, 470n **41p**; 680n **48p**; 1µF **64p**; 2µ2 **82p**. **160V**: 10nF, 12n, 39n, 100n, 150n, 220n **11p**; 330n, 470n **19p**; 680n, 1µF **22p**; 2.2µF **32p**; 4.7µF **36p**. **1000V**: 10n, 15n **20p**; 22n **22p**; 47n **26p**; 100n **38p**; 470n **53p**; 1µF **175p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V: 10n, 15n, 22n, 27n **5p**; 33n, 47n, 68n, 100n **7p**; 150n **10p**; 220n, 330n 13p; 470n **17p**; 680n **19p**; 1µ **22p**; 1µ5 **30p**; 2µ2 **34p**.

FEEDTHROUGH CAPACITORS 1000pF/350V **8p**

ELECTRONIC CAPACITORS: (Values are in µF) **500V**: 10 **50p**; 47 **78p**; **250V**: 100 **65p**; **63V**: 0.47, 1.0, 1.5, 2.2, 3.3, 4.7, 6.8 **8p**; 10, 15, 22, **11p**; 32, 47, 50, **12p**; 63, 100, **27p**; **50V**: 50, 100, 220, **25p**; 470, **32p**; 1000, **60p**; **40V**: 2, 33, **8p**; 100, **12p**; 2200, 3300, **85p**; 4700, **98p**; **35V**: 10, 33, **7p**; 330, 470, **32p**; 1000, **50p**; **25V**: 10, 22, 47, 80, 100 **8p**; 160, 220, 250, **15p**; 470 **25p**; 640, 1000, **35p**; 1500, **40p**; 2200, **45p**; 3300, **77p**; 4700 **85p**; **16V**: 10, 47, **7p**; 100, 125, **8p**; 220, 330, **14p**; 470, **20p**; 1000, 1500, **30p**; 2200 **36p**; **10V**: 100, **7p**; 640, **12p**; 1000, **16p**.
TAG-END TYPE: 450V: 100µF **180p**; **70V**: 4700, **165p**; **64V**: 3300 **150p**; 2500 **110p**; **50V**: 4700, **150p**; 3300 **135p**; 2200 **99p**; **40V**: 15,000 **399p**; 4700 **130p**; 4000 **92p**; 3300 **98p**; 2500 **90p**; **30V**: 4700 **110p**; **25V**: 15000 **195p**; 6400 **120p**; 4700 **100p**; 3300 **80p**; 2200 **60p**.

TANTALUM BEAD CAPACITORS
35V: 0.1µF, 0.22, 0.33, 0.47, 0.68, 1.0µ, 2.2µF, 3.3, 4.7, **25V**: 10, **20V**: 6µ8 **16V**: 2µ2 4µ7, 10 **15p**; **16V**: 22µ **28p**, 47, 100 **50p**, 220 **80p**; **10V**: 15µ, 22µ, 33, **24p**; 100µ **35p**; **6V**: 47µ, 68, 100 **28p**; **3V**: 100.

POTENTIOMETERS: Rotary, Carbon, Track. 0.25W Log & 0.5W Lin. 470Ω, 680Ω, 1KΩ & 2KΩ (Linear only) Single Gang **29p**
5KΩ-2MΩ Single Gang Log & Lin **29p**
5KΩ-2MΩ Single Gang D/P Switch **69p**
5KΩ-2MΩ Double Gang Log & Lin **88p**
Wire Wound Single Turn 1 Watt 20Ω 20KΩ **105p**

MYLAR FILM CAPACITORS
100V: 0.001, 0.002, 0.005, 0.01µF **6p**
0.015, 0.02, 0.04, 0.05, 0.056µF **7p**
0.1µF **9p**, 0.2 **11p**. **50V**: 0.47µF **12p**

SLIDER POTENTIOMETERS
0.25W log and linear values 60mm
5KΩ-500KΩ single gang **60p**
10KΩ-500KΩ dual gang **80p**
Self Stick Graduated Bezels **30p**

CERAMIC CAPACITORS 50V
Range: 0.5pF to 10,000pF **4p**
0.015µF 0.022µF, 0.033µF **5p**
0.047µF **5p** 0.1µF, 0.2µF **7p**

PRESET POTENTIOMETERS
0.1W 50Ω—5MΩ Miniature Vertical & Horizontal **7p**
0.25W 100Ω—3.3MΩ horiz. larger **10p**
0.25W 200Ω—4.7MΩ Vert. **10p**
Cermet, Precision, multiturn, 0.75W ¾in 100Ω-100KΩ **90p**

SILVER MICA (Values in pF) 3.3, 4.7, 6.8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 220 **11p** each
250, 270, 300, 330, 360, 390, 470, 600, 800, 820 **16p** each
1000, 1200, 1800, 2000 **26p** each

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

	RANGE	VAL	1-99	100+
¼W	2.2Ω-4.7M	E24	2p	1p
½W	2.2Ω-4.7M	E12	2p	1p
1W	2.2Ω-10M	E12	5p	4p
2%Metal Film	10Ω-1MΩ		6p	4p
1%0.5W	51Ω-1M	E24	8p	6p

100+ price applies to Resistors of each type not mixed values

POLYSTYRENE CAPACITORS:
10pF to 1nF **8p**; 1.5nF to 47nF **10p**

MINIATURE TYPE TRIMMERS
2.5-6pF 3-10pF 10-40pF **22p**
5-25pF 5-45pF 60pF 88pF **30p**

COMPRESSION TRIMMERS
3-40pF 10-80pF 25-190pF **30p**
100 500pF **45p** 400-1250pF **58p**

GAS & SMOKE DETECTORS
TGS 812 & 813 **415p**; Socket **25p**

JACKSONS VARIABLE CAPACITORS

DILICON		0.2 365pF with slow	
100/300pF	205p	motion Drive	450p
500pF	250p	00 208/176	350p
6.1 Ball Drive		with slow	
4511/OAF	145p	motion drive	410p
Dial Drive 4103		C804-5pF 10, 15:	
6:1/36:1	775p	25: 50pF	250p
Drum 54mm	55p	100, 150pF	335p
0-1-365pF	325p	'L' 3x310pF	725p
00 2 365pF	395p	00-3x25pF	550p

RF CHOKES

1µH 4.7 10 22 33 47 100 200 470 750, 1mH, 2.5 5 10 **30p each**
43mH 100 **60p each**

VEROBOARD

	0.1 (copper clad)	0.15	0.1 (plain)
2½ x 3¼"	58p	51p	42p
2½ x 5"	68p	62p	—
3¾ x 3¾"	68p	—	—
3¾ x 5"	77p	86p	65p
2½ x 17"	204p	—	—
3¾ x 17"	264p	229p	—
4¾ x 17"	345p	—	210p

Pkt. of 36pins **20p**. Spot face cutter **105p**. Pin insertion tool **140p**. VQ Boards **129p**. DIP Boards **290p**. Veroblock **324p**.

VERO WIRING PEN

Plus Spool **325p**
Spare spool (wire) **80p** Combs **7p** each

FERRIC CHLORIDE

1lb bag Anhydrous **125p** + **35p** P&P

DALO ETCH RESIST PEN + spare tip **75p**

COPPER CLAD BOARDS

Fibre Glass	Single-sided	Double-sided	SRBP 9.5"x8.5"
6" x 6"	90p	110p	95p
6" x 12"	150p	195p	

DIL PLUGS (Headers)
14 pin **35p**; 16 pin **40p**; 24 pin **85p**; 40 pin **375p**.

Soldercon pins 100 **55p**; 500 **250p**.

DIL SOCKETS (TEXAS)

	Low prof.	Wire Wrap
8pin	10p	25p
14pin	12p	35p
16pin	13p	46p
18pin	16p	52p
20pin	22p	65p
22pin	25p	70p
24pin	38p	78p
28pin	39p	85p
36pin	—	105p
40pin	50p	109p

EDGE CONNECTORS: (Double type)

	.1	.156
2x10 way	—	85p
2x15 way	—	99p
2x18 way	115p	120p
2x22 way	130p	135p
2x25 way	149p	160p
2x30 way	170p	—
2x36 way	194p	—
2x40 way	210	—
2x43 way	232p	—

DIODES

BA102	15
AA119	18
AAZ15	15
BY100	24
BY126	12
BY127	12
CR033	157
OA9	75
OA47	12
OA70	12
OA79	15
OA81	15
OA85	14
OA90	7
OA91	7
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
IN4001/2	5
IN4003	6
IN4004/5	6
IN4006/7	7
IN4148	4
IN5404	17
IS44	20
IN5401	13
IN5402	14
IN5406	18
IN5408	30

BRIDGE RECTIFIERS

(plastic case) p

1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
4A/100V	72
4A/400V	79
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	50

ZENERS

Range 2V7 to 39V 400mW **8p each**
Range 3V3 to 33V 1.3W **15p each**

NOISE

Z5J **180**

VARICAPS

BA102	25
BB105B	40
BB106	40
MVAM2	150
MVAM115	140

SCRs Thyristors

1A/50V	37
1A/100V	42
1A/200V	47
1A/400V	55
5A400V	39
5A600V	43
8A300V	48
8A500V	58
8A600V	85
12A100V	42
12A300V	59
12A500V	92
12A800V	120
BT106	150
BT116	150
C106D	38
TIC44	22
TIC45	25
2N4444	140
2N5064	35

TRIACS

3A200V	49
3A400V	50
8A100V	54
8A400V	64
8A800V	108
12A100V	60
12A400V	70
12A800V	115
16A100V	240
16A400V	105
16A500V	120
25A500V	235
25A800V	295
T2800D	120

DIAC

ST2 **20**

COMPUTER ICs

2102	125
2102-2	225
2112-2	250
2114	299
2708	595
27L08	995
4116	850
4047	750
6502	995
6503	850
6504	785
6505	850
6520	525
6532	1050
6551	1150
6800	800
6810	360
6821	500
6850	485
6852	485
8080A	595
8085A	1220
81LS95	130
81LS96	130
81LS97	140
8251	700
8253	1275
8726A	235
8T28A	280
8T95N	160
8T97N	150
AY-3-1015	550p
AY-5-1013	395
AY-5-2376	920
CP1610	920
DM8123	200
MC14B8	85
MC1489	90
MC14411	1020
MC14412	1520
MK4027-2	470
MK4027-3	445
MK4027-4	350
MK4116	850
MK4118-4	2099
RO-3-2513L	690
RO-3-2513U	650
SFF96364E	1050
SFC71301	820
TMS2516	1750
TMS2716	1450
TMS4035	250
TMS4039	250
TMS4045	720
TMS6011	365
Z80 CPU 2.5M	990
Z80 CPU 4M	1099
Z80 CTC	595
Z80A CTC	720
Z80 P10	660
Z80A P10	720

LINEAR ICs

702	75
709 14 pin	38
709C 8 pin	35
710	67
733	99
741 8 pin	17
747C 14 pin	78
748C 8 pin	36
753 8 pin	150
810	159
AY-1-0212	595
AY-1-1313A	660
AY-1-1320	315
AY-1-5050	190
AY-1-5051	160
AY-1-6721/6	210
AY-3-1270	840
AY-3-8500	390
AY-3-8910	850
AY-5-1224A	235
AY-5-1230	450
AY-5-1315	595
AY-5-1317A	630
AS-5-3500	510
AY-5-3507	415
AY-5-3600	1090
AY-5-4007D	650
AY-5-8100	735
CA3011	110
CA3012	150
CA3014	157
CA3018	68
CA3019	70
CA3020	186
CA3023	191
CA3028A	80
CA3035	235
CA3036	115
CA3043	275
CA3045	365
CA3046	71
CA3048	214
CA3059	175
CA3075	213
CA3080E	65
CA3081	190
CA3085	95
CA3089E	215
CA3090AQ	375
CA3123E	150
CA3130	90
CA3140	48
CA3160	95
ICL7106	795
ICL7107	975
ICL8038CC	340
ICL8211A	150
ICM7205	1150
ICM7215	1050
ICM7216AJ	1950
ICM7216B	1950
ICM7216C	1950
ICM7217A	790
ICM7224	785
ICM7227A	885
ICM7555	89
LD130	452
LF356	90
LM10	395
LM301AP	23
LM308T	70
LM311	80
LM318S	195
LM324A	45
LM339	70
LM348	90
LM349	125
LM379	375
LM380	80
LM381N	145
LM382	125
LM386	99
LM387	150
LM1458	40
LM3900	60
LM3909N	70
LM3911	125
LM3914	240
LM13600	135
M252AA	625
M253AA	1150
MC1204	250
MC1301	79
MC1303	88
MC1304P	260
MC1310P	175
MC1312PQ	195
MC1458	45
MC1495	350
MC1496L	92
MC1596	225
MC3302	150
MC3340P	120
MC3360P	120
MC3401	52
MC3403	135
MC3405	150
MEM780	205
MFC6040	97
MK50398	635
MM5303	635
MM5307	1275
MM57160	620
NE515	80
NE518	210
NE543K	210
NE544	185
NE555	22
NE556	55
NE560	325
NE561	395
NE562B	410
NE564	425
NE565A	120
NE566	160
NE567V	170
NE570	375
NE571	420
RC4136D	110
SG3402	295
S556B	275
SAB3209	425
SAB3210	TBA
SL414A	150
SN76003N	240
SN76013	170
SN76013ND	130
SN76018	148
SN76023	170
SN76023ND	130
SN76033N	195
SN76115N	215
SN76131	110
SN76227N	95
SN76477	175
SN76660	120
SP8629	299
TAA621AX1	250
TAA661A	155
TAA700	353
TAA960	320
TAD100	159
TBA120S	70
TBA540Q	220
TBA550Q	330
TBA641-A12	
BX or BX11	250
TBA651	190
TBA800	90
TBA810	95
TBA820	70
TBA920Q	260
TBA990Q	270
TCA270Q	220
TCA965	120
TDA1004	290
TDA1008	310
TDA1022	575
TDA1024	105
TDA2020	320
TDA1490	290
TDA2030	300
TL061CP	54
TL062CP	125
TL064CN	159
TL071	45
TL072CP	90
TL074CN	140
TL081CP	42
TL082CP	96
TL083CP	95
TL084CN	120
UAA170	150
UAA180	150
XR2206	350
ZN414	80
ZN423	195
ZN424E	130
ZN425E	415
ZN1034E	200
ZN1040E	685

TRANSISTORS

	p
AC125	35
AC126	25
AC127	22
AC128	20
AC141	27
AC142	28
AC176	25
AC187	26
AC188	26
ACY17	60
ACY18	60
ACY19	60
ACY20	53
ACY21	40
ACY22	60
ACY28	60
ACY39	80
ACY41	39
AD149	75
AD161	42
AD162	42
AF114	60
AF115	60
AF116	60
AF117	50
AF118	75
AF139	40
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BC149	9
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BC158	10
BC159	11
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BC179	15
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BCY78	19
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BD245	50
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BD696A	85
BDY56	170
BDY60	140
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BF158	30
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BFR79	24
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BFR98	105
BFX29	26
BFX81	45
BFX84	26
BFX85	28
BFX86	28
BFX87	28
BFX88	28
BFY50	21
BFY51	21
BFY52	21
BFY53	28
BFY55	38
BFY56	32
BFY64	40
BFY71	20
BFY81	99
BRY39	39
BSX20	20
BSX26	75
BSX29	45
BSX78	75
BSY26	40
BSY95A	18
BU105	115
BU205	125
BU208	215
E421	158
MD8001	225
MJ490	90
MJ491	175
MJ2955	105
MJE170	130
MJE180	130
MJE340	54
MJE370	58
MJE371	54
MJ490	90
MJE520	65
MJE521	74
MJE2955	90
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MPF102	66
MPF103	36
MPF104	36
MPF105	36
MPF106	40
MPSA05	15
MPSA06	16
MPSA12	22
MPSA55	22
MPSA56	22
MPSU02	58
MPSU05	50
MPSU06	50
MPSU52	65
MPSU55	55
MPSU56	60
MPU131	45
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OC42	48
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TIP36A	145
TIP36C	185
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TIP42B	82
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ZTX503	15
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ZTX550	25
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AC188	26
AF139	40
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BC237	10
BC238	10
BC337	12
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BCY45	50
BCY78	19
BD112	95
BD158	60
BD206	110
BD222	65
BDY56	170
BDY60	140
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BF185	25
BF245	24
BF337	32
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BFY55	38
BFY56	32
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2N5138	20
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2N55305	20
2N5308	20
2N5879	140
2N6388	126

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TTL 74 (TEXAS)

7400	11
7401	12
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7405	18
7406	48
7407	48
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74284	385
74285	385
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74293	125
74297	236
7'298	185
74365	95
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74490	150

74L

74L00	78
L30	80
L47	395
L75	220
L85	360
L121	195
L123	340

74S

74S00	60
S04	73
S132	350
S138	250
S158	524
S188	210
S189	158
S194	195
S195	795
S241	195
S262	895
S287	325
S288	210
S470	325
S472	1150
S475	825

74LS

LS00	13
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LS02	15
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LS168	210
LS169	210
LS170	288
LS173	105
LS174	147
LS175	110
LS181	295
LS183	298
LS189	120
LS190	120
LS191	120
LS192	125
LS193	125
LS194	125
LS195	125
LS196	120
LS197	120
LS199	
LS200	345

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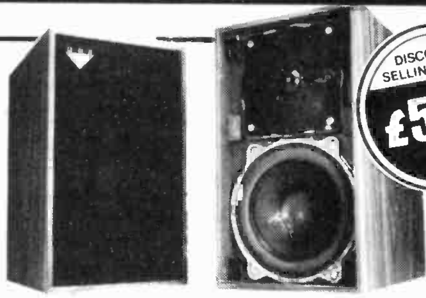

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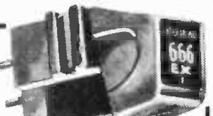

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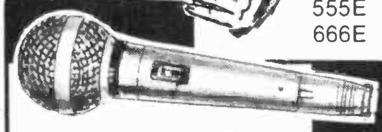

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MU 105-22	£29.30
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MU 25 C	£17.39

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This new range of Electronics from Videotone redefines the words quality and value for money to a new high.

30 watt amp MC input SA4130	£75.00
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Cassette full features SC3200	£98.00
50 Watt amplifier WA7700	£77.00
20 Watt amplifier LA2020	£58.00

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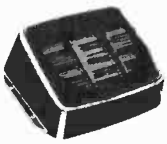

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Small Wedge	£2.95
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HP 90 Headphone	£12.65
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ETI/7/80

DIGEST

Continental Time

An attractive new instrument from CSC offers time and frequency measuring capabilites plus signal conditioning facilities.

The model 5001 has two DC-coupled BNC inputs, both of 1M plus 20 pF input impedance with a sensitivity of 20 mV RMS. Each has three position attenuator (x1, x10 and x100), a positive/negative going slope selector and a variable trigger-level control. Maximum frequency at the A input is specified as 10 MHz and at the B input as 2 MHz. Readings can be held on the display for a variable period.

The frequency counter, with a maximum input frequency of 10 MHz, has a selectable resolution of 100 Hz, 10 Hz, 1 Hz or 0.1 Hz.

The period measurement mode, with a range of 400 nS to 10 S and a maximum input frequency of 5 MHz, can resolve to 100 nS, 10 nS, 1 nS or 100 pS depending on the range chosen.

Time intervals from 200 nS between a rising edge at the A input and the next rising edge at B can be measured, with resolution down to 100 pS.

The ratio of cycles appearing at the A input per cycle at B can also be displayed. The unit will count the number of rising edges arriving at A before the reset button is pushed, in the count mode.

Power consumption is 10 W. The model 5001 Universal Counter-Timer is available at £185 plus VAT from Continental Specialties Corporation, Shire Hill Industrial Extate, Saffron Walden, Essex CB11 3AQ.

Look Out Busby

Phillips' M100 Direct Speech System is part of a new range of intercom equipment being launched for the 1980's. Fully compatible with the existing M100 system, its built-in microprocessor enable instant 'hands free' voice links for between two and many thousand stations and extra stations are simply plugged into the eight pair parallel cable and reprogrammed within seconds. The keyboard layout includes an improved volume control and privacy button as well as standard optional functions such as automatic call-back, triplex conversations, group call and links with the DP600 digital paging system through a coupler. There is also facility for twelve programmable direct call buttons for frequently called stations. The M100 system therefore dispenses with the need for a large central exchange and the expense of wiring every station to it. It is available from Pye Business Communications, Cromwell Road, Cambridge CB1 3HE. The BBC has already shown interest in this system by placing a £75,000 order with Pye to instal internal communications in the Beeb's News Department at Television Centre, this covers seven floors and initially 140 stations will be installed. It will replace part of the existing custom-built system.

Calculate-A-Calendar

The casio HR10 is a slightly out of the ordinary printing calculator, in that apart from all the usual functions and a 10 digit display, it has the capacity to print calendars to order. Simply key in any year and month between January 1901 and December 1099 and it will print out a full conventional calendar. Press add or subtract and it will print the month following or preceding it. The unit can be used either with four AA batteries, rechargeable battery pack or mains adapter. The HR-10 is 3½" wide by 6¾" deep and 1¾" high. Recommended price is £35.95 including VAT. So, if you want to find out which day of the week your Granny was born on. . . .

Battery Farming

1980 may well herald a new era for the motor vehicle, this is due to the Chancellor of the Exchequer abolishing Excise Duty from electric vehicles. The interest recently shown in this form of transport is being further strengthened by the forthcoming Drive Electric '80 exhibition to be held at the Wembley Conference Centre in London during October this year. It will be an international show case of electrically powered vehicles. In Great Britain over a thousand new electric road vehicles are made each year and only here do electrically powered vehicles run as many as 300 million miles each year. The intention of the conference and exhibition is to prove the reliability and performance of the electric vehicle and to extend its acceptability as a means of transport.

Pinball Prices Slashed

Remember the ETI Pinball Wizard project, featured in the November 1979 issue? It has proved to be so popular (hundreds have been built) that the supplier has made a further bulk purchase of the chips.

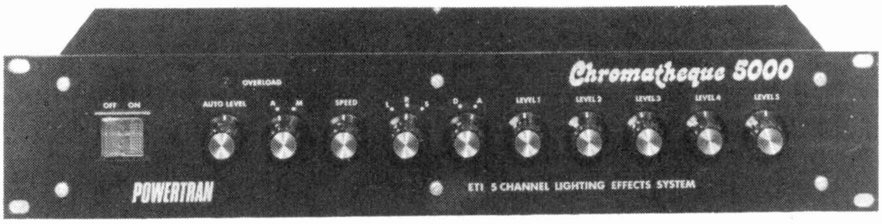
ETI readers can now buy the PCB and chip for a mere £9.95 all inclusive only if you send off the attached form.

To: Pinball Offer, NIC,
61 Broad Lane, London N15 4DJ
Please send me . . . .
Pinball Wizard PCB/Chip sets at £9.95 per set. I enclose cheque/PO payable to NIC for . . . .
NAME . . . .
ADDRESS . . . .
. . . .

CHROMATHEQUE 5000

POWERTRAN

5 CHANNEL LIGHTING EFFECTS SYSTEM



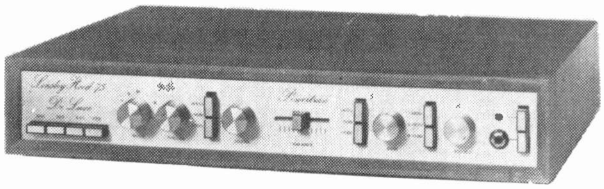
Panel size 19.0" × 3.5". Depth 7.3"

COMPLETE KIT ONLY £49.50 + VAT!

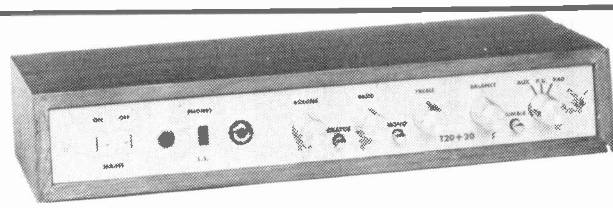
This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel Control of the lights is comprehensive to say the least You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control or use the internal digital circuitry which produces some superb random and sequencing effects Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward

Kit includes fully finished metalwork, fibreglass PCB controls, wire, etc — Complete right down to the last nut and bolt!

All kits also available as separate packs (eg PCB, component sets, hardware sets etc) Prices in our FREE CATALOGUE



Matching Tuners. See our FREE CATALOGUE



DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £99.30 + VAT

This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward The design was published in Hi-Fi News and Record Review and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring whilst distortion is less than 0 01%

T20+20 20W STEREO AMPLIFIER £33.10+VAT

This kit, based upon a design published in Practical Wireless, uses a single printed circuit board and offers at very low cost, ease of construction and all the normal facilities found on quality amplifiers A 30-watt version of this kit (T30+30) is also available for **£38.40** + VAT

Above 2 kits are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet cable nuts, bolts etc and full instructions—in fact everything!

BLACK HOLE

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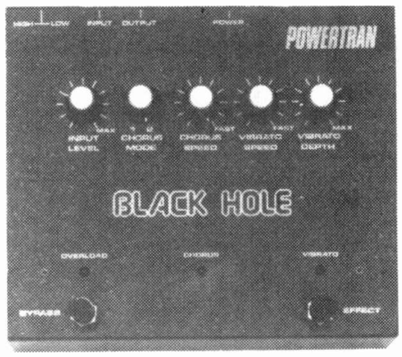

The BLACK HOLE designed by Tim Orr, is a powerful new musical effects device for processing both natural and electronic instruments, offering genuine VIBRATO (pitch modulation) and a CHORUS mode which gives a spacey feel to the sound achieved by delaying the input signal and mixing it back with the original Notches (HOLES), introduced in the frequency response move up and down as the time delay is modulated by the chorus sweep generator An optional double chorus mode allows exciting antiphrase effects to be added The device is floor standing with foot switch controls, LED effect selection indicators, has variable sensitivity input has high signal/noise ratio obtained by an audio compander and is mains powered — no batteries to change! Like all our kits everything is provided including a highly superior, rugged steel, beautifully finished enclosure

COMPLETE KIT ONLY £49.80 + VAT (SINGLE DELAY LINE SYSTEM)

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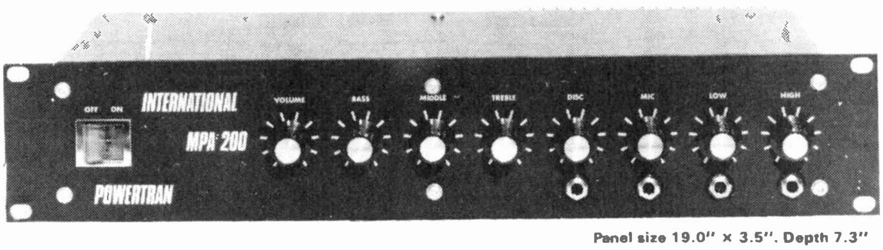
Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier It features adaptable input mixer which accepts a wider range of sources such as microphone, guitar, etc There are wide range tone controls and a master volume control Mechanically the MPA 200 is simplicity itself with minimal wiring needed making construction very straightforward
The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc — complete down to the last nut and bolt



Panel size 19.0" × 3.5". Depth 7.3"

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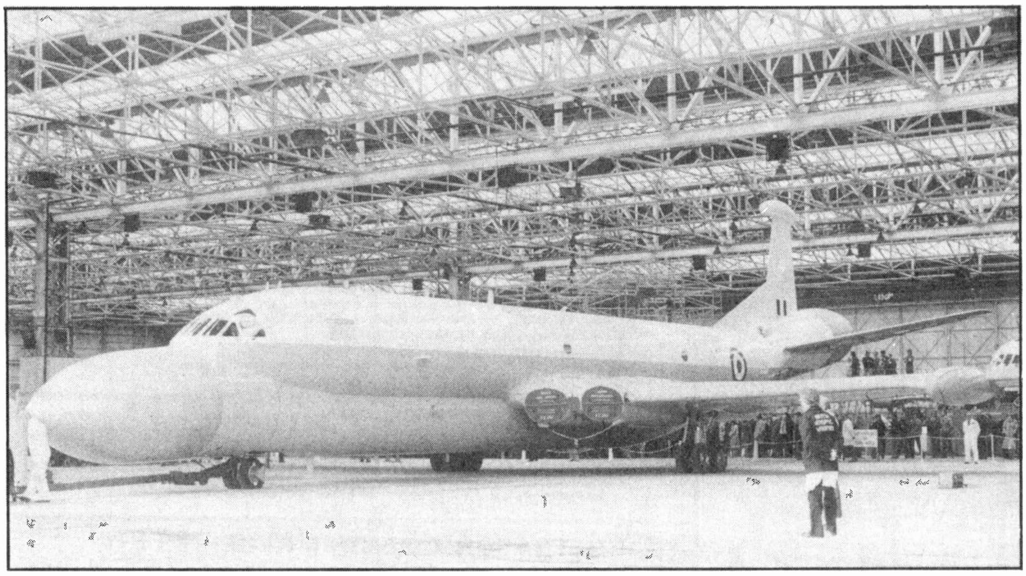


Nimrod the Mighty Hunter

The latest addition to Britain's Airborne Early Warning (AEW) system was recently unveiled at a British Aerospace airfield 'somewhere' in Cheshire. The modified Nimrod aircraft is the first of a fleet of eleven ordered by the RAF.

The AEW radar system has been undergoing development since 1977. Ground-based radar cannot see beyond the horizon. The airborne system carried by Nimrod can see further and, therefore, give earlier warning of approaching enemy aircraft.

Nose and tail radomes give the aircraft its odd bulbous appearance. The sophisticated avionics, designed by Marconi with electronic warfare in the crowded airways of Europe in mind, can detect ships and aircraft even against strong ground or sea 'noise' or deliberate jamming and can eliminate friendly craft. In addition to the active radar, there is a passive system, carried as sensors on each wing tip, to analyse and classify radiation received from targets.

Nimrod AEW has been designed to be fully compatible with other AEW systems, such as the American AWACS. Information can be transmitted from Nimrod AEW to the ground, ships, other aircraft or to virtually anywhere in the world via satellite link.

The first aircraft is due to make its first flight in August and enters service with the RAF in 1982.

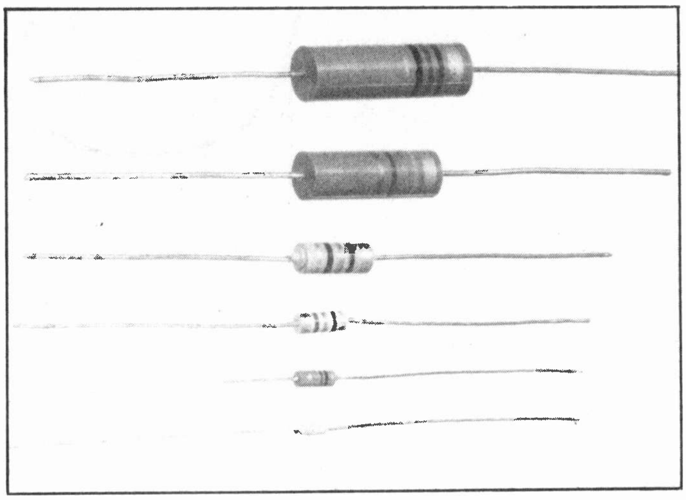
Martian Gremlins

Hot news from our science correspondent on Mars — the Viking 2 Lander isn't a well spacecraft at all. Its on-board battery is presenting a low profile: It's flat. There isn't sufficient charge to keep the transmitter going.

Viking Lander 2 now sits on the rusty planet at its landing site in Utopia Planitia, where the daytime temperature rarely gets above -115°C. It has been working in that temperature since it landed there on September 3rd 1976.

Circuit Handbook (June)

We missed a denominator out of the equation for E_0 accompanying Fig.11 p.60. The first term of the equation should read (RA + RB)/RB. Also, on p.61, in the equation for Ein below Fig.12c, 'bandwidth' should not be squared. Therefore, two lines down, '20,000' should not be squared. In the design example the resistor noise effective resistor is RA/(RB + RC) ≏ 1k0. The thermal noise term is then derived from Fig.12b.



Choked Up

Gone are the days when chokes looked like lumpy coils of wire. The new range of ultra miniature moulded RF chokes from RBS Capacitors look more akin to the common or garden carbon resistor.

The series 8 chokes have a body length of only 5 mm and a diameter of only 2 mm (free magnifying glass with every order?). They come in values of 0.1 uH to 10,000 uH with minimum Q from 35 to 95.

These military spec components can tolerate up to 1000 V RMS and if you fancy fixing your private jet's radio with one, you can use it up of 70,000 feet. Ten percent toleranc is standard, but five percent is available.

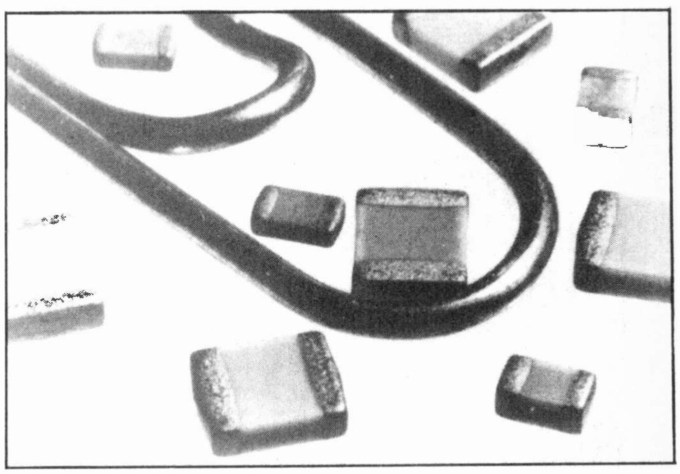
For further information on the Series 8 chokes contact RBS Capacitors Ltd, Orchard Works, Vencourt Place, London W6.

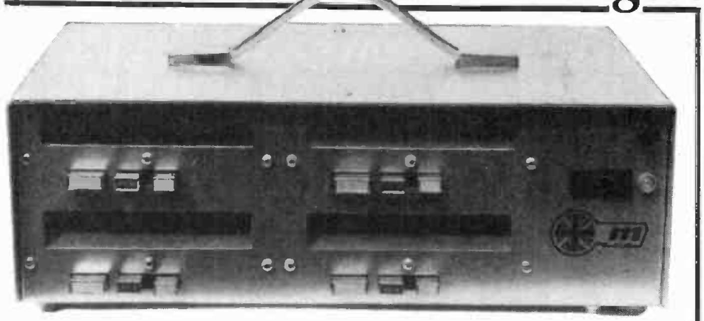
Flat Caps

Looking a bit like microscopic liquorice all sorts, the new range of capacitors from Welwyn Electric are designed specifically for micro-microelectronic applications. The largest of the range is only 3 mm x 2.5 mm x 1.8 mm.

Initial production will cover values from 1 pF to 100 nF in two dielectrics. BX is suitable for most applications and NPO can be used where high temperature stability is required. Three working voltages are available — 50 V, 100 V and 200 V. The components have no leads. They have palladium silver terminations for flat soldering onto a substrate or PCB.

For further information on the new range of small multilayer chip capacitors contact Welwyn Electric Ltd, Bedlington, Northumberland NE22 7AA.





Cassette Copying

Foxebay have announced the introduction of the first portable machine capable of making three copies at a time. Despite its name, the 3-Kassette-Copier is British made. It costs less than all other two copies cassette copiers.

Foxebay's copier is compatible with both half track IEC and quarter track Japanese formats. It uses the compatible C-format (erase tracks 3 & 4, record onto track 4). A Hi-Lo switch can compensate for over-recorded/distorted masters and the auto recording takes care of the rest.

There is also a portable seven cassette copying version, consisting of the three-cassette machine linked to a slave four-cassette unit.

The 3-Kassette-Copier (£398 plus VAT) and the 7-Kassette-Copier (£796 plus VAT) are available from Foxebay Ltd. 41/43 Charlbert Street, London NW8 6JN.

Project 80

The Project 80 Modular Synthesiser is alive and well! A number of readers, who have already invested a great deal of time and money in Project 80 modules, are a little concerned that we do not feature a module in *every* issue.

The modular synthesiser was conceived as a series of projects, each of which was complete in itself. However, if you build all of them and put them in one box with a keyboard, you end up with a formidable synthesiser.

Occasionally we will miss amonth, but Project 80 will continue to the end of its natural life span.

Inscrutable Japanese

JVC are holding their Third Tokyo Video Festival in December this year. In celebration of this they are holding a competition to judge video compositions from all over the world. The prize is an all expenses paid trip to Japan, a trophy and 300,000 yen (£699). So if you have a yen (ouch) to try for it, all you need is a video camera, recording on ½" or ¾" tape in any format. The film should be no more than 20 minutes in length and black and white or colour programmes are equally acceptable.

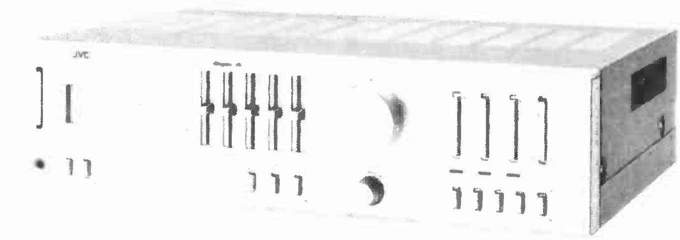
JVC Super Range

JVC have just revealed their new range of equipment, including three new turntables, four new amplifiers, four tuners, four receivers and five new metal tape cassette decks.

All four of the new AX series of amplifiers and two receivers incorporate what JVC describe as 'a remarkable innovation in amplifier design — the development of Super A amplification'. JVC claims that this combines low distortion ahd high efficiency. Well, we'll let you know what we think when we get one to play with.

Two of the new turntables feature another JVC technical innovation, the Electro-Dynamic Servo Tonearm. The arm senses record eccentricity, warp, etc and compensates for their effects. Tracking force and anti-skating force can be adjusted electronically with no contact between the arm and other parts of the turntable.

The range of metal tape cassette decks includes a budget model selling for under £100. You can build up one of nine recommended, rack-mounting systems from the separates to suit your needs and your pocket.



ETI NEXT MONTH

ON SALE JULY 4th

100W MOSFET Amplifier

Yet another in the long line of top line audio projects from ETI. Next month we give you a 100 + 100W power amp with bargraph output display, separate PSUs for each channel and a brilliant sound that puts this unit at the very top end of audio today. You will find it costs a lot less than you think to build, too.

Electromagnetic Pulse Effect.

Never heard of it eh? Most people haven't — yet EMP could be the deciding factor in a nations fight for survival during nuclear attack. With the international situation steadily worsening around us, the facts ETI has turned up about Britain's susceptibility to EMP are very, very disturbing and make mandatory reading for anyone concerned with keeping civilisation alive in the age of the Bomb!

As an indication of the situation, did you know that in 1958 a small warhead test in the Johnstone Islands produced power systems failure in Hawaii, SOME 1000 KM FROM THE EXPLOSION, due to EMP? (The British Isles are approx. 800 km in length).

Video Today — And Tomorrow

Next month ETI takes a detailed look at the expanding world of home video and offers a buyers guide to inform the intending purchaser. In addition we have a look at the next 12 months from Richard Dean (editor — TV and Home Video) — probably the leading writer in the field today.

Circuits Appetiser

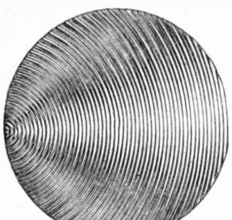
How many times have you glanced at book titles all neatly aligned on a shelf and wondered just how interesting they *really* are? Well, as of next month maybe we can help. "110 Timer Circuits for the Home Constructor" has just been released by Newnes and ETI is publishing a chapter from it next month. Circuits galore and full details of this very nifty litttle volume. It is hoped that more books will receive this treatment in the future.

Projects, Projects, Projects, Projects.

In addition to that truly amazing MOSFET AMPLIFIER we have a further four constructional projects for you next month. There is an excellent VCA module which fits in with Project 80 if you're following it. Also we give full details of an ULTRASONIC BURGLAR ALARM which could ensure than any visitors you get are at least invited. Two test gear "quickies" are featured in the shape of a LINEAR CAPACITANCE METER with good accuracy and easy construction and a very versatile LOGIC PROBE to allow you to hunt out those missing bits.

With all this how can you possibly *not* buy ETI next month?

Articles mentioned herein are in an advanced state of preparation, however, circumstances may dictate charges to the final contents.



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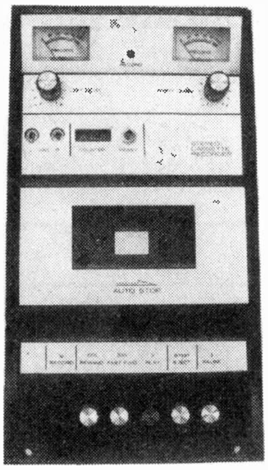
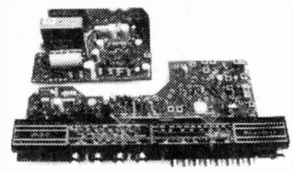
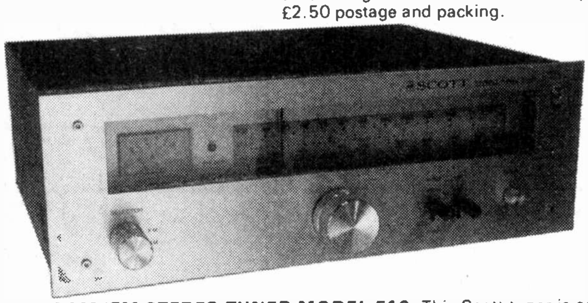


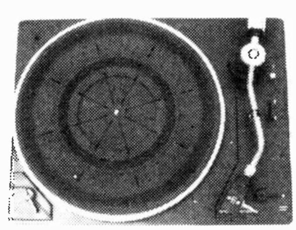
STEREO CASSETTE TAPE DECK ASSEMBLY. Comprising of a top panel assembly and tape mechanism coupled to a record/play back printed board assembly. For horizontal installation into cabinet or console of own choice. Brand new, ready built and tested. **Features:** Pause control, auto stop, 3 digit tape counter, illuminated twin VU meters with individual level controls, twin mic, input sockets, AC erase system, LED record indicator. (Separate power amplifier required.) **Input Sensitivity:** 6 MV (with level control set at max). **Input Impedance:** 47 kOhms. **Output Level:** To both left and right hand channels 150 MV. **Output Impedance:** < 10k. **Signal to noise ratio:** 45 dB nominal. **Power Supply Requirements:** 12V AC at 300M/A. **Connections:** All connections to the unit are via a wander lead terminated with a nine pin plug (socket provided). **Dimensions:** Top panel — 11½in x 6½in. Mechanism fits through a cut out 5¾in x 10½in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram etc. **Price £30.50** plus £2.50 postage and packing.



GEC AM/FM STEREO TUNER AMPLIFIER CHASSIS. Originally designed for installation into a music centre. Supplied as two separate built and tested units which are easily wired together. **Note:** Circuit diagram and interconnecting wiring diagrams supplied. **Rotary Controls:** Tuning, on/off volume, balance, treble, bass. **Push-button controls:** Mono, Tape, Disc., AFC, FM (VHF), LW, MW, SW. **Power Output:** 7 watts RMS per channel, at better than 2% THD into 8 ohms. 10 watts speech and music. **Frequency Response:** 60Hz-20kHz within ±3dB. **Tape Sensitivity:** Output — typically 150 mV. Input — 300 mV for rated output. **Disc Sensitivity:** 100mV (ceramic cartridge). **Radio:** FM (VHF), 87.5MHz — 108MHz. Long wave 145kHz — 108kHz. Medium wave. 520kHz — 1620kHz. Short wave. 5.8MHz — 16MHz. **Size:** Tuner — 2¾in x 15in x 7½ in approx. Power amplifier — 2in x 7½in x 4½in approx. 240V AC operation. Supplied complete with fuses, knobs and pushbuttons, and LED stereo beacon indicator. **Price £21.50** plus £2.50 postage and packing.



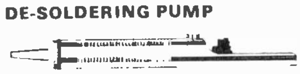
SCOTT AM/FM STEREO TUNER MODEL 516. This Scott tuner is one of the top American makes and is offered at a very realistic price. Features: ★ FM tuning range 87.5 to 108 MZ ★ AM tuning range 535 to 1605 kHz ★ Usable FM sensitivity 6.2dBF 2.2μV ★ 300 ohm & 75 ohm Aerial inputs for FM ★ Signal strength tuning meter ★ Stereo beacon indicator ★ Ferrite aerial for AM ★ Mute switch. Size: Height 5in, Width 14½in, Depth 12in. Silver front panel. Black body. Modern stacking format. Price **£40.50** plus £2.50 postage and packing.



JVC TURNTABLE. JVC Turntable supplied complete with an Audio Technica AT10 stereo magnetic cartridge.
- ★ 'S' shaped tone arm.
- ★ Belt driven.
- ★ Full size 12in platter.
- ★ Precision calibrated counterbalance weight (0-3 grms.)
- ★ Anti-skate (bias) device. Nylon thread weight.
- ★ Damped cueing lever.
- ★ 240V AC operation, (50Hz).
- ★ Cut-out template supplied.

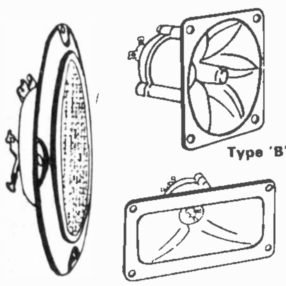
Size — 12¾in x 15¾in (approx).
Price £29 plus £2.50 postage and packing.

DE-SOLDERING PUMP

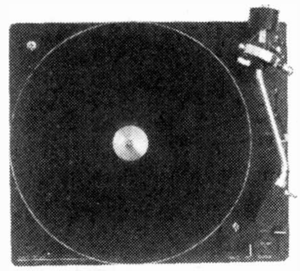


This de-soldering pump made to a very exacting specification is ideal for the removal of small components from printed circuit boards, etc. Comes complete with spare PTFE tip. **£5.30** post free.

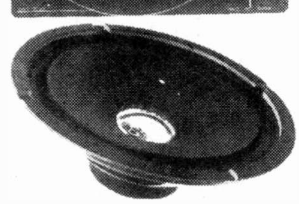
PIEZO ELECTRIC TWEETERS — MOTOROLA
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover **is not** required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series).



Type 'A' 3in round with removable wire mesh. Ideal for bookshelf hi-fi speakers. **Price £3.80 each.**
Type 'B' 3½in super horn. For general purpose speakers disco and PA systems, etc. **Price £4.80 each.**
Type 'C' 2in x 5in wide dispersion horn. For hi-fi systems and quality disco etc **Price £6.20 each.**
Type 'D' 2in x 6in wide dispersion horn. Frequency response extending down to mid-range (2000 c/s) suitable for hi-fi systems and quality disco. **Price £9 each.**
Post and Packing, all types, 15p each (or SAE for Piezo leaflets).



BSR P163 BELT DRIVE TURNTABLE. This famous B.S.R. turntable is ideal for disco/hi-fi use and is offered at a special price of **£22** plus £2.50 postage and packing. Suitable stereo magnetic cartridge type TTC/J2203. Price **£4** post free. (Also available separately.)



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FILTER DESIGN

Following up his supplementary efforts last month, Tim Orr tackles the subject of Active Filters in the same explanitory manner.

The frequency response plot of a first order low pass filter (Fig.1) reveals several important features. The break frequency Fc, is defined as the point at which the output signal is attenuated by 3 dB. The curve then approximates to a –6 dB/octave roll off slope. By using a straight line approximation it is easy to calculate attenuations caused by the filter. For example, an 8 kHz sinewave filtered by a 1 kHz first order lowpass filter will be attenuated 18 dB, a reduction in level of almost one tenth. The calculation is simple; 8 kHz is 3 octaves above 1 kHz. The filter attenuates at 6 dB per octave, therefore the final attenuation is 3 x 6 = 18 dB.

To increase the roll off slope, the filter order must be increased, figure 2. When constructing high order filters, it is necessary to assemble them out of smaller filter sections each having different Q factors. A high order filter constructed from sections all having the same Q factor will have a very 'unabrupt' frequency response curve, which is generally not what is required.

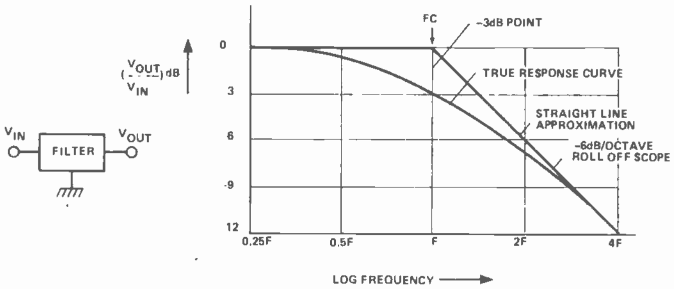


Fig.1. Frequency response of a first order low pass filter.

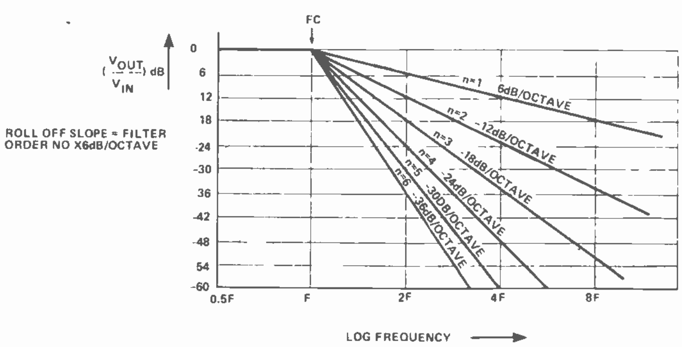


Fig.2. Filter roll-off slopes. As n increases so does the roll-off.

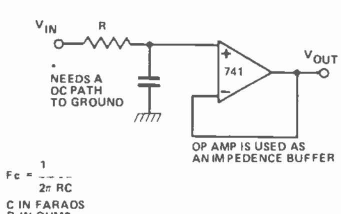


Fig.3. Simple first order low pass filter.

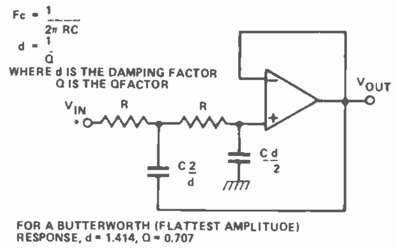


Fig.4. Second order unity gain Sallen and Key low pass filter.

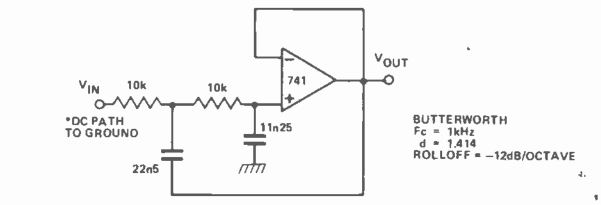


Fig.5a. Second order low pass filter, 1 kHz.

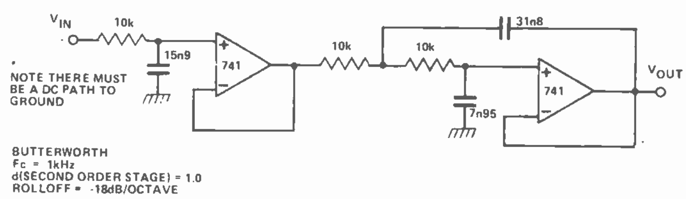


Fig.5b. Third order low pass filter, 1 kHz.

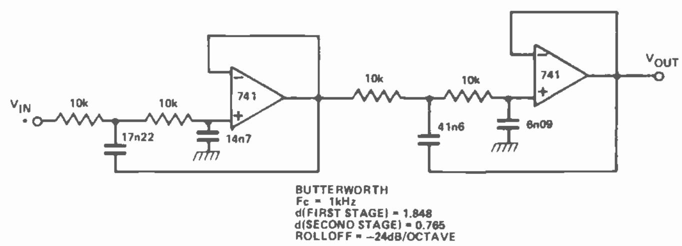


Fig.5c. Fourth order low pass filter, 1 kHz.

A simple first order filter (Fig.3) merely requires a resistor, a capacitor and a voltage follower. A second order filter (Fig.4) requires two RC networks. This circuit has a 'flattest amplitude' response (when it has a Q of 0.7) and is often referred to as a Butterworth response. The response may be modified by altering the Q factor, but in all the following examples a Butterworth response has been chosen. This design is known as a 'unity gain Sallen and Key' filter. The Q factor is deteremined by the ratio of the two timing capacitors. This often leads to a circuit design which employs non-preferred capacitor values as can be seen in the three filters by a process known as scaling. For instance, if the required break frequency is 5 kHz, then the resistors, or the capacitors in the filter should be reduced by a factor of five. If say the filter in figure 5a had to be redesigned to operate at 250 Hz, then the required component changes would be to change the 10k resistors to 40k. Active filters generally employ op amps and so care should be taken so as not to operate them near to their bandwidth limit, which would cause the filter response to be degraded. A 741, for instance, should not be used for frequencies above 50 kHz.

Figure 6 shows the effect of varying Q in a low pass filter. Generally, the response that is wanted is the 'flattest amplitude' curve. A fourth order filter (Fig.5c) is constructed from a low Q and high Q filter. The overall response of this filter is seen in figure 7. Note that the flattest amplitude curve (A) is made up out of the product of curves B and C. The peak in the high Q curve (C) is flattened out by the droop of the low Q curve (B).

The problem of having different and unpreferred capacitor values is greatly reduced by using an 'equal component' design, figure 8a,b,c. The Q factors are controlled by the gain of the op amp and so the capacitor values are all the same. Note that these filters provide a voltage gain which is in fact

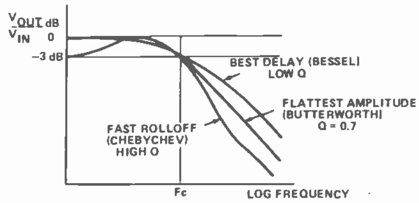


Fig.6. Frequency response versus Q factor.

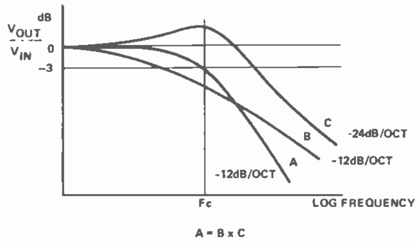


Fig.7. Combining high and low Q factors.

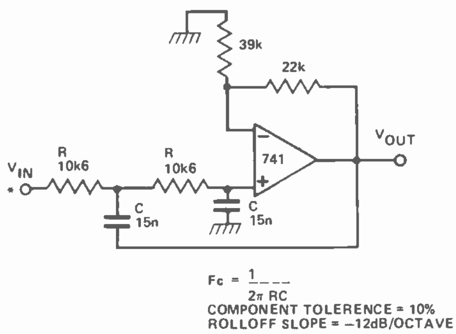


Fig.8a. Second order low pass filter, 1 kHz.

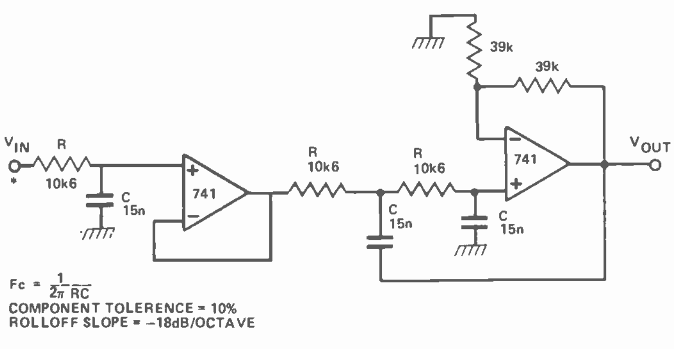


Fig.8b. Third order low pass filter, 1 kHz.

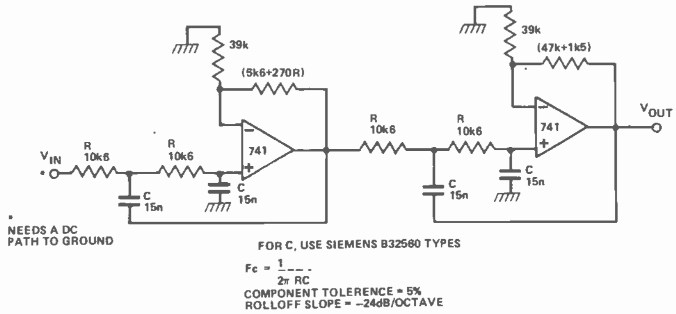


Fig.8c. Fourth order low pass filter, 1 kHz.

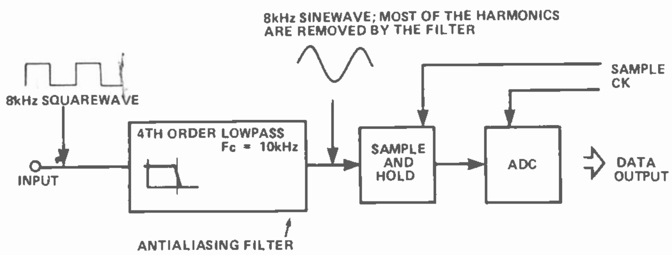


Fig.9. Use of a low pass filter in an ADC system.

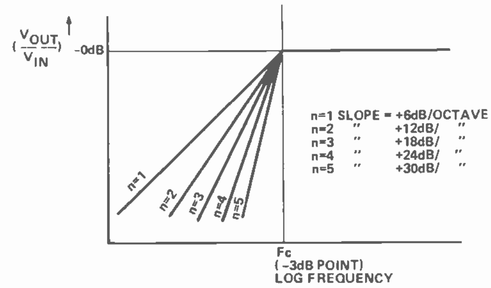


Fig.10. Frequency response of different orders of high pass filter.

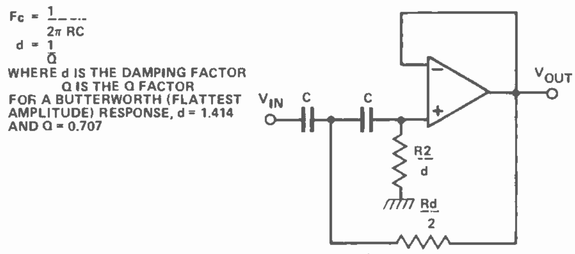


Fig.11. Unity gain Sallen and Key high pass filter.

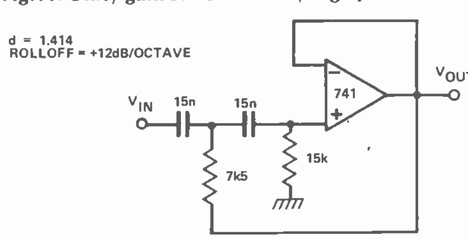


Fig.12a. Second order Butterworth 1 kHz high pass filter.

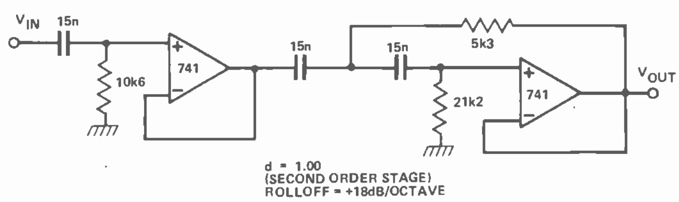


Fig.12b. Third order Butterworth 1 kHz high pass filter.

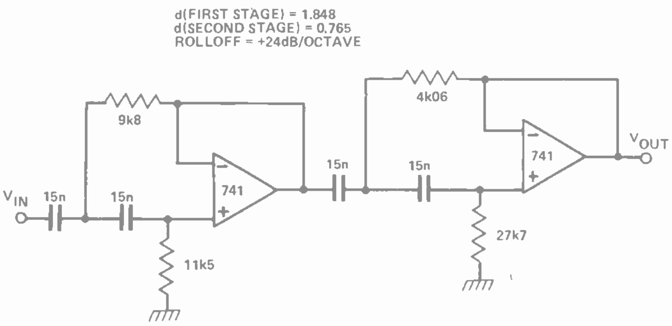


Fig.12c. Fourth order Butterworth 1 kHz high pass filter.

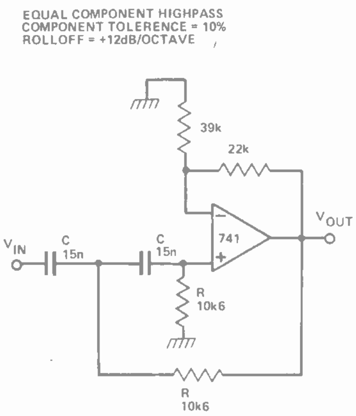


Fig.13a. Second order Butterworth 1 kHz high pass filter.

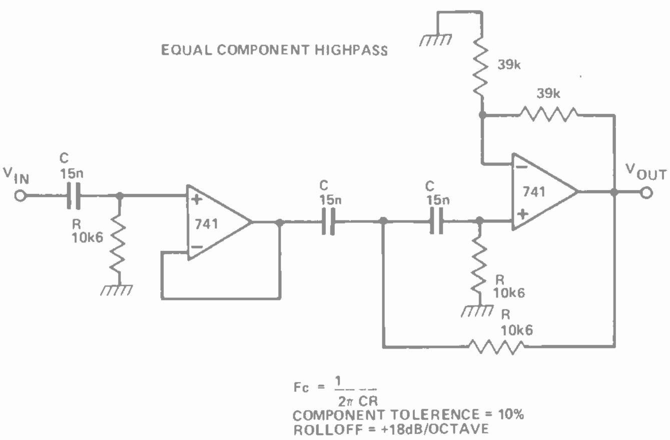


Fig.13b. Third order Butterworth 1 kHz high pass filter.

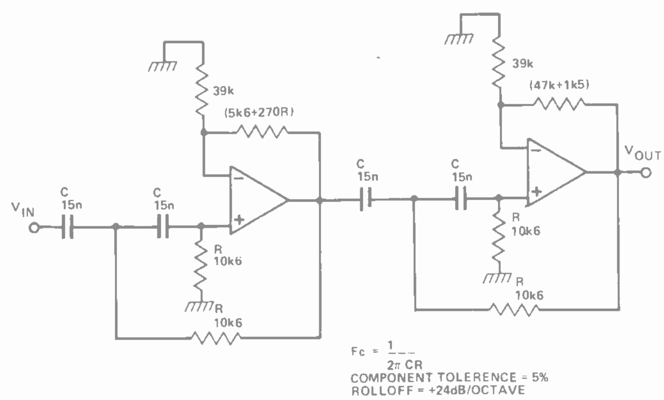


Fig.13c. Fourth order Butterworth 1 kHz high pass filter.

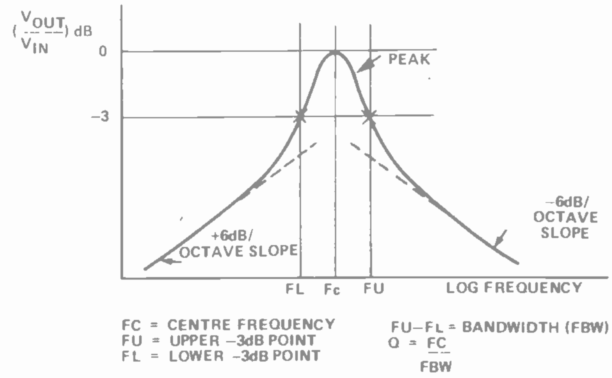


Fig.14. Band pass response (single pole).

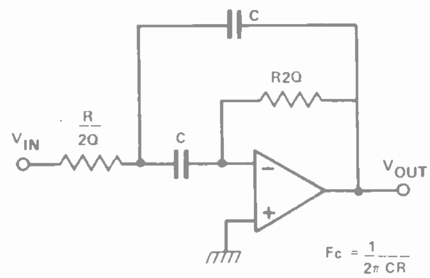
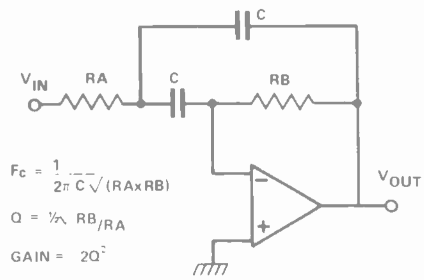


Fig.15. Single pole multiple feedback bank pass filter.



C	RA	RB	Fc	Q	GAIN
15n	10k6	10k6	1kHz	0.5	x 0.5
15n	5k305	21k22	1kHz	1.0	x 2.0
15n	2k652	42k44	1kHz	2.0	x 8.0
15n	1k326	84k88	1kHz	4.0	x32.0

Fig.16. Multiple feedback filter selection chart.

the product of the DC gains of each amplifier. Frequency scaling can be performed by modifying the R and/or the C components. Capacitors generally are available in E6 or E12 values, whereas resistors can be obtained in the E24 series, and so it is usually much easier to scale the R components, keeping them within the range 1k to 100k. Low pass filters find many uses in audio processing and are often used in data acquisition systems (Fig.9). The high pass filter (Fig.10) is exactly complementary in operation to the low pass device. The unity gain Sallen and Key structure is seen in figure 11 with calculated values for second, third and fourth order filters in figure 12a,b,c. Also there are calculated values for 'equal component' realizations in figure 13a,b,c.

The band pass response is defined in figure 14. This can be realized with a single op amp circuit, the multiple feedback band pass filter, figure 15. Calculated values are seen in the chart of figure 16. The maximum Q should be kept below a value of 20 at 1 kHz, otherwise the filter may become unstable and oscillate. Frequency scaling may be performed by multiplying the R or the C components with a constant. High Q, high frequency operation is not possible with this design because the op amp runs out of bandwidth.

The state variable filter (Fig.17) overcomes this problem by using the bandwidth of three op amps. Q factors of several hundred at 1 kHz are obtainable with this circuit. It also produces four outputs; high, low, band pass and notch, making it a very versatile design. The frequency may be scaled by altering the R or the C components and also the Q factor is separately programmable and is invariant with frequnecy. The all pass filter (Fig.18) has a flat frequency response, which in itself is of no use at all. However, it does suffer a 180° phase shift as a function of frequency. By cascading two stages (Fig.19) it is possible to obtain a 180° phase shift at the frequency Fc. This phase shifted signal when mixed with the original will give a notch response due to the cancellation of the two signals.

Testing active filters is very easy if you have a swept sinewave generator and an XY oscilloscope (Fig.20). The frequency response appears as a linear amplitude versus log frequency display. It is generally possible to sweep five times a second, which gives an almost continuous display and allows you to see immediately the effect of any changes that you make to the filter.

ETI

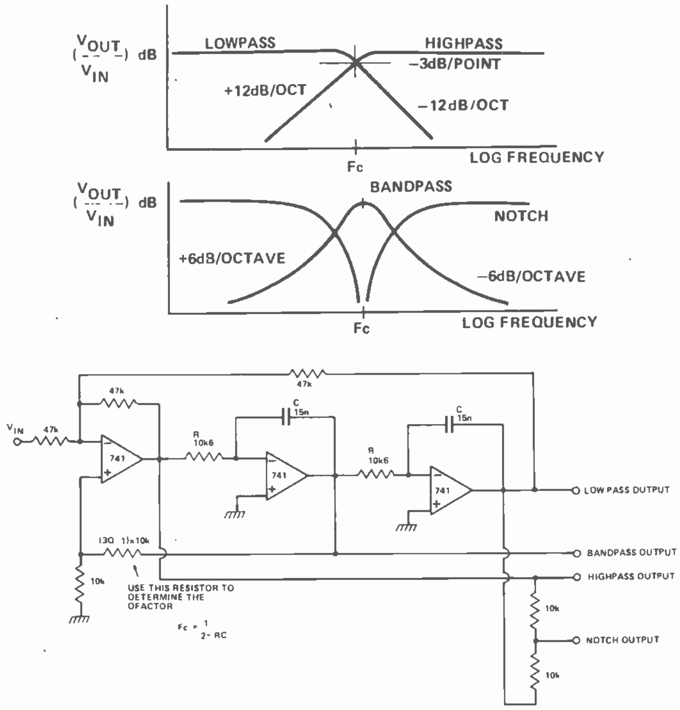


Fig.17. State variable filter.

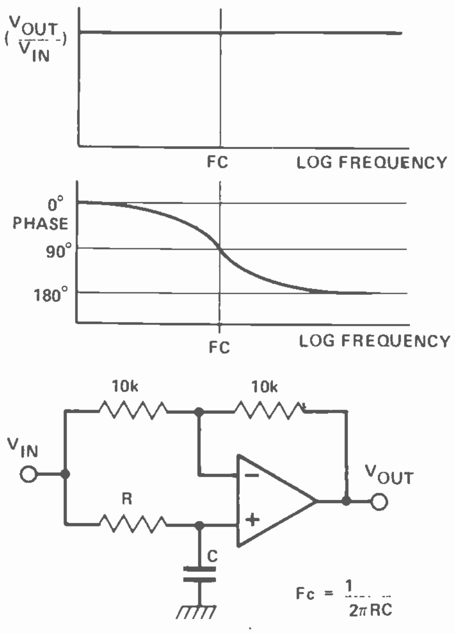


Fig.18. All pass filter.

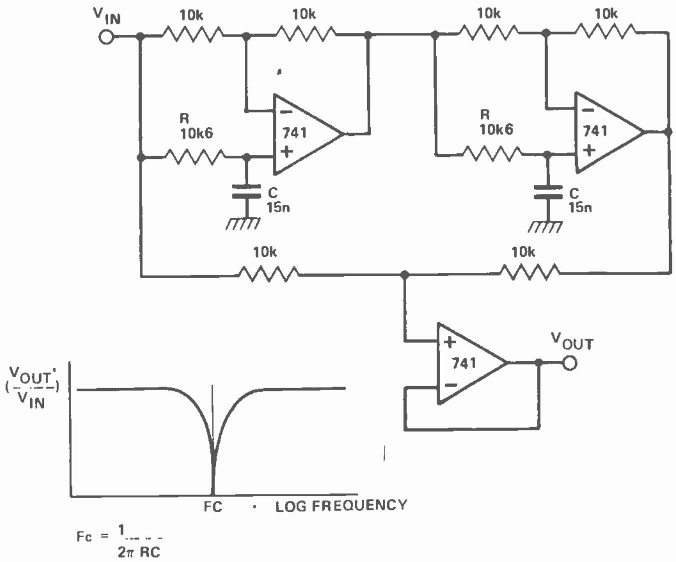
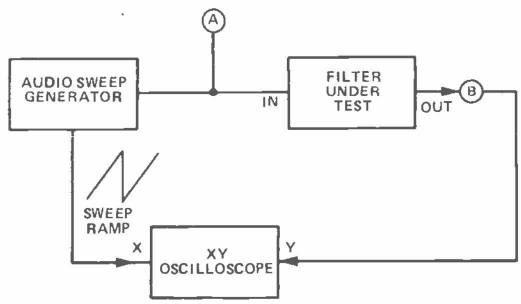


Fig.19. Notch filter using all pass sections.



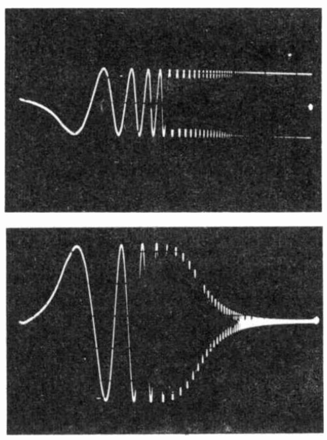


Fig.20. Testing filter design with an oscilloscope. 'Scope traces from points A and B are shown left (A above, B below).

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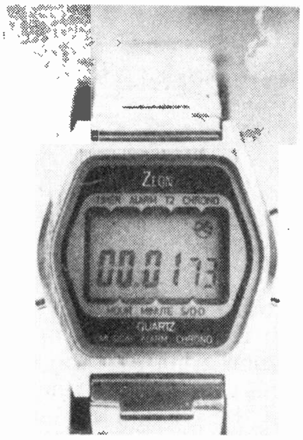

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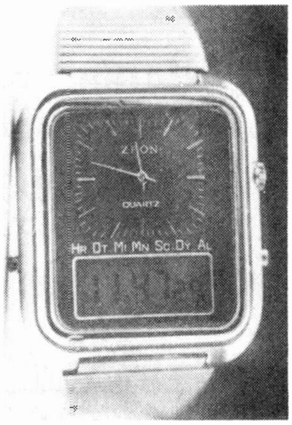

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A HISTORY OF SPACECRAFT

Ian Graham takes a well illustrated look at Spacecraft past and present and discovers just how far we've come in the twenty three since Sputnik.

On April 12th 1961, a charred ball weighing over 10,000 lbs lay in a field near the village of Smelovaka. Inside lay Yuri Gagarin, the first man to orbit the Earth and begin Man's adventure in space. Gagarin's flight marked the culmination of a research programme going right back to the first artificial satellite, Sputnik 1. Less than a month after Sputnik 1 proved the orbital equations correct, Sputnik 2 carried the first live passenger into orbit (apart from stowaway bacteria onboard Sputnik 1). The first 'cosmonaut' was a dog called Laika.

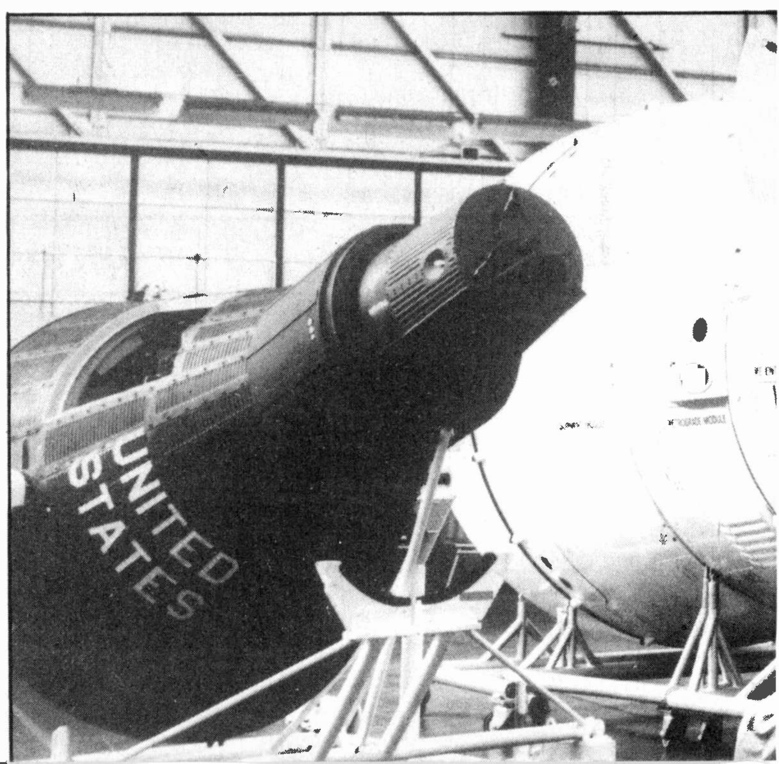
America boldly went where only one man had gone before, when, barely a month after Gagarin, Alan Shepard made a fifteen minutes sub-orbital hop to a height of 116 miles. In February 1962 a silver-suited John Glenn wedged himself into the cramped confines of his Mercury 6 capsule and made the first three orbits of the American experience in space. By then, however, Russia had established a commanding lead. Herman Titov had already spent more than a day orbiting the Earth in Vostok 2. The list of Russian firsts continued — first double flight, first woman in space, first three-man craft, first space-walk, etc. The six Vostok flights (from April 1961 to June 1963) made 259 orbits, in comparison with a grand total of 34 orbits for the six Mercury flights from May 1961 to May 1963.

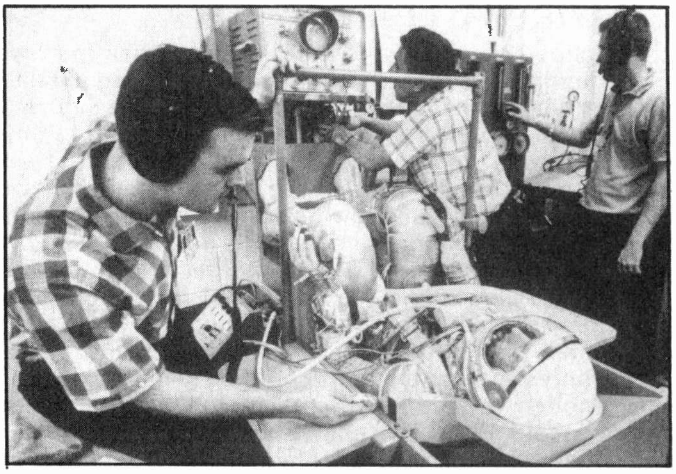
Human Satellite

Gemini gave astronauts invaluable experience in long duration flight and the rendezvous and docking manoeuvres necessary for an Apollo-type moon mission and for future space station operations. In less than two years there were a staggering ten Gemini flights. In the same time Russia flew only one mission — Voshkod 2. (Voshkod 1 was the first three man spacecraft. It flew four years before the first Apollo. Voshkod 2 carried a crew of only two). It achieved yet another first for Russia — Alexei Leonov's space-walk. It was the first time a man had left his craft and orbited the Earth as a human satellite, albeit still tethered to his craft. Three months later Ed White spent 21 minutes outside his Gemini 4 spacecraft for America's first space-walk.

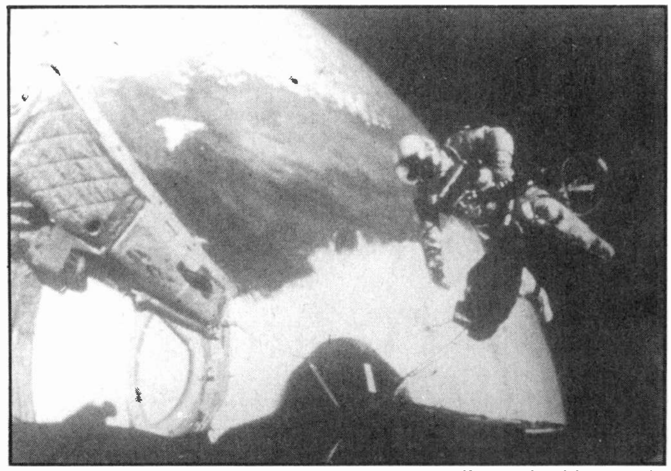
Gemini 3 carried the first computer into space. Although it was glossed over at the time, largely overshadowed by the impact of Leonov's space-walk, it was an important development in manned spaceflight. The astronaut was no longer a passenger carrying out predetermined routines or commands from the ground. He could make independent decisions on, for example, course corrections based on information on position, thrust, etc from his on-board computer. In addition, whereas most of the Mercury systems were carried inside the pressurised compartment with the astronaut, many of the Gemini systems were removed to a separate instrument module. The astronaut benefited by gaining a more spacious cabin and the system became more flexible, allowing the astronaut to work outside the craft on any defective instrument. Gemini 5, an eight day flight, proved that men could work in space without any adverse effects for the duration of a moon-landing mission.

Rendezvous and docking manoeuvres were practiced between two manned Gemini craft and between Gemini and the unmanned Lockheed Agena target vehicle. Gemini 6 should have rendezvoused with an Agena but when the Agena failed it used Gemini 7 instead. The craft manoeuvred to within 2m of each other. Gemini 8 achieved the first docking, but the operation nearly ended in disaster. Shortly after docking, a jammed open thruster rocket started the couplet tumbling faster and faster. The crew, Neil Armstrong and David Scott, broke free from the target vehicle and ended the mission two days earlier than planned — survivors of the first major emergency in space. Gemini 11 carried out the first computer-controlled re-entry.





Before flight a Mercury astronaut's pressure suit was thoroughly tested.

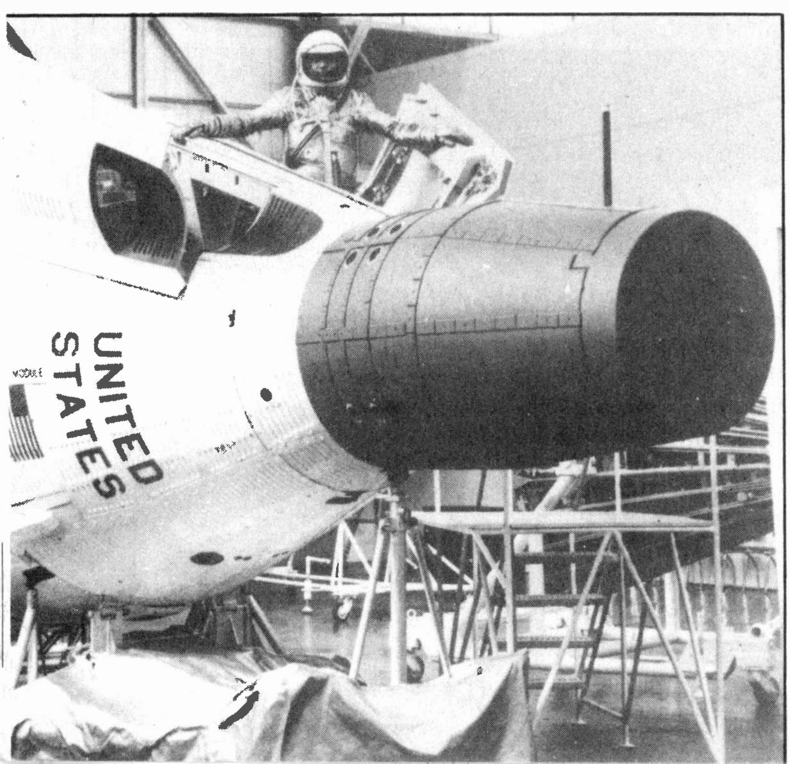


The first American astronaut to make a space-walk — Ed White in orbit around Mother Earth.

Apollo

The next stage in America's successful space programme, now well ahead of Russia's, was the flight testing of the Apollo moon-landing systems and procedures. A Saturn 1 lifted the first Apollo Commmand Module into Earth orbit in May 1964. The first Apollo crew (Virgil Grissom, Roger Chaffee and Ed White) climbed aboard Apollo 204 for a countdown rehearsal on January 27th, 1967 and the Command Module hatch was bolted down. A fire started unseen, somewhere below Grissom's feet and spread to nylon netting, fastenings and insulation material. In the 100% oxygen atmosphere it took only 15 seconds from Chaffee's first warning for the fire to burn through to the outer shell of the spacecraft. All three astronauts were dead before the hatch could be opened.

The Apollo programme was immediately suspended. A quick release mechanism was developed for the access hatch. Although pure oxygen continued to be used in space, ground operations were carried out with the safer 60/40 oxygen/nitrogen atmosphere (gradually changed to 100% oxygen after launch by the environmental control system). Less flammable materials were used in the cabin. Where non-metallic materials had to be used, they were positioned so as to behave as a fire break. The design of electrical equipment, location of wiring and equipment checking procedures were also reviewed.



Nearly two years after the fire, the Apollo programme was resumed. Apollo 7 successfully tested the hardware in Earth orbit for eleven days in October 1968. Only two months later NASA reached for the moon. Apollo 8 was the first manned craft to be launched by the giant Saturn 5, necessary for the circumlunar mission. You may remember Commander Borman's reading of a passage from Genesis against the backdrop of another world on Christmas morning, 1968. Borman, Lovell and Anders could not have landed on the moon if they'd wanted to — they did not carry a Lunar Module.

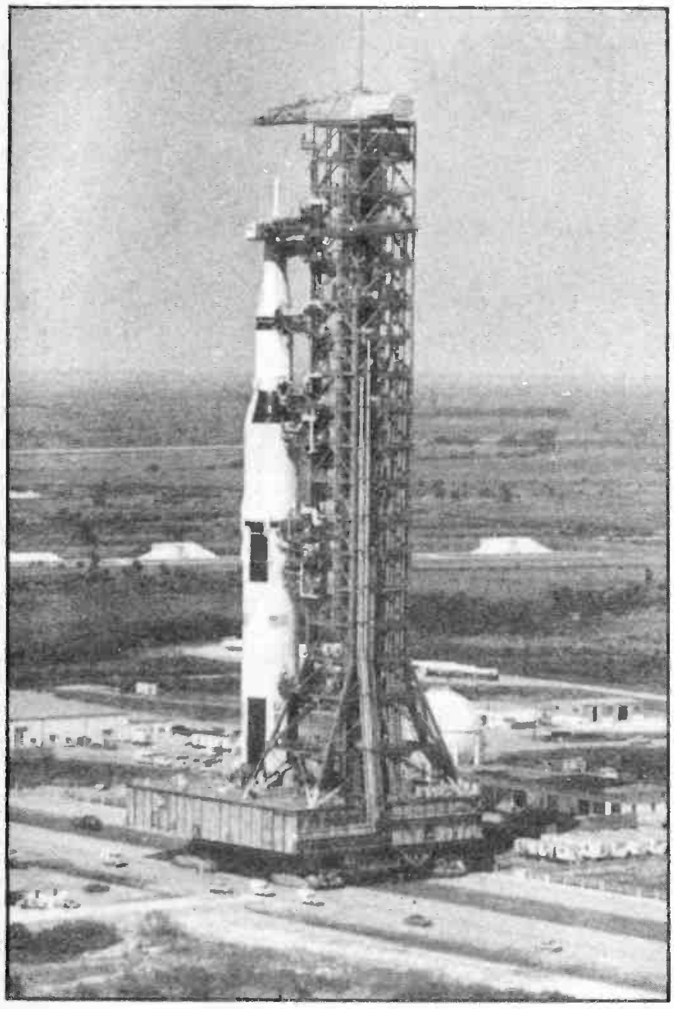
Apollo 9, the first manned mission with a Lunar Module, remained in Earth orbit rehearsing rendezvous and docking manoeuvres with the LEM (Lunar Excursion Module). While Schweickart was standing on the LEM porch he took the memorable photographs of Scott's head and shoulders out of the CM access hatch. Apollo 10 combined the experience gained from Apollo 8 and 9, taking the LEM to within 15 kms of the moon's surface.

Tranquillity Base

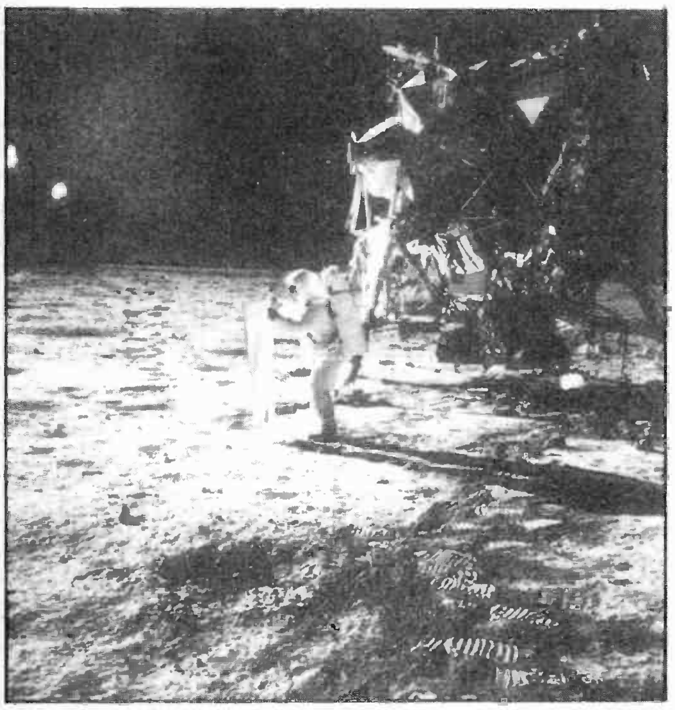
Approximately one million people were at Cape Canaveral on July 16th 1969 to see Apollo 11 blast off for the moon. The television audience was around 500 million. After a trouble-free flight, Armstrong and Aldrin separated their Lunar Module from Collins' Command Module and began their descent. Armstrong interrupted the automatic landing sequence and flew the LEM manually when he saw boulders ahead, making it impossible to land. He finally touched down with only 2% of his fuel left.

I've met many, many people (not all space nuts like me) who sat up all night to watch the fuzzy image of Armstrong descending the LEM ladder and stepping off the landing pad on to the dusty surface of another world at 3.56 am on July 21st, 1969. Aldrin joined him and together they loped around the surface placing scientific instruments and collecting samples. On their return to Earth the astronauts put on Biological Insulation Garments and were transferred to the Mobile Quarantine Facility to isolate any bacteria which they may have brought back from the moon.

The Mercury capsule was just large enough to carry one astronaut. By comparison Gemini was a deluxe model.



Apollo 10's Saturn 5 stands on the launch pad atop its mammoth transporter.



Edwin Aldrin deploys the Apollo 11 solar wind experiment.

Strike A Light

Apollos 12 and 13 were more eventful than the first moon landing. Apollo 12 was struck by lightning at take-off. Fortunately, neither the spacecraft nor the Saturn 5 launch vehicle were damaged. When the Apollo 13 Command, Service and Lunar Modules were more than 200,000 miles from Earth on their way to the moon, the astronauts felt a jolt and saw power and oxygen readings rapidly fall on their control panel. The moon-landing was abandoned. To conserve fuel it was decided to let the spacecraft swing round the moon and return to Earth. The crew moved into the Lunar Module, now aptly nicknamed the 'lifeboat'. Systems were powered down — the only way that the craft could be kept operational long enough for the return to Earth. Reduced power meant a cold, dimly lit cabin. The LEM air conditioner could not cope with the extra volume of both CM and docking tunnel. To keep carbon dioxide down to a safe level, the crew improvised an air conditioner from materials on board.

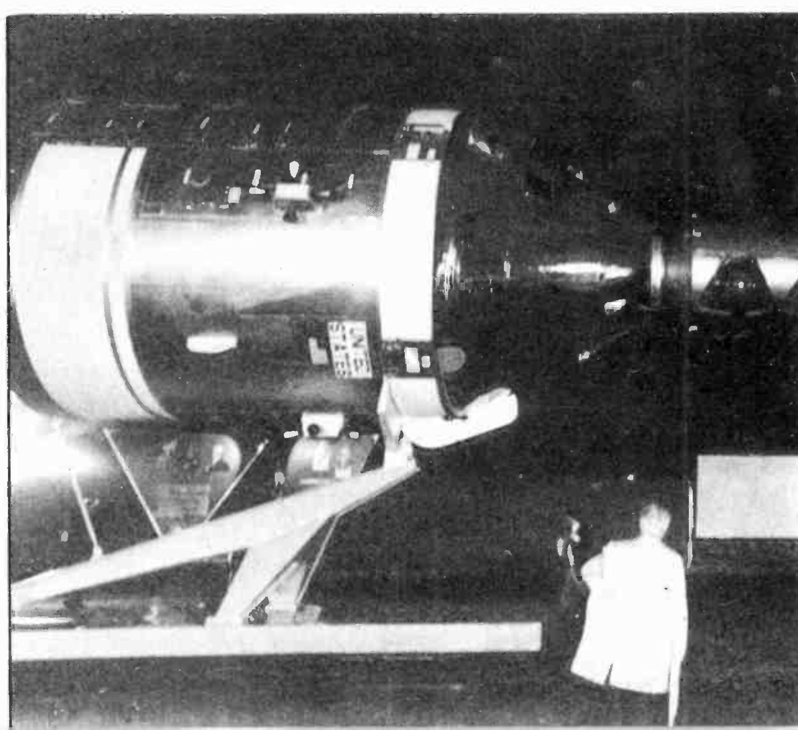
When the Service Module was discarded just before re-entry, the crew saw for the first time the extent of the damage. One panel (4m x 1.8m) had been blown away completely, exposing a tangle of pipes and tanks. It was later found that heater switches had welded closed causing an oxygen tank to overheat and explode. It wasn't known if the explosion had damaged the CM's heat shield. However, re-entry went as planned and the crew of Apollo 13, launched at 13.13 (Houston time) on April 13th, returned safely to Earth. In 1972, four flights later, the programme was brought to a close with Apollo 17, the last of three missions intended to devote more energy to Apollo's scientific potential. Despite six moon landings and the return of over 380 Kg of rock samples, the origin of the moon is still not conclusively proven.

Meanwhile in the USSR

Meanwhile In The USSR

Like Apollo, the Soviet Soyuz programme had its setbacks. The test flight of Soyuz 1 seems to have been cut short. After re-entry, the parachutes failed to open properly and the spacecraft crashed to Earth, killing the one-man crew (Vladimir Komarov).

Further flights achieved the first docking of two manned craft and the first welding in space. Soyuz 11 (June



1971) spent 23 days docked with Salyut 1. The flight went well until re-entry, when contact with the crew was lost. On opening the access hatch after a normal re-entry, the three man crew was found to be dead. The craft had suffered rapid depressurisation in the upper atmosphere. From then on the crew wore spacesuits (during re-entry at least) instead of light overalls and flying helmets. The additional life support gear carried meant that the crew had to be reduced from three to two.

The Soyuz programme continued, successfully carrying out astronomical, Earth resources, EVA (spacewalking) and hardware experiments.

The first post-launch abort occurred several minutes after what would have been Soyuz 18 lifted off. When the third stage began to go astray, the spacecraft was automatically detached from the launcher and brought down. The next flight (Soyuz 18) prepared the way for the joint US/USSR Apollo/Soyuz link-up.

The Apollo/Soyuz Test Project (ASTP) was agreed on as early as 1972, with a planned launch date of July 15th 1975. Both craft did, in fact, take off on July 15th 1975 and docked for a total of 48 hours. Minor problems included failure of the Soyuz TV system. The huge television audience had to be content with pictures of Soyuz taken from Apollo. Stafford became the first US astronaut to fly in a Russian Spacecraft.

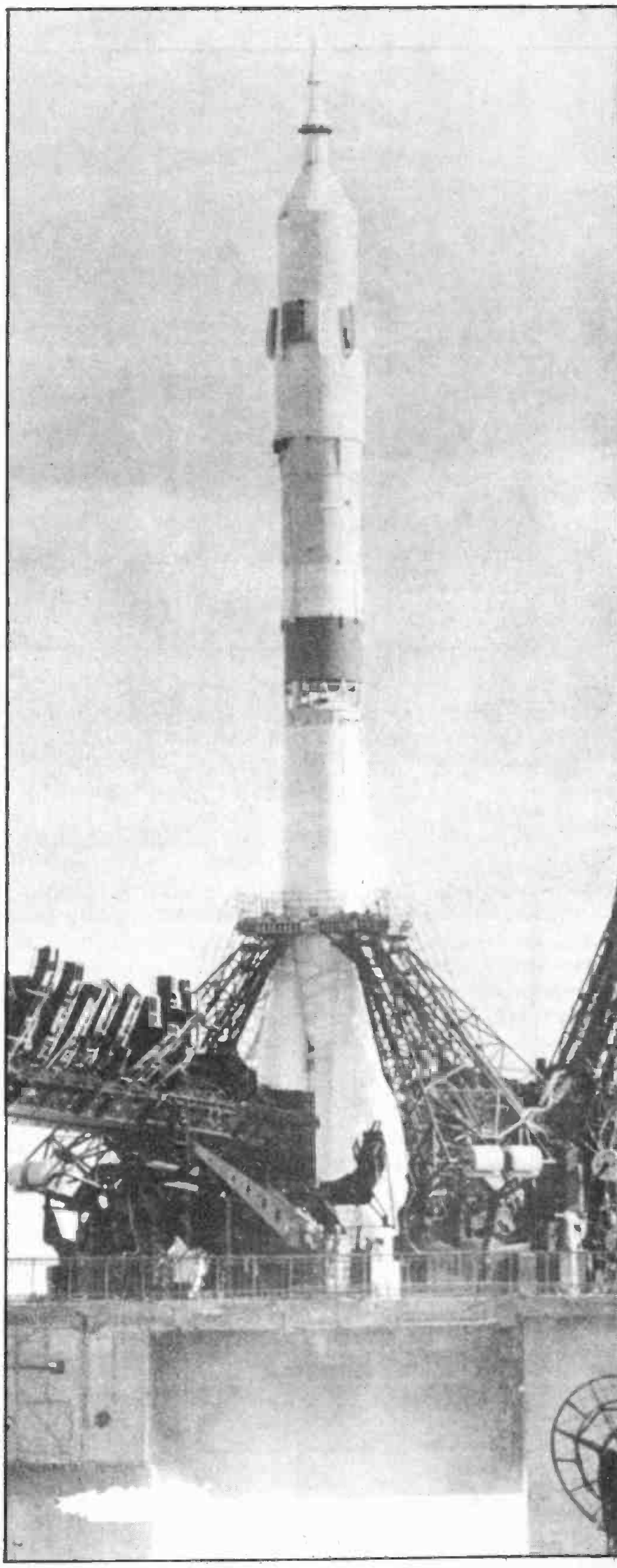
Secret And Wet

Soyuz 22 achieved the dubious honour of being, it is believed, the first manned spy satellite. Its unusual orbit took it over a major NATO exercise. Soyuz 23 achieved yet another first — the first Soviet splashdown. During its descent high winds pushed the craft off course and into a lake. The crew were unhurt.

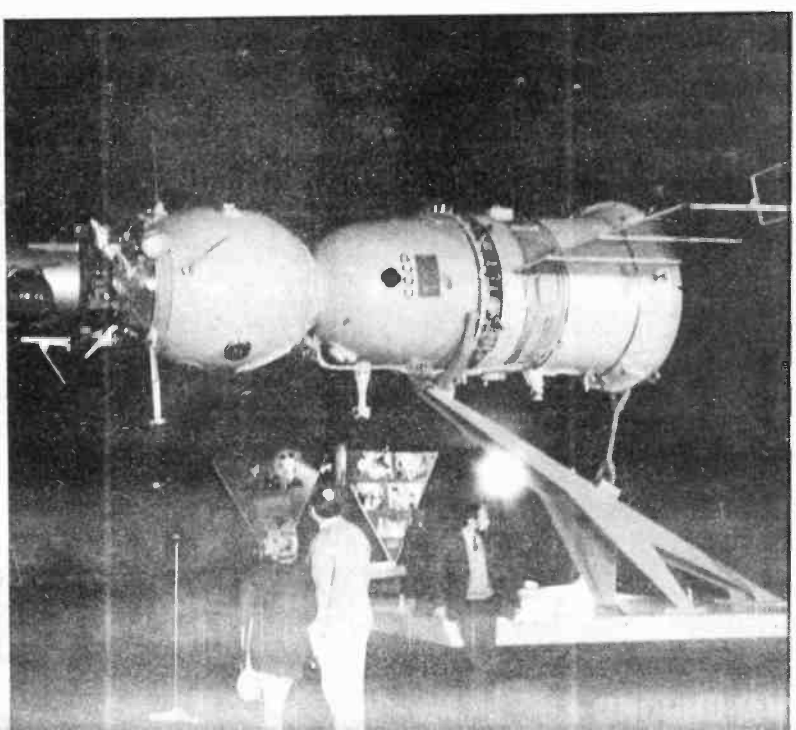
Stations In Space

In the early to mid seventies, both the Soviet and American space programmes moved into their second generation. The hugely expensive one-shot all or nothing flight gave way to the space station. Once again Russia led the way with Salyut 1 (April 1971). The first few years of the programme were beset with technical problems with both the Salyut space stations and the Soyuz crew transporters, but Soviet persistence had paid off by 1975. The Soyuz 18 crew set up a new Soviet duration record of almost 64 days on-board Salyut 4.

Unlike Skylab, there appear to be two distinct types



The Russian end of the Apollo/Soyuz Test Project — Soyuz, still clamped down to the launch pad.



The Soyuz/Apollo spacecraft cluster with the newly designed docking module.

of Salyut craft. One performs a civilian role, similar to Skylab, but the other is part of a separate military programme.

Skylab

In May 1973 Skylab 1 lifted off, launch vibration being so great as to seriously damage the craft. The meteoroid/thermal shield had been torn away completely, turning the workshop interior into an orbiting oven. The debris from the shield had also ripped off one of the solar panels, giving the spacecraft its familiar lop-sided appearance.

The laboratory was only made habitable by the installation, by the Skylab 2 crew, of a makeshift sun-shade over the workshop.

Life Out There

Astronauts complained of stuffiness and congestion of the inner ear for as long as twelve weeks. Red blood cell production was disturbed for about nine weeks. Hygiene and waste management seemed to constitute the most annoying problems. Urine was spilled. Astronauts found if they missed a meal they would experience flu-like symptoms. Heavy exercise helped

The first captive flight of America's Space Shuttle on the back of a NASA 747.

crews make more rapid recovery after their return to Earth. Health problems amounted to minor skin infections and eye trouble.

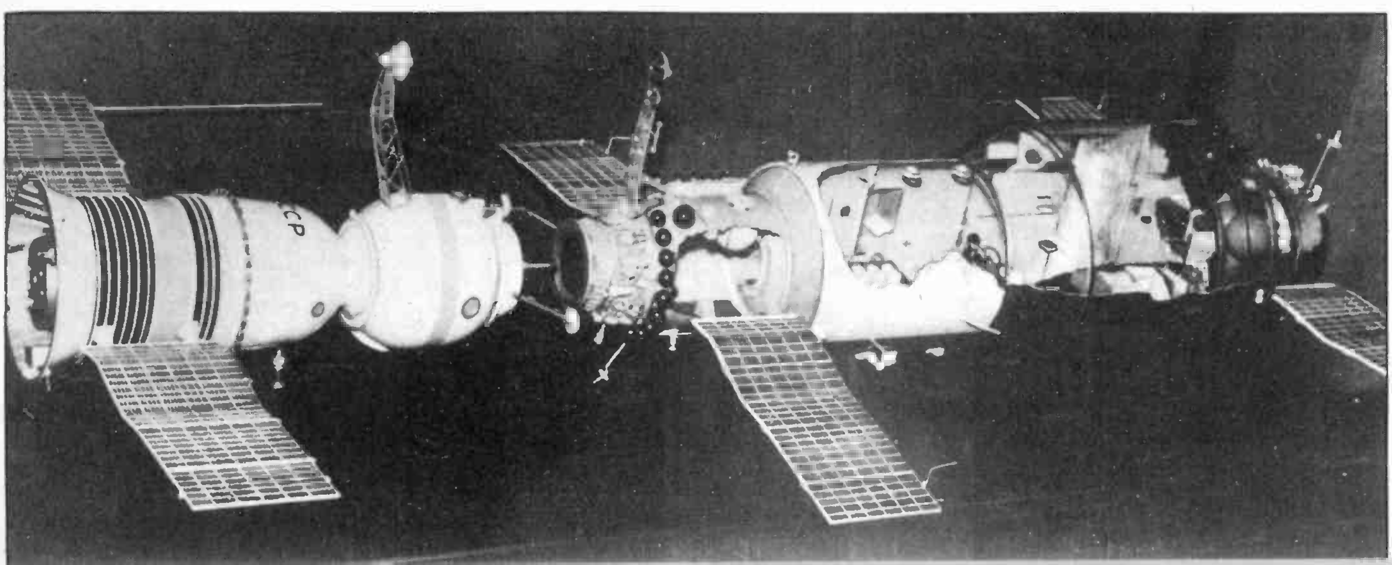
Results from the first few years of space station operation will themselves take years to analyse. The Skylab crews brought back over 40,000 pictures of the Earth's surface and over 180,000 frames of film of the Sun. They also carried out melting, welding and brazing experiments. One of the Earth Resources experiments identified a possible deposit of copper in Nevada. It may be worth several billions of dollars — more than the cost of the entire space programme to date.

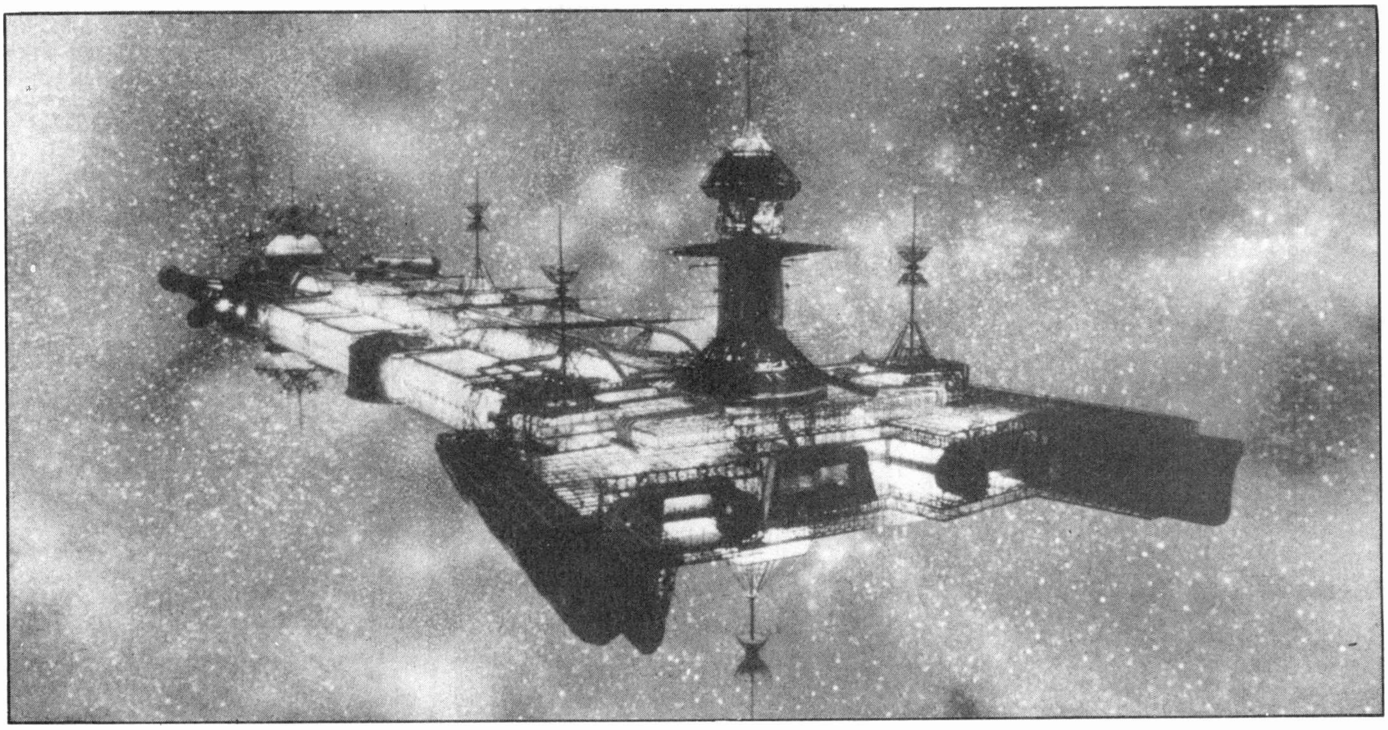
Planes In Space

The most exciting development so far in space hardware is that of the Space Shuttle — a plane capable of being launched with the aid of strap-on boosters, flying on to orbit and returning to Earth, landing like a conventional aircraft.

Although the Commander and Pilot could take

A cut-away model of the Salyut space station with Soyuz 11.





The shape of things to come — the mile-long 'Palomino' spacecraft featured in Walt Disney's 'The Black Hole'.

manual control, the Space Shuttle is such a complex flying machine that it is usually flown with the aid of computers or completely under computer control.

After take-off the two boosters fall away and are recovered from the ocean to be used again. The huge external tank, whose fuel powers the Orbiter's three main engines almost to orbit, is discarded and breaks up in the atmosphere. Once in orbit, 44 tiny rocket motors position the Shuttle accurately.

With the cargo doors open, satellites can be launched or collected for repair by using the Remote Manipulator System — a remotely controlled arm made by Spar Aerospace in Canada.

A variety of materials protect the craft from the enormous temperatures of re-entry. The nose of the Orbiter reaches over 1400°C. Normally the crew will not interrupt the completely automatic landing sequence. After landing, the Orbiter is serviced and repositioned on the launch pad for its next flight.

Technical problems have caused a serious of postponements to the first launch, which is now not expected until at least November 1980.

The Competition

America may appear to be way ahead of the Soviet Union, but there is already news of a Soviet Space Shuttle. So far very little information has been released. Known as the Raketoplan (Rocket Plane), it measures 60m long (probably including the launcher) and 8m across with three main engines. A prototype has already been test flown, dropped from a Tu-95 bomber.

Coming Soon

What does the future hold? The Space Shuttle is the first spacecraft to offer the possibility of carrying into orbit raw materials of prefabricated elements from which larger structures can be constructed. Film buffs may recall the Space Shuttle approaching the spinning wheel station in Stanley Kubrick's film of Arthur C Clarke's '2001:A Space Odyssey'. Which of the current rash of space westerns will prove as prophetic as 2001 is sure to be — 'The Black Hole' perhaps, with its spaceship modelled on Brighton pier, or Star Wars, with its World War I dog fights in space?

Table 1. A comparison of manned spacecraft to date.

	MERCURY	GEMINI	APOLLO	SKYLAB	SHUTTLE	VOSTOK	VOSHKOD	SOYUZ	SALYUT
LAUNCH WEIGHT (kg)	1935	3792	5558	90265	68000	2400	5320	6000	18700
BASE DIAMETER (m)	1.89	3.05	3.90	6.58	.	2.3	.	2.63	4.1
LENGTH (m)	2.90	5.60	3.48	36.12	37	2.3	.	10.63	22
WORK VOLUME (m^3)	.	1.558	5.97	361.4	71.5	.	.	9	100
WINGSPAN (m)	.	.	.	.	23.7	.	.	10.06	.

ETI

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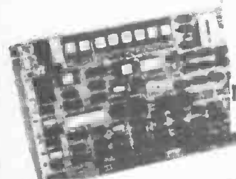

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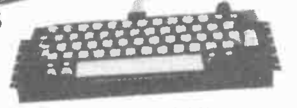

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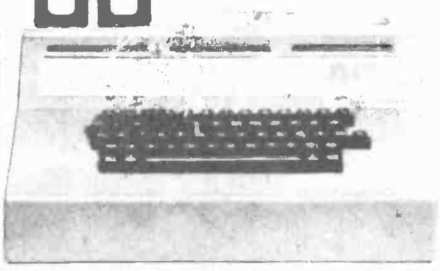
2K Monitor — Nas-sys 1. 1K Video RAM
(MK 4118). 1K work space/User RAM
(MK 4118) (8K Microsoft Basic)
(MK 3600 ROM) (8K Static RAM/2708E).

Microprocessors Z80A, 8 bit CPU. This will run at 4MHz but is selectable between 2/4 MHz. This CPU has now been generally accepted as the most powerful 8 bit processor on the market.
INTERFACE
Keyboard New expanded 57 key Licon solid state keyboard especially built for Nascom. Uses standard Nascom, monitor controlled, decoding.
T.V. The Iv peak to peak signal can drive a monitor directly and is also fed to the on-board modulator to drive the domestic T V.
I.O. On-board UART (Int. 6402) which provides serial handling for the on-board cassette interface or the RS232/20mA teletype interface.
The cassette interface is Kansas City standard at either 300 or 1200 baud. There is a link option on the NASCOM-2 for 2400 Baud.
The RS232 and 20mA loop connector will interface directly into any standard teletype.
The input and output sides of the UART are independently switchable between any of the options — i.e. it is possible to have input on the cassette and output on the printer.
PIO There is also a totally uncommitted Parallel I/O (MK 3881) giving 16, programmable. I/O lines. These are addressable as 2 × 8 bit ports with complete handshake controls.
Documentation Full construction article is provided for those who buy a kit and an extensive software manual is provided for the monitor and Basic.
Basic The Nascom 2 contains a full 8K Microsoft Basic in one Rom chip with additional features like DEEK, DOKE, SET-RESET for simple programming.

SYSTEM 80 KITS from £225



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P/IO interconnect only (for I/O board)	3.80
Econographics kit for additional 128 characters (N1 only)	30.00
2708/2716 Programmer suitable for N1 and N2 under NAS-SYS	20.95 + VAT
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Super Tiny Basic 3 × EPROM	37.50
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2114 1K × 4 Static RAM	3.95
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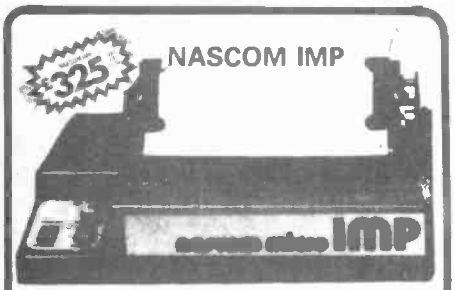
NASCOM IMP



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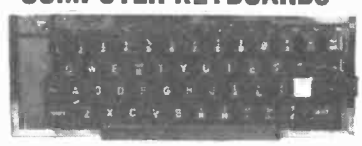

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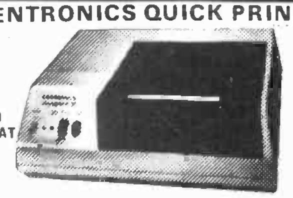

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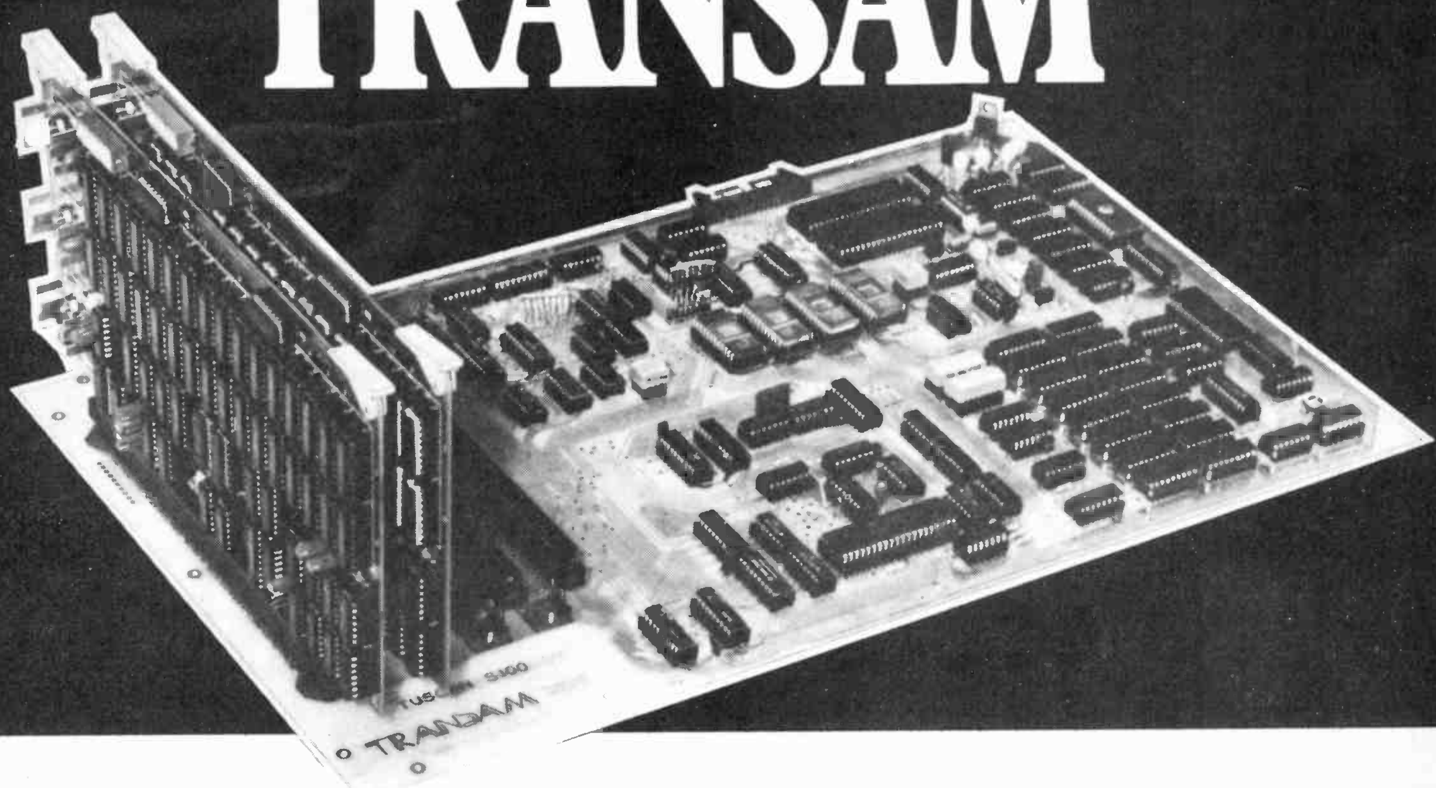

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ANTI-MATTER

Does antimatter really exist or is it a figment of your imagination? Have you an antimatter double in another universe? A.S. Lipson explains.

Antimatter is, figuratively speaking, the very stuff of which science fiction is made. Most of us have heard of it somewhere or other, but the most we actually know about it can be summarised in the immortal sentence from a TV series that will remain un-named, 'Ye cannae mix matter with antimatter, Captain. . .'. So what is this stuff? If it's 'antimatter' does it have 'antiweight'? Has it actually been made? Read on . . .

In 1928, a British physicist, Paul Dirac, had developed an equation which seemed to solve an awful lot of the problems current in physics at the time. (Among these was the prediction and explanation of a quantity known as the 'giromagnetic ratio' of the electron – but that is really another story.) There was only one slight snag. In addition to ordinary matter, the equation seemed to be saying something about something rather different – a sort of 'negative energy' particle, previously unknown. Well, to cut a long story short, this eventually led to a theoretical understanding of what became known as 'antimatter'. The only thing left to do was to look for it and in due course antimatter was actually found! (Physicists are

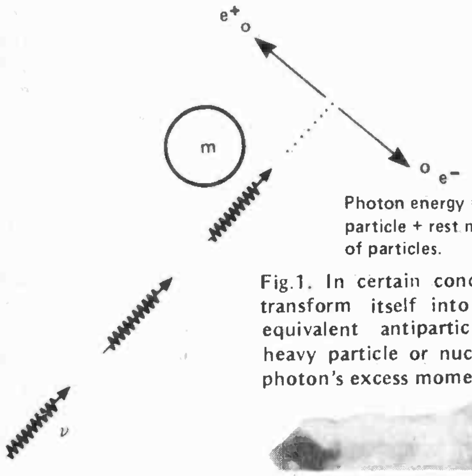

Fig.1. In certain conditions, a photon can spontaneously transform itself into an electron and a positron (its equivalent antiparticle). The photon must pass by a heavy particle or nucleus which absorbs most of the photon's excess momentum.

ingenious fellows; they have to be to get their grants.) In fact, it turned out that antimatter had already been noticed in sub-atomic reactions, but had been interpreted as anomalous results!

Doing The Impossible

We have said that antimatter was found. It would be more correct to say that antimatter equivalents of sub-atomic particles were found. It all started off with the antimatter equivalent of the electron, in fact, and the people involved with its discovery were so excited about it that, instead of just calling it an 'anti-electron', they gave it a special name — the positron.

It wasn't long before other 'anti-particles' began to be discovered. Corresponding to the already known proton and neutron, which exist in the nuclei of atoms, there were an 'anti-proton' and 'anti-neutron'. In fact, right through to the present day, as more and more sub-atomic particles were discovered, it has been found that each has, corresponding to it, an anti-particle of equal mass (with the exception of a few particles which appear to be their own anti-particles). This was exciting! If every particle known had a corresponding anti-particle, then just as ordinary matter is made up of atoms, themselves made up of sub-atomic particles, it might be possible for there to be matter which was in the same way made up of 'anti-atoms', which would themselves be made up of anti-particles. . . Antimatter! Fine. There was just one small problem — anti-matter in any form, even just anti-particles, isn't very easy to contain. In fact, it would probably be fair to say that containing anti-matter is one of the closest things to 'impossible' that the physicists have cooked up yet. To understand this, we'll have to go right back to the discovery of the positron. . .

Disappearing Act

So far, we have completely omitted to say exactly what it is that is so special about antimatter. We can find this out most easily by looking at the way the positron — the 'anti-electron' — behaves. Now, the positron had a few rather interesting properties. In every way possible, it seemed to be the exact opposite of the electron; whereas the latter was negatively charged, the positron was positively charged (hence its name) and so on. The positron did not have negative mass, though. Negative mass, so far, is still in the realms of science fiction. Antimatter has positive mass, and hence, weight. This was interesting enough as it was, but things only really started to get going when a positron met an electron. If this happened the two particles would disappear into nowhere and a high energy particle of light, or 'photon' would be created. This was, in fact, an actual demonstration of the truth of Einstein's equation $E = mc^2$, which says that mass and energy are equivalent. Under the right circumstances (such as meeting anti-matter) mass can be turned into energy. When an electron collides with a positron, then the mass in each of them gets turned into pure energy and this is given off in the form of light photons. Pretty impressive eh? The same thing happens when other particles meet their own anti-particles; they disappear and all their mass is turned into energy, which is given off in the form of photons. The more massive the sub-atomic particle, the more energy is contained in the photons. When a proton and anti-proton meet and 'mutually annihilate', for instance, the energy produced is 1836 times as much as that produced when an electron and positron meet, because the proton and anti-proton have masses 1836 times as great as the electron and positron.

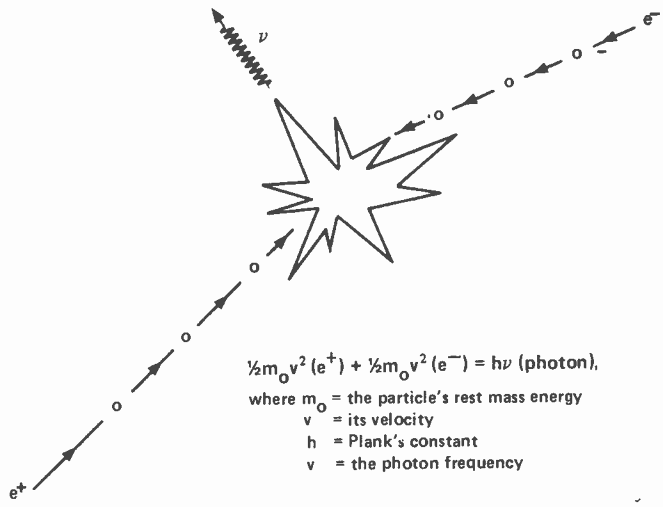

Fig.2. When an electron and positron meet, they annihilate one another and produce a photon whose energy (E=hv) equals the combined rest mass energies of the particles.

Let There Be Light

It now becomes apparent why it is so difficult to contain antimatter in normal containers; if we tried to do so, the positrons would quickly meet electrons, the anti-protons would meet protons and so on. All in all, the antimatter, together with an equal mass of the container, or whatever else was handy, would disappear and a lot of energy would be produced. A lot of energy. According to Einstein's equation (which has been very thoroughly tested), even a very small amount of mass, is equivalent to an incredibly large amount of energy. If a matchstick could be completely turned to energy, there would be enough produced to keep a 100 watt light bulb burning brightly for several centuries!

So far it looks as though the only likely way of containing antimatter would be to hold it in very strong magnetic fields, but the technique is far from perfected. Even if we could contain it easily, which so far we can't, there would remain the problem of obtaining antimatter in reasonable quantities. It is extremely rare and when it is found, (or made, in high energy particle accelerators) it always consists of sub-atomic particles; nothing anything as complicated as 'anti-atoms'. Certainly, antimatter has not been made in sufficiently large quantities even to weigh, with the most sensitive instruments available — supposing that we could weigh it without it reacting with matter and producing enough energy to blow up the balance we were using . . .

The rarity of antimatter has presented a problem to physicists, who like everything to be symmetrical in the universe; there is no apparent reason why there should be more matter than antimatter in the universe and yet antimatter seems to be very rare. This has led some people to suggest that, in fact, there is just as much antimatter as matter, but not in this galaxy. Perhaps about half of all galaxies are made out of antimatter, and half of matter; so, there is just as much of each kind of matter and the universe is nicely symmetrical. If this is so, then it is possible that, sometimes, out in space, a large quantity of matter might meet a large quantity of antimatter and the whole lot would disappear, giving off vast quantities of energy in the form of radiation. If this happens, our astronomers might see this radiation, and deduce what was going on. . . It is a fascinating idea. And just think; if there are 'anti-galaxies', then maybe some of them carry life. Perhaps, somewhere, an 'anti-person' is reading a positronics magazine and wondering about the possibility of galaxies made of matter. . .

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BZX79C12	10p	74C10	20p	2N3053	15p	4013	30p
BC212B	5p	MC4049	35p				
SN76550	5p						
IC 7451	10p						

REGULATORS — att at **45p each.** MC7805; 7812; 7815; 7912; 7915.
MC1496L **70p**
16 pin DIL Socket **10p.** 14 pin DIL Socket **8p**
LED type TIL 209 Red with holder **10p** each
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ROCKER SWITCHES 2 pole c/o — **15p** each
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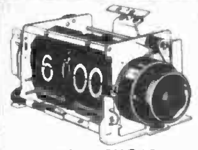

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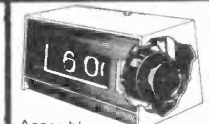

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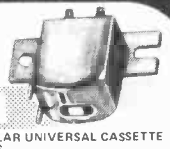

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0.6, 0.6	1A 1A	212	**2.95**	.70
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0.9, 0.9	330 330	235	**2.10**	.65
0-8-9, 0-8-9	500 500	207	**2.70**	.70
0-8-9, 0-8-9	1A 1A	208	**3.80**	.70
0-15, 0-15	200 200	236	**2.10**	.65
0-20, 0-20	300 300	214	**2.70**	.85
20-12-0-12-20	700(DC)	221	**3.45**	.85
0-15-20, 0-15-20	1A 1A	206	**4.55**	1.00
0-15-27, 0-15-27	500 500	203	**4.00**	.85
0-15-27, 0-15-27	1A 1A	204	**6.05**	1.00

12 AND/OR 24 VOLT
Pri: 220-240 Volts

Amps 12v	24V	Ref.	Price £	P&P
0.5	0.25	111	**2.25**	.70
1.0	0.5	213	**2.70**	.85
2	1	71	**3.20**	.85
4	2	18	**4.00**	.85
6	3	70	**5.55**	.90
8	4	108	**7.40**	1.15
10	5	72	**8.20**	1.15
12	6	116	**8.80**	1.15
16	8	17	**10.80**	1.25
20	10	115	**13.80**	1.45
30	15	187	**16.80**	1.45
60	30	226	**33.30**	1.75

30 VOLT (Pri: 220-240V)
Sec: 0-12-15-20-24-30V

Amps	Ref. No.	Price £	P&P
0.5	112	**2.80**	.85
1.0	79	**3.55**	.85
2.0	3	**5.55**	1.00
3.0	20	**6.25**	1.15
4.0	21	**6.55**	1.15
5.0	51	**9.55**	1.15
6.0	117	**11.05**	1.15
8.0	88	**14.30**	1.45
10.0	89	**16.55**	1.45

50 VOLT (Pri: 220-240V)
Sec: 0-19-25-33-40-50V

Amps	Ref. No.	Price £	P&P
0.5	102	**3.55**	.85
1.0	103	**4.55**	1.00
2.0	104	**7.25**	1.15
3.0	105	**8.55**	1.15
4.0	106	**10.80**	1.25
6.0	107	**15.05**	1.45
8.0	118	**20.15**	1.65
10.0	119	**24.05**	2.15

60 VOLT (Pri: 220-240)
Sec: 0-24-30-40-48-60

Amps	Ref. No.	Price £	P&P
0.5	124	**3.80**	.85
1.0	126	**5.55**	1.00
2.0	127	**7.50**	1.15
3.0	125	**11.05**	1.25
4.0	123	**12.30**	1.45
5.0	40	**14.10**	1.55
6.0	120	**17.55**	1.55

AUTO TRANSFORMERS
Input/Output Tapped 0-115-210-240V

VA (Watts)	Ref. No.	Price £	P&P
20	113	**2.60**	.85
75	64	**4.05**	.85
150	4	**5.55**	1.00
Input/Output Tapped 0-115-210-220-240V			
300	53	**10.05**	1.15
500	67	**10.80**	1.45
1000	84	**18.55**	1.55

Also 1500/2000/3000VA

MAINS ISOLATING (Centre Tapped & Screened)
Pri: 120/240V Sec: 120/240V

VA (Watts)	Ref. No.	Price £	P&P
60	149	**6.55**	1.00
100	150	**7.55**	1.25
200	151	**11.05**	1.25
250	152	**13.25**	1.45
350	153	**16.25**	1.55
1000	156	**37.05**	3.15

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AC127	25p	BC547	8p	ZTX108	12p
AC128	25p	BCY71	18p	ZTX109	12p
AD161	40p	BD131	35p	ZTX300	14p
AD162	40p	BD132	35p	ZTX500	15p
BC107	10p	BD139	35p	2N3053	25p
BC108	10p	BD140	35p	2N3055	55p
BC109	10p	BFX29	25p	2N3702	9p
BC147	9p	BFX84	26p	2N3703	9p
BC178	16p	BFY50	23p	2N3704	9p
BC182	10p	BFY51	23p	2N3819	22p
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BC184L	10p	DIODES			
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BC214	10p	1N4006	7p	1N5401	14p
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		LM339	55p	NE531	140p
		LM348	100p	NE555	23p
741	18p	LM377	170p	NE556	60p
747	70p	LM378	230p	NE567	120p
748	40p	LM380	80p	RC4136	100p
7106	850p	LM381	140p	SN76477	230p
CA3046	70p	LM382	120p	TBA800	80p
CA3080	75p	LM386	90p	TBA810	110p
CA3130	100p	LM387	120p	TDA1022	630p
CA3140	60p	LM1458	40p	TL081	45p
LF347	170p	LM1830	180p	TL082	85p
LF351	45p	LM3900	60p	TL084	125p
LF353	90p	LM3909	72p	XR2206	390p
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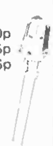
	0.125in.	0.2in.	
Red	TIL209	TIL220	10p
Green	TIL211	TIL221	16p
Yellow	TIL213	TIL223	16p
Clips	3p	3p	



DISPLAYS

DL704	0.3in	CC	130p
DL707	0.3in	CA	130p
FND500	0.5in	CA	100p

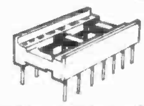
CMOS

		4025	25p	4072	25p
		4026	150p	4081	30p
		4027	50p	4082	30p
		4028	90p	4085	85p
4001	25p	4029	110p	4093	80p
4002	25p	4040	110p	4095	110p
4006	95p	4042	85p	4510	90p
4007	25p	4046	110p	4511	100p
4011	30p	4048	60p	4518	90p
4013	45p	4049	50p	4520	110p
4015	85p	4050	50p	4527	165p
4016	48p	4052	80p	4528	100p
4017	80p	4060	120p	4532	125p
4018	90p	4066	63p	4543	170p
4020	110p	4068	25p	4583	80p
4022	100p	4069	25p	4585	115p
4023	25p	4070	25p		
4024	60p	4071	25p		

SKTS

Low Profile Texas

8 pin	9p	22pin	20p
14pin	11p	24pin	22p
16pin	12p	28pin	26p
18pin	16p	40pin	38p
20pin	18p		



SWITCHES

TOGGLE

Standard	SPST	40p	DPDT	55p
Miniature	SPDT	80p	DPDT	90p
Subminiature	SPST	65p	DPDT	85p

SLIDE Standard DPDT 17p. Miniature 16p each.
PUSH Push to make 16p. Push to break 22p.

TTL

		7447	65p	74123	50p
		7448	65p	74125	60p
		7472	35p	74126	60p
		7473	38p	74132	70p
7400	15p	7474	36p	74141	95p
7401	15p	7475	40p	74145	90p
7402	15p	7476	40p	74150	120p
7404	16p	7483	80p	74154	110p
7406	38p	7485	80p	74157	80p
7408	22p	7486	35p	74164	120p
7410	18p	7490	45p	74165	120p
7413	35p	7492	55p	74174	100p
7414	56p	7493	45p	74175	95p
7420	16p	7494	70p	74190	100p
7427	30p	7495	70p	74191	100p
7430	30p	7496	70p	74192	100p
7432	35p	74121	45p	74196	100p

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DESIGNER'S NOTEBOOK

In this month's 'Notebook' Ray Marston looks at practical applications of a neat little eight pin National chip, the LM3909 LED flasher/oscillator

A common and seemingly trivial task often facing the design engineer is that of providing an illuminated (glowing or flashing) indication of the ON state of a piece of electronic equipment or the location of a passive device (fire extinguisher, emergency switch, etc) in a darkened room.

These tasks are obviously easily solved if mains power is readily available, but can present serious problems when battery powered equipment is concerned. LED indicators typically draw 12 mA or more when illuminated and can thus place a fairly heavy strain on small supply batteries. LEDs, in any case, drop two or more volts under the ON condition and can thus not readily be powered from battery voltages below 3 V or so.

National Semiconductors provided an ingenious solution to this problem some years ago when they introduced the eight pin LM3909 LED flasher/oscillator chip. This device acts basically as a low duty cycle (brief ON period, long OFF period) oscillator that provides a voltage-doubled high-current pulse to an external LED. Because of the voltage-doubling facility, the IC can flash a LED even when powered from cell voltages down to 1V1. Because of the low duty cycle facility, the device can provide high pulse currents (up to 100 mA) while still drawing very low mean currents (typically 0.3 to 1.5 mA) and can thus provide months, or even years, of continuous operation from a single 1V5 cell.

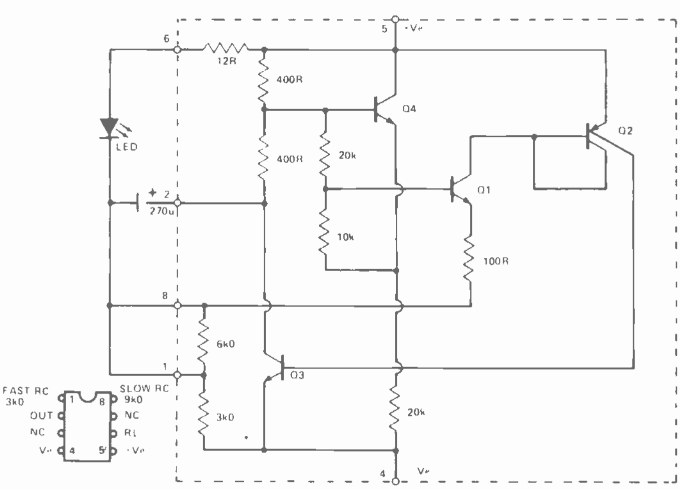

Fig.1. The internal circuit and practical connections of the LM3909 low voltage LED flasher/oscillator IC. The IC outline is also shown.

CELL SIZE	ESTIMATED BATTERY LIFE UNDER CONTINUOUS OPERATION	
	STANDARD CELL	ALKALINE CELL
AA	3 MONTHS	6 MONTHS
C	7 MONTHS	15 MONTHS
D	1.3 YEARS	2.6 YEARS

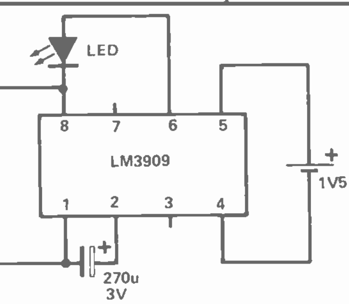

Fig.2. Practical 1V5 LED flasher with details of estimated battery life. Nominal flash rate is 1 Hz and typical average drain current is 0.63 mA.

The LM3909

The internal circuit of the LM3909, together with typical external connections for 1V5 flasher operation, is shown in Fig.1. In this application, the LED receives current (via the 270 uF capacitor and the internal 12R resistor and Q3) for only about 1% of the time. For the remaining part of each operating cycle all transistors except Q4 are off. The 20k resistor from Q4's emitter to supply common draws only about 50 uA. The 270 uF capacitor is charged through the two 400R resistors connected to pin 5 and through the 3k0 resistor connected to pin 4 of the circuit.

Transistors Q1-3 remain off until the 270 uF capacitor becomes charged to about 1 V. This voltage is determined by the junction drop of Q4, its base-emitter voltage divider and the junction drop of Q1. When the voltage at pin 1 becomes a volt more negative than that at pin 5 (the supply positive terminal) Q1 begins to conduct and then turns Q2 and Q3 on.

The LM3909 then supplies a pulse of high current to the LED. The current amplification of Q2 and Q3 is between 200 and 1000: Q3 can handle over 100 mA and rapidly pulls pin 2 close to supply common (pin 4). Since the 270 uF capacitor is charged at this time, its other terminal at pin 1 goes *below* the supply common; the voltage at the LED is then higher than the battery voltage; the internal 12R resistor (between pin 5 and 6) limits the LED current to a safe value.

Thus, the 270 uF capacitor alternately charges via the 3k0 timing resistor and discharges via the LED and 12R resistor. In some other applications, the short between pins 1 and 8 can be removed, enabling the capacitor to charge through a total of 9k0, with a consequent reduction in duty cycle and mean current consumption.

If voltage boosting is not needed (with or without current limit), loads can be hooked directly between pins 2 and 6 or pins 2 and 5 of the IC.

Let's look now at some practical applications.

LED Flasher/Indicator Circuits

Figure 2 shows the Fig.1 1V5 flasher circuit redrawn in a practical configuration. The circuit gives a brief flash once every second or so and typically draws an average current of only 0.63 mA. As you can see from the table, this circuit will give from three months to 2.6 years of continuous operation from a battery, depending on the size and type of cell that is used.

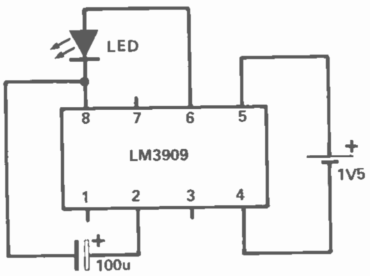

Fig.3. Minimum power 1V5 flasher. Nominal flash rate is 1.1 Hz and average drain current is 0.32 mA.

An even longer life can be obtained from the 'minimum power' flasher circuit of Fig.3. This is similar to the one described above, except that the short is removed from between pins 1 and 8, causing the capacitor to charge via 9k0 of internal IC resistance and so operate with a reduced duty cycle and reduced mean current consumption. The circuit has a typical current drain of 0.32 mA.

The Fig.2 and Fig.3 circuits are of particular value as 'indicator' or 'locator' becons for use on fire extinguishers, emergency lanterns, torches, emergency switches, etc. The operating frequencies of these circuits are heavily dependent on supply voltage, as indicated in Fig.4. This circuit is similar to that of Fig.3, except that it is designed for 3 V operation, in which case the timing capacitor value has to be increased by a factor of 2.7 for approximately the same flash rate.

Figure 5 shows another variation of the 1V5 flasher circuit. In this case the internal timing resistors are

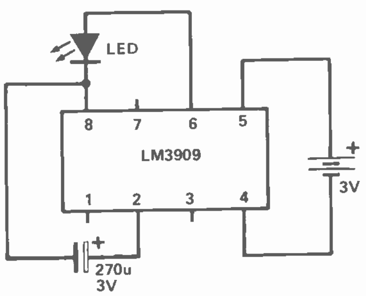

Fig.4. 3V 1 Hz flasher consumes an average current of 0.77 mA.

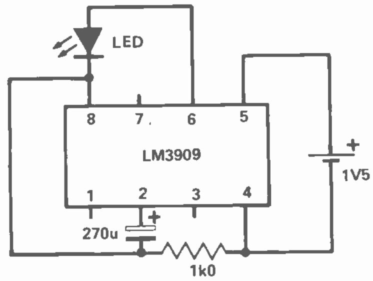

Fig.5. Fast 1V5 blinker. Flash rate is 2.6 Hz and drain current is 1.2 mA.

shunted by an external 1k0 resistor, thereby reducing the charge time constant of the circuit and causing the flash rate to increase (to 2.6 Hz) and the duty cycle and mean current consumption to rise. The circuit gives a more noticeable flasher indication than the three earlier circuits, but at the expense of 1.2 mA of mean current drain.

If you enjoy experimenting with circuits, you can build the variable rate flasher of Fig.6. The rate is variable from zero to 20 Hz via the 2k7 potentiometer. The two external 68R resistors are used to stabilise the duty cycle of the circuit and maintain a fairly steady apparent brilliance level in the LED as the rate is varied.

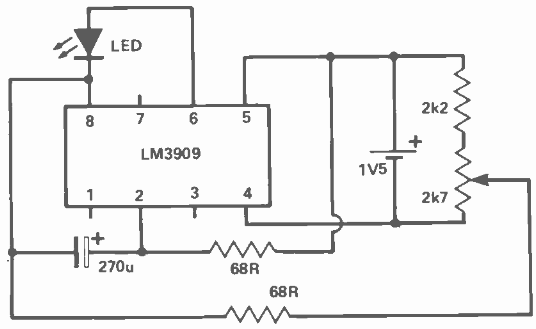

Fig.6. Variable rate flasher. The rate is variable from zero to 20 Hz.

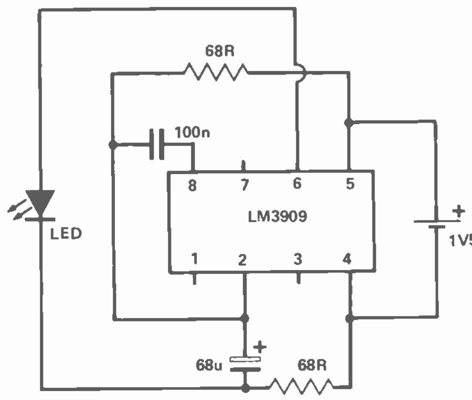

Fig.7. High efficiency 'continuous' 1V5 LED indicator. The circuit provides a steady but dim illumination by pulsing the LED at 2 kHz. Drain current is 4 mA.

The Fig.7 circuit is designed to give apparently continuous illumination of the LED when powered from a 1V5 cell. The circuit in fact acts as a 2 kHz square wave generator, the two external 68R resistors being used to approximately equalise the on and off times of the generator. The circuit gives a dim LED Illumination and has a battery drain of about 4 mA. LED brilliance can be increased, if required by using the alternative connections of Fig.8, but at the expense of 12 mA of battery drain.

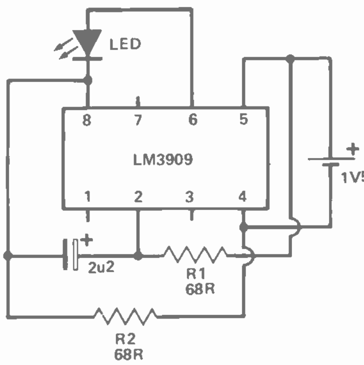

Fig.8. This 1V5 circuit gives an apparently steady and continuous LED indication. Battery drain is 12 mA.

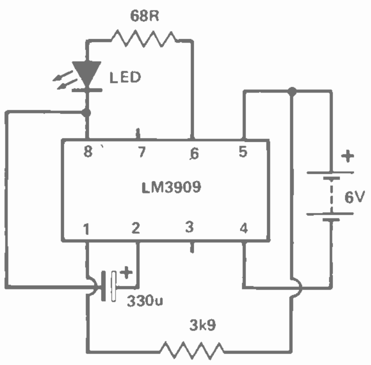

Fig.9. This 6 V flasher operates at about 1 Hz.

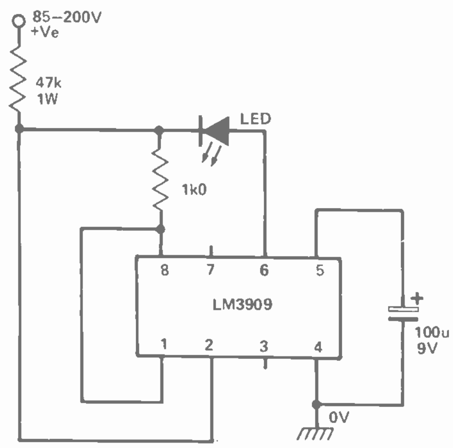

Fig.10. This LED flasher circuit can be operated from any supply in the 85-200 V range.

All of the LED flasher circuits that we've looked at so fare are intended for operation from 1V5 or 3 V supplies. Most of these designs can in fact be used, in slightly modified form, at voltages up to 6 V, as shown by the circuit of Fig.9. Note in this case that a 68R resistor is wired in series with the ALED, to limit its drive currents.

The LM3909 IC has a 6V5 zener built in between pins 2 and 4 (not shown in Fig.1). This fact is put to practical use in the flasher circuit of Fig.10, which ca be powered from any DC supply in the 85-200 V range. The 100 uF timing capacitor is connected between pins 4 and 5 in this application. **ETI**

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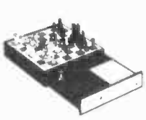

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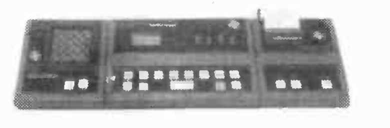

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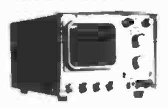

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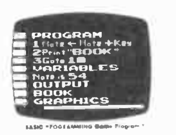

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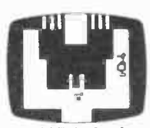

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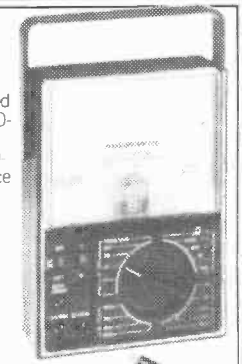

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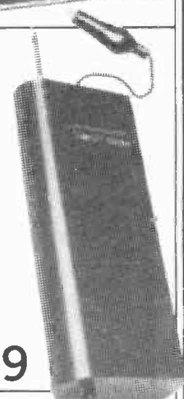

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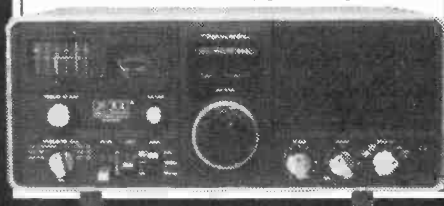

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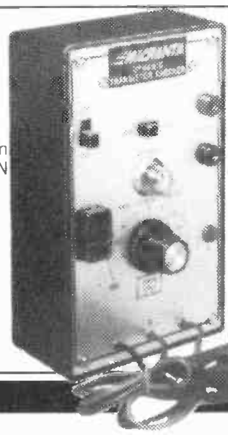

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AUDIOPHILE

A small step for an electron, a quantum jump for amplifiers? Being unable to resist the obvious puns, Ron Harris takes a searching look at one of Britains newest amplifier stars.

Show-time again this month. Spent an editorial hour or eight wandering around the hallowed halls of the Cunard Hotel. My annual pilgrimage to the Far East (or London) this — all face the Mecca Bingo Hall and pay homage to the gods of high technology.

Frankly, though, I thought this year's offering a little below the standard that this event has set itself in the past. Somehow there did not seem to be that charisma, that indefinable something, that electric charge to propel the visitor from room to room, eyes goggling at the plethora of mind mangling miracles wrought since last he trod these boards. . . . . . .

Or to put it another way a lot of it was boring. Naturally there were exceptions, but somehow the best demos were given by companies showing established products. One which particularly caught my ear was the minute A4-14 active loudspeakers, from Audio Pro. These have a sub-woofer built in to the enclosures and are capable of bone bleaching sound levels with a bass that sounds a lot larger than its 20 x 12 x 10 inches. The sound is simply stunning and would appeal to a very large number of people, I think.

Also making an impressive debut was the new JBE loudspeaker, with its unusual 'four-box' approach. The bass drivers are separately housed and would win no prizes for appearance despite the well finished enclosures. Still, the sound was very nice indeed, being well balanced and possessing excellent transient ability. Nice legs, shame about the facia?

B & Ws new offspring is also worth a listen if you get a chance.

Aside from that people like Trio, Shure, Goldring, STD, Quad and Crimson made the most pleasing noises to be detected, others being either too full of people or too empty of ideas to attract the attention. KEF 105s appeared to have been breeding quietly between the staircases — there were hundreds of them everywhere.

The prize for making WORST use of your equipment (if you'll pardon the expression) goes to Audiostatic of Holland. They were showing off a quite incredible electrostatic 'panel' speaker with built-in valve amplifier — and making a right mess of it when we went in. I only hope things improved later on. The sounds I heard have done much to persuade the average audio man that perhaps his idols have clay feet after all.

One little twenty second burst of a very well recorded opera is the only reason I bother to mention them at all. Insipid musical wallpaper and delicate solo flute is no way demonstrate such a systems capability in a crowded, noisy environment.

If you've got it — flaunt it, don't flute it.

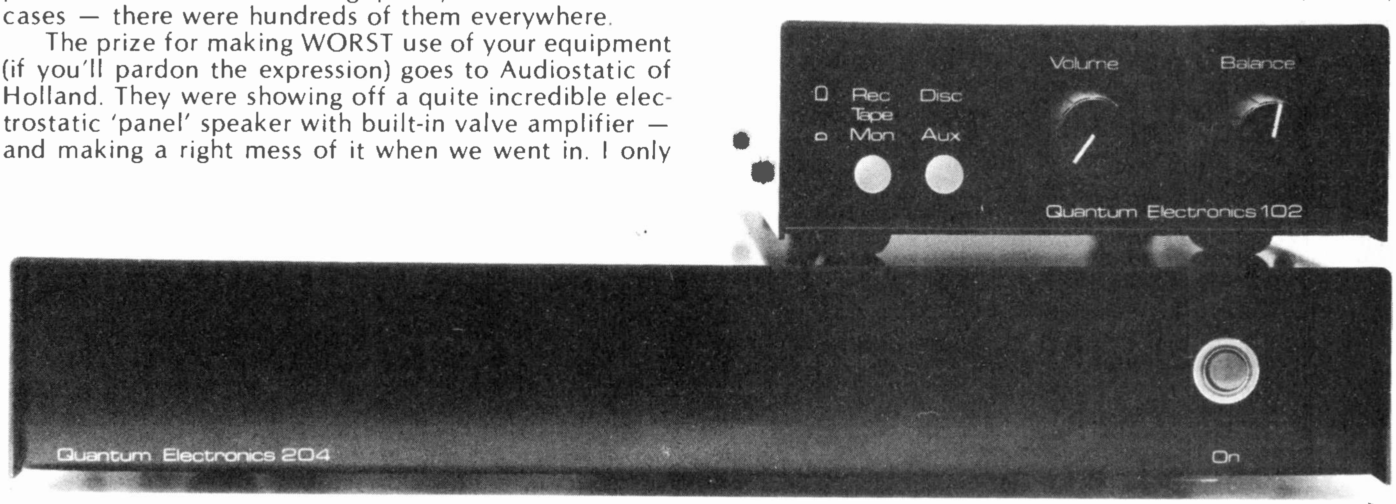
Quantum Amplification

Having started somewhat slowly, Quantum Electronics are well on the way to becoming one of Britain's most successful amplifier manufacturers. At that miserable Hi-fi 80 exhibition their room was one of the few that was continually carpeted with wall to wall people, which did detract considerably from the demonstration, admittedly. This sort of thing need not concern the Audiophile reader, however, as I'd already arranged for a review model.

Listening is infinitely more pleasant sat sitting at home, in front of the speakers you know and love, than packed into a tiny hotel room like a demented sonic sardine trying to pick up *some* of the sound waves being absorbed by the solid wall of bodies around you.

The particular combination from Quantum under scrutiny here is the 102 pre-amp and 204 power amp. It is available in many many forms, from ready built and tested, down to modules and hardware. In former form it will cost you £80.41 (102) and £153.42 (204). Modules (minus metalwork) cost £51.75 and £109.42 (204 kit).

It is worth a few words to point out that Quantum are in no way, shape, size or form connected with, or any



→

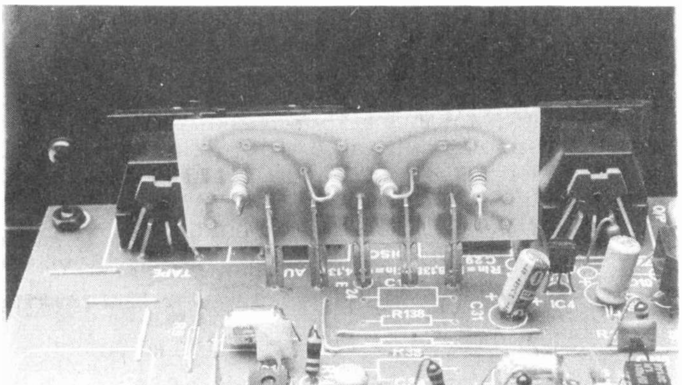
part of, Crimson Electrik, the company that is now their biggest rival. Tim Nind, Quantum's designer and brain trust, *left* Crimson to form Quantum and is rightly niggled by being repeatedly referred to as part of the company he is now in battle against. The products are both black(!) and that is as far as any similarity goes.

One Oh Two Preamp

The 102 replaces Quantum's earlier 'dual-version' machine, employing instead a very well thought out 'matching card' system to cater for all sorts of pickup cartridge from moving coil on down through any sort of magnetic variation.

Above: the 102 Quantum pre-amp full frontal. It is black, of course.

A small edge connecting PCB is plugged into the main PCB and carries the input matching components. Thus by changing card any pickup loading can be optimised. Handy for people upgrading, the pre-amp never dates. Even handier for deranged souls like me who are always swopping cartridges around. A link has to be made/removed on the board for MC/MM, however, and I fail to see why this could not have gone on the matching card, too.



Above: the matching board for the pickup input in close-up. Note the nicely worked up edge connections. This particular board is for a Shure V15 IV pickup, I think. Trouble was I tried so many it is now impossible to remember which one was in when the camera went off!

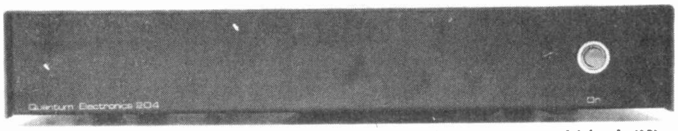
Inputs and outputs are via DIN, with phono for disc. As I cannot abide DIN plugs of any sort, this drove me around the nearest loop, but no criticism intended, of the Quantum. As you can see from the photographs, controls have been "minimised" to a volume and balance with input selector arrangement. Adequate in most situations, but Baxandall help you if you live in an awkward room as there is no tonal correction facility at all. Still, if you need it build an equaliser as treble and bass probably won't help anyway.

Tape sensitivity is variable by on-board switching and as all hardware is of board mounting variety there is little chance for noise/hum et al to creep in past the shielded cables that festoon most other equipment.

Table One displays the numbers, both claimed and measured, to which I'll return some paragraphs further on.

Two Oh Four Power?

Long black boxes would appear to be the only way British companies can produce amplifiers. Where has all the chromium gone? I think the correct word to describe this shade of approach is functional.



Above: the 204 power amplifier. Finished in an unusual black (!?)

The 204 unit consists of two 110W audio modules, PSU with toroidal transformer (which buzzes audibly!) and separate supply for the pre-amp (±15V) One DIN (yeuk!) carries out the pre-amp volts and carries in the signal for amplification. Neat. Speaker output is via 4mm plugs. Thank God *this* isn't DIN.

The hardware package is more or less standard across the range, so that you can house any power you like, up to around 200W, in the same box.

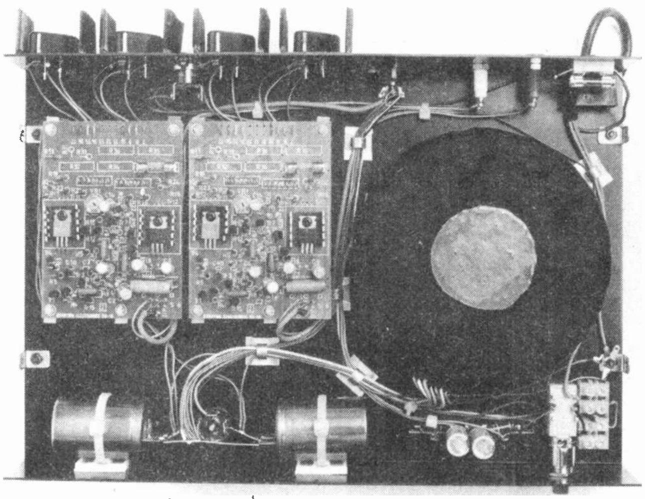
Table One

PARAMETER	SPECIFIED	MEASURED
THD	< 015% to clipping Moving Coil < 01% to clipping	below noise floor unmeasurable
Input Sensitivity & Overload	Disc 3 5mV or 100uV standard Variable Tape 150mV Disc 34dB Tape infinite	Disc overload 35dB at 3 5mV and 100uV
Signal to Noise	Disc 70dB ref 3 5mV or 52dB ref 100uV Tape 96dB	65dB/50dB 85dB
Frequency Response	Disc ±1dB RIAA 50Hz-20kHz Tape —	agreed ±1dB, 20Hz-20kHz
Separation	46dB at 1kHz, 36dB at 20kHz	45dB/38dB (R on L)
Outputs & Impedances	775mV and 150mV tape 600R main, 1k8 on disc, 10k on aux	agreed agreed

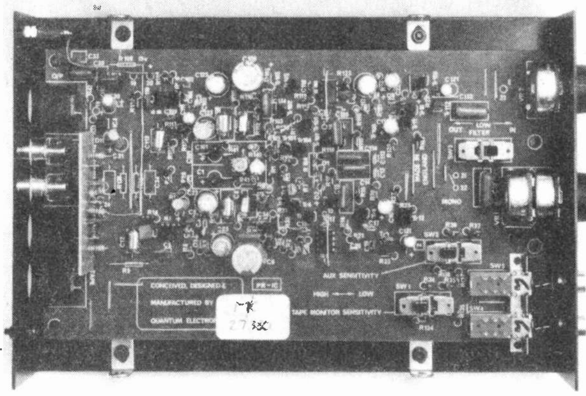
Table Two

PARAMETER	SPECIFIED	MEASURED
Output Power (RMS, 8R at 1kHz) Peak Delivery	110W 300 VA	121W 205W
Signal to Noise Ratio (unweighted)	>100dB	102dB
THD (any level to clipping)	<0 015%	below noise
Gain	30dB	agreed
Power Bandwidth (−3dB)	6Hz-50kHz	5Hz-45kHz
Damping Factor (50Hz)	80	agreed
Input Impedance	50k	agreed
Protection Operation Load	|4R|	|4R3|

Tables One and Two. These are for the pre-amp and power amp respectively, comparing the claims against the measurements.



Above: the 204 power amp revealed. Note the huge toroidal mains transformer and pre-amp PSU board away to the left. Separate heatsinks are used for each power output device.
Below: a de-cased 102 pre-amp. Most components are PCB mounted to cut down interwiring. Instructions on pickup matching are written on the *inside* of the lid! (not shown).



Figuring Out The Figures

In summary of Tables One and Two we can say that the Quantum 102/204 is an amplifier of better than average noise performance with excellent distortion figures — or lack of them — which has a high enough overload on the disc input to ensure that no problems will ever be encountered in normal use.

The S/N on moving coil input is very good indeed, practically up to moving magnet input standards and has little hum component to give trouble. No mean feat this. My review model was set-up, to match the inevitable Coral MC81 as a 'norm', but I spent many a happy hour playing with the matching cards for Ortofon, Goldring and Shure moving magnet designs. The moving coil input bettered Coral's own H300 head amp for noise and distortion — which suggests that the self-standing Quantum moving coil pre-amps would be worth a look or two.

The 204s figures are unimpeachable — with the exception of that minimum impedance into protection. I would like to have seen around 2R there — the lower the better I suppose. Still it *is* honestly specified and lower impedance driving modules are available if you're troubled. In use the 204 drove my 105 IIs with no sign of distress at all. Check your speaker impedance curves before matching though. Better safe than burning.

What A Turn On

Funny how all reviewers leave discussing the sound of equipment until the end of an article, as though we test it all out first, THEN sit and listen. No chance. Just like everyone else it's a case of home with the packages, out of the boxes and CLICK . . . . . . In fact unwiring it all to start injecting boring test signals is the worst part of this job.

Quite frankly I didn't know what to expect from the Quantum, I knew the sound of its competitor Crimson well and respected it as the best module sound around and comparisons are inevitable I suppose. A direct AB test will have to wait though as our German edition has our Crimson set-up at present and is more than a little reluctant to part company with it. Damn cheek if you ask me, who won the war anyway?

So it is to the Lecson AC1/AP3 II combination that the Quantum was to be referenced, using KEF 105 II speakers and Coral MC81 and Ortofon/SME 30H cartridges. (The sound of the latter grows on me the more I hear it.)

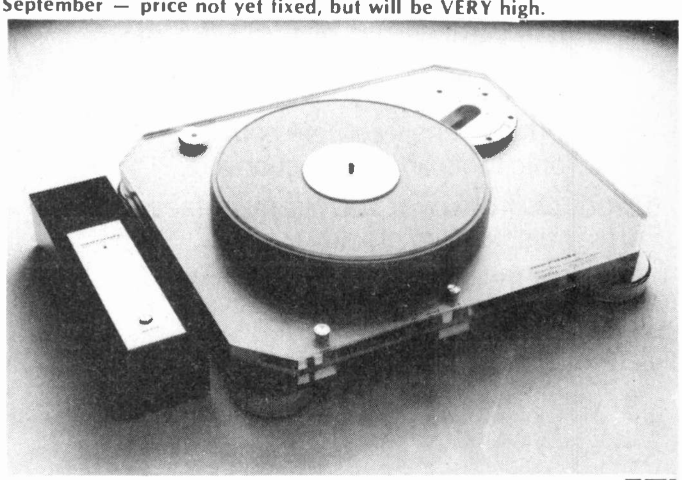
With the 102 set to moving coil, the first thing I noticed was the much better noise performance. At first I thought something wasn't connected! The sound is open and beautifully rich in all the little things that make music on a good system worth listening to. The pre-amp is very good indeed, but I felt that against the Lecson the 204 lacked bass punch. The lowest registers were not as well defined, or as 'coherent'. Mid-range and treble were little different.

Summary

In a word — yes. A good solid product which does its job superbly and gives excellent value for money, both in terms of its sound quality and its engineering. Home built hi-fi has a new championship contender!

Marantz Esotec

Below: the new Marantz Esotec TT 1000 turntable. This employs a glass and aluminium 'sandwich' as a base and a 5mm thick glass turntable mat. The idea is to cancel any resonances due to the base material and produce a truly non-resonant support. Air suspension is employed to hold this massive machine clear of the ground and the motor is claimed to have sufficient power to reach full speed in ¼ turn. Released in September — price not yet fixed, but will be VERY high.



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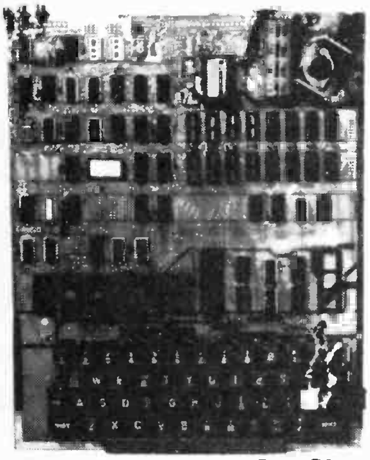

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74LS138	0.65
74LS139	0.65
74LS145	0.97
74LS151	0.81
74LS153	0.52
74LS154	1.30
74LS155	0.72
74LS156	0.72
74LS157	0.57
74LS158	0.57
74LS160	1.09
74LS161	0.69
74LS162	1.16
74LS163	0.69
74LS164	1.06
74LS165	0.72
74LS166	1.65
74LS168	1.71
74LS169	1.71
74LS170	1.72
74LS173	0.81
74LS174	0.97
74LS175	0.97
74LS181	2.77
74LS188	0.44
74LS189	2.08
74LS190	0.86
74LS191	0.86
74LS192	1.04
74LS193	1.04
74LS194	0.86
74LS195	0.97
74LS196	0.97
74LS197	0.97
74LS221	0.92
74LS240	2.08
74LS241	2.08
74LS242	2.08
74LS243	2.08
74LS245	2.50
74LS247	1.09
74LS248	1.09
74LS249	1.09
74LS251	0.96
74LS253	0.92
74LS257	0.92
74LS258	0.92
74LS259	1.39
74LS261	4.50
74LS266	0.37
74LS273	1.70

74LS279	0.57
74LS283	1.09
74LS289	4.50
74LS290	0.91
74LS293	0.91
74LS295	1.30
74LS298	1.16
74LS348	1.39
74LS352	1.04
74LS353	0.92
74LS362	4.21
74LS365	0.47
74LS366	0.47
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74LS386	0.36
74LS393	0.84
74LS668	1.17
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CAPACITORS AND TIME CONSTANTS

A.S.Lipson takes the bull by the time constants and explains how to use capacitors in timing circuits.

Those little brown discs or large blue cylinders that do funny things to your multimeter if you try to measure their resistances are frequently used as AC coupling devices, but they are also of great use in timing circuits. A resistor and capacitor together can produce a changing voltage whose magnitude at any moment can easily be calculated.

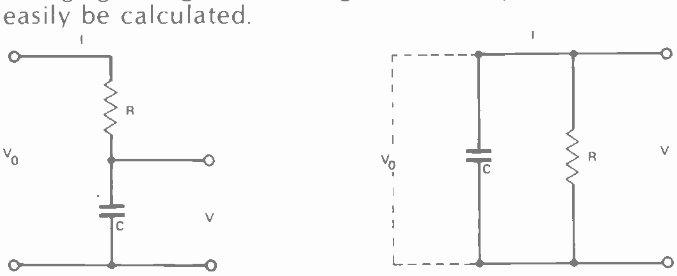


Fig.1 Series and parallel RC networks.

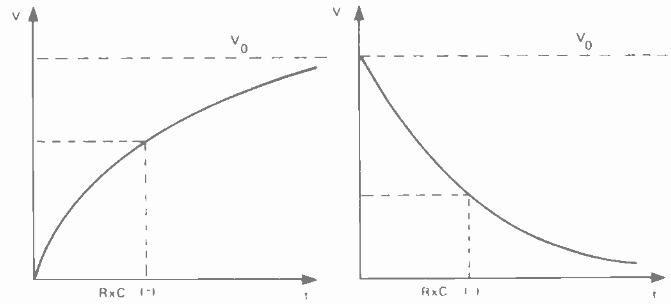


Fig.2 The output voltages associated with the RC networks of Fig.1.

First The Circuits

The first circuit in Fig. 1 consists of a resistor, R in series with a capacitor, C. A voltage, V_O, is applied across the combination and the output voltage (that across the capacitor) is monitored. The output voltage (V) slowly rises from zero, coming closer and closer to the value of V_O, although it never actually quite reaches it. A graph showing output voltage plotted against time is shown in Fig. 2a. It is found by experiment that the rate of increase of voltage becomes smaller if either R or C are increased, and greater if either is decreased. That is, the voltage rises more slowly for large values of R and C than it does for small values of C. In fact, if we take the product RxC, (R in ohms, C in Farads) we find that this gives the time (in seconds) required for the output voltage V to reach about two thirds the value of V_O.

The second of the two circuits consists of a capacitor and resistor connected in parallel. The capacitor is charged by an external source to a voltage V_O, and then disconnected. The output voltage, V is monitored once again. Here, we find that V slowly decreases from V_O to zero, getting smaller and smaller, but, again never quite making it (Fig. 2b). Again, it is found that the voltage changes more slowly if either the resistance or the capacitance (or both) are increased and changes faster if they are decreased.

Time Constant

The product RxC is called the 'time constant' τ (the greek letter Tau) of the circuit and it can be used to find rough values for V at different times. It turns out that, no matter how long the voltage has been changing in the circuit, it always takes τS for the voltage across the capacitor (in the first circuit) to increase by two thirds of the *remaining* voltage. eg If V_O is 9V, and the output voltage V at a time t is 4V, then after τS, at time $t + \tau$, V will have risen by two thirds of (9 - 4) volts, or 3 1/3 volts. This can be used to plot a graph of V against time. At τ seconds, V will be two thirds of V_O. At 2τS, V will have risen by two thirds of the remaining voltage, ie by two thirds of $1/3V_O$, and will thus have risen to eight ninths (approximately) of V_O. Similarly, voltages at 3τS, 4τS and so on may be calculated and plotted on a graph (Table 1 and Fig. 3). A line may then be drawn in freehand, joining the points, and approximate values for V at different times calculated.

This is all very well for rough values, but it is of considerably less use if we want to find exact figures — especially at times much less than the time constant. Fig. 4 shows a freehand curve drawn onto the first three calculated points on a graph. We know nothing from our method about the voltage before it reaches 2/3 of its final value, except that it starts at zero. The correct graph could be A or B or anything in between — we have no way of knowing,

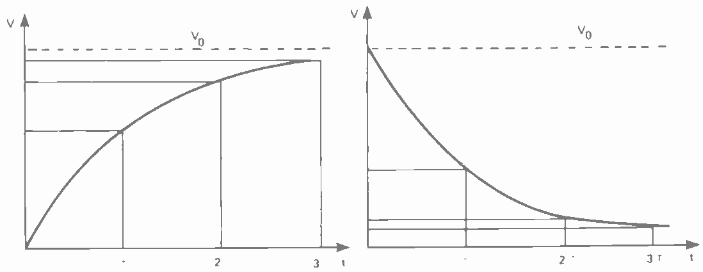


Fig.3 Plotting graphs of output voltage against multiples of time constant.

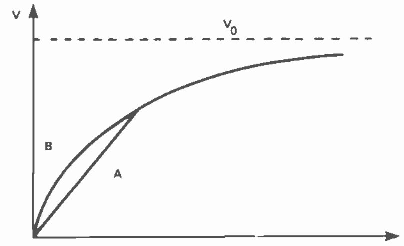


Fig.4 A freehand curve drawn onto the first three points calculated.

Curve Drawing (No, Not . . .)

It is an interesting and useful property of the way in which the voltage changes in these circuits that, at any instant, if the voltage continued to increase (or decrease) at the same rate, it would reach its final value in exactly τS. The reason why it doesn't actually do this is simply that the rate of increase is not constant. As the voltage becomes larger (Fig.1a) or smaller (Fig.1b) its rate of change decreases. However, as has been stated, if the rate of increase of the voltage, dV/dt was constant from any time t, then V would reach V_0 (or zero, as the case may be) at time t + τ (Fig.5).

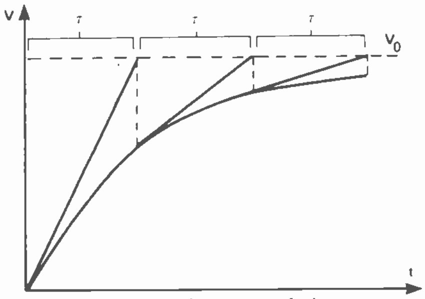


Fig.5 V tends towards Vo.

We can make use of this property of the curve. Mark on the graph (Fig.6) a line representing the final voltage, V_0, of the system. Now mark along this line a distance τ from the beginning (point A) and draw in a straight line from this point to the origin, 0. This, then, will give a fair approximation to the voltage as it changes *in the first few moments*. Now choose a point on this line, near the bottom (P1). Mark a distance τ along from P1 and find the point on the line representing V_0 directly above. Call this point B. Draw a line from P1 to B. Now choose a point P2, near P1 on this line, and repeat the same process. Eventually, the lines shape themselves round a curve, which turns out to be a fair approximation to the graph of voltage plotted against time.

This method is fine, but it has three great disadvantages; it takes a long time to draw the curve this way, it isn't very accurate beyond about 2τ and (as you will have realised if you had to read the last few paragraphs more than four times) it's complicated. If we want to find values of V beyond τ seconds, we can use the first method of drawing the graph and if we want values of V for times less than τ seconds, this second method can be used, but it is simpler, if we only want to know one value,

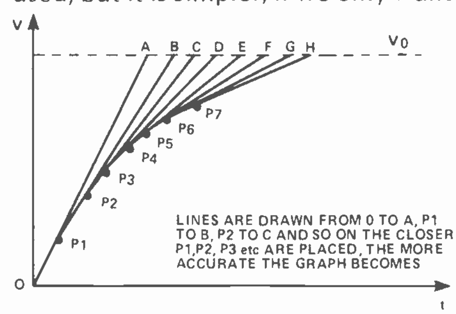


Fig.6 This method of drawing graphs is reasonably accurate up to twice the time constant.

Capacitors.

We are so used to thinking in terms of currents and voltages that it is very easy to forget the existence of a more basic quantity — charge. Charge is what passes when a current exists. Current, then, is actually rate of passage of charge. Now capacitance is defined as the ratio of the charge stored in a component to the voltage developed across it. That is, if C is the capacitance in Farads, Q is the charge in coulombs and V is the voltage,

or $C = QN$ $\quad Q = VC$

We can differentiate each side of the equation:-

$$\frac{dQ}{dt} = \frac{d}{dt}(VC) \qquad = V\,dC \qquad dV$$

Now C is a constant, so dC/dt is zero:-

$$\frac{dQ}{dt} = C\frac{dV}{dt}$$

Finally, we can see that, since current is rate of flow of charge, dQ/dt is the current flowing into the capacitor, so

$$I = C\,dV$$

Now let's take another look at the circuit in Fig.1a. If we assume that no current is being drawn from the output, then the current into the capacitor must equal the current through the resistor. The voltage across the resistor, though, V_R, is obviously equal to V_0-V, and by Ohm's law;

$$(V_0-V)/R = I$$

Therefore,

$$(V_0-V)/R = C\frac{dV}{dt} \qquad V_0-V = RC\frac{dV}{dt}$$

This is the differential equation that must be solved to find V. The mathematicians out there might like to show that the equation is solved by

$$V = V_0(1-e^{-t/RC})$$

where e, as any scientific pocket calculator will tell you, is 2.7182818 and t is the elapsed time. This is the equation we can use for precise values. We'll do an example; a 9V power source is connected across a series combination of a 47k resistor and a 10uF capacitor. What is the voltage across the capacitor after 0.6 S? Fitting the values into the equation:-

$$V = V_0(1-e^{-t/RC})$$
$$= 9x(1-\exp(0.6/(4.7x10^4 \times 10^{-5}))$$
$$= 6V49$$

(If you don't believe me, try it . . .)

A similar sort of argument works for the circuit in Fig.1b. The output voltage V is given, by Ohm's law, by

$$V = IR$$

However, I in this case is the current flowing *out* of the capacitor, and so it is given by the relation

$$I = -C\frac{dV}{dt}$$

Hence we have

$$V = -RC\frac{dV}{dt}$$

Andwe find that this differential equation has the solution

$$V = V_0e^{-t/RC}$$

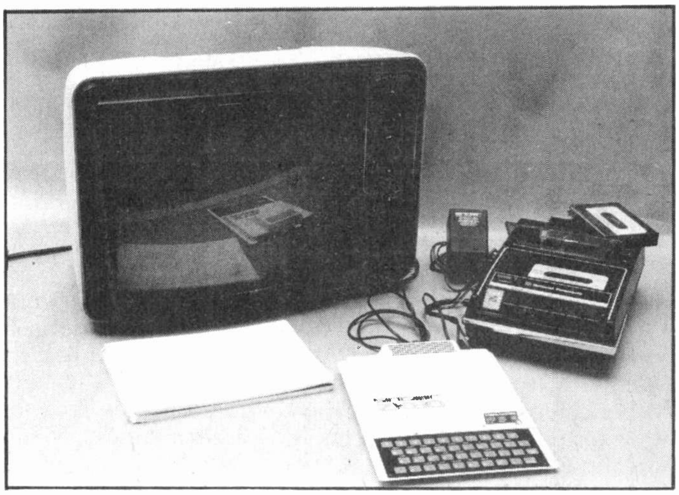
where V_0 is the voltage to which the capacitor was charged.

Let us suppose we have a 200 uF capacitor in parallel with a 330k resistor. The capacitor is charged up to 12 V and the supply removed. What is the voltage across it after 2 S? Well, plugging these values into our equation, V_0 is 12 V, t is 2 S, R is 3.3 x 10^5 ohms, and C is 2 x 10^{-4}

ETI

MICROFILE

By popular request Henry Budgett reviews the Sinclair ZX 80 microcomputer kit.



Ever since the first announcements and press comments on the new Sinclair ZX 80, Microfile's phone has been ringing with readers asking for a review. Well, after a few months of controversy and careful study here is the report you've all been waiting for.

Kitted Out

If a system such as the ZX 80 is offered in kit form, it is often worth buying it in this form to save the odd few pounds and so we took a kit and built it. There are few components that raise any eyebrows and the whole thing was slotted neatly together in less than two hours. Whilst we were putting it together we also built in the suggested modification to change the video from black on white ("standard") to white on black ("normal") and this has proved very useful.

The instructions supplied with the kit are adequate and clear enough to allow any reasonably competent constructor to achieve success. There is a circuit diagram of sorts. We found great difficulty in deciphering the various bits and pieces so it would not be of any great help in debugging a "dead" system.

The Great Turn On

The first thing to be said about the ZX 80 is that it worked, albeit a little hesitantly. I am rather accustomed to full size keys and have yet to come to terms with a touch keyboard. It does work very well, though, and shows no signs of wearing away even after weeks of hard use. The TV picture produced by the system is less than satisfactory. The much publicised juddering when keys are pressed is not in the least beneficial and, when you actually get round to running a program, the blank and flickering screen is positively unnerving.

The BASIC has been another point of considerable controversy. Inside the 4K ROM is a compressed Integer BASIC, the character set and the (minimal) operating system or monitor. This BASIC may give the beginner a feel for high level language programming but anyone who has used systems such as PETs or Apples will find it very restrictive. The single keystroke programming facility is certainly not my cup-of-tea. I'm too used to typing the whole thing out, but it would be of benefit to the beginner.

Manual Intercourse

The "Course in BASIC Programming" that is supplied with the system is a very poor substitute for books such as "Basic BASIC" and "Illuminating BASIC" but is adequate for finding your way round the ZX 80. The format needs to be considerably improved, odd and even chapter numbers are aimed at different people. There are a number of errors; some are corrected in an addendum, but several trap the unwary.

The explanation of many of the functions of the system is very poor indeed and in some cases can lead one rather up the garden path. The best function concealed within the system is the Editor, truly a marvellous system. We did wonder why they had made it so good. It must use up a fair proportion of the available space which, it could be argued, would be better used by providing more BASIC functions.

The Ins And Outs

Tape interfaces come in many different disguises. The ZX 80 is no exception and offers an "around 300 Baud" audio cassette interface which works tolerably well. You can experience trouble if you leave both input and output jacks connected to the tape recorder but I gather a note to this effect is being included in the manual. The VDU is less praiseworthy, the aforementioned flicker being just one of its little quirks. The problems really start to occur when you find that the program crashes every time you fill the screen. The cause is that the VDU is acting as a serial output device and needs a buffer. When the buffer is full it stops everything and tells you — nasty!

We also encountered another interesting VDU quirk for which there appears to be little explanation. On some TVs you encounter you will find that white on black is unreadable but black on white is, or vice versa. We also discovered, again no explanation is offered, that the system would produce a double (ghost) image on some colour sets. The designer assured us that the modulator was not, as we had suspected, a cheaper version that could not handle the bandwidth so there must be something funny going on.

Hardware Design

A certain number of design features of the ZX 80 are worthy of note. It is generally understood that an eight bit micro, with its sixteen bit address bus, can have up to

➔

NewBear's New Brain — a professional, hand-held micro .... coming soon.

64K of memory hung on it. The ZX 80 offers a maximum of 16K of RAM and a (possible) 16K of ROM, done by moving PC tracks around. What you may well ask has happened to the other 32K? Sorry chaps, but it is used for other things like decoding the keyboard, so the thoughts of giant, disc based systems fade rather rapidly. Whilst on the topic of memory it should be noted that the 3K Sinclair RAM boards are *not* capable of being "piggy backed", you'll have to wait for the 15K RAM plane. You cannot use the cheaper dynamic RAM either because the RFSH signal produced by the Z80 CPU is utilised by the video synchronisation circuitry and this means that instead of getting a mean refresh every 2 mS that the dynamic memory needs, it may have to wait 20 mS, which is cutting things very fine. Under normal operating conditions this might not cause problems, but if the temperature of the RAM chips rises then they may well start to lose data.

The final oddity in the design of the hardware is the lack of a crystal controlled clock. It uses a ceramic filter instead. This is not to be recommended as it simply isn't accurate enough. The ZX 80 runs at 3.25 MHz, which is a multiple of the TV linebase frequency. The filter appears to be used to save a couple of divider chips and possibly pass this saving on in a reduced price, but it should be remembered that the earlier Sinclair computer, the now defunct Mk 14, was equipped with a crystal and cost about half the price.

Expansion Capabilities

Apart from the memory expansion problems mentioned earlier, there is another, more subtle, problem that will occur when the user wishes to attach that most popular of peripherals, the printer. This problem arises because the ZX 80 does not use the normal ASCII character code set but its own. This means that to interface to a printer, a task of more than average complexity, the user will have to write a look-up table routine to convert between the two code sets.

However, the first thing that any expansion minded user must do is to put buffers onto all the bus lines. Space and pricing have omitted these and, although it is hoped that Sinclair will produce a buffer board, it does not appear to rank highly on their list.

Mention has been made of certain possible add-ons like Prestel and it is worth making the point that, because the ZX 80 uses a serial output screen format rather than a memory mapped type, it will be almost impossible to connect exotic systems such as Viewdata and Teletext. In the same way it is impossible to use the ZX 80 for playing interactive video games of the Space Invaders type.

Software

At the moment there is not much commercial software available. The Users Group is probably the best source after magazines like Computing Today, but there are very strong indications that a professional software house will be supplying the user with a range of programs. For users who are looking for software now the following points should be borne in mind;

a) the BASIC is Integer only,
b) the cassette format is not "standard",
c) you can't use interactive graphics, PEEK and POKE,
d) The BASIC is not compatible with Microsoft types, in *either* direction.

Conclusion

Sinclair and his Science of Cambridge team have produced what is probably the forerunner of the 1980 generation of personal computers and in common with most "firsts" it has a number of faults that its competitors will rapidly seek to iron out of their, yet to be released, products. The currently poised opposition include Acorn with their Atom, NewBear with the New Brain and (allegedly) Sharp with a similar type of system. The competition is going to be fierce and as yet Sinclair is the only runner in the race.

As regards the system we feel that it would probably make a starting point for the complete beginner, but for anyone experienced in microcomputing it may not have sufficient facilities compared with other low cost systems like Acorn and Tangerine. The lack of proper machine code access may put the system down in some people's opinions but as a first time system for the complete beginner, be they in the classroom or at home, it is currently the cheapest and that may well be the overriding factor.

New from NewBear

Newbury, the terminal company who opened the NewBear computing shops to gain access to the world of microcomputing, have launched a professional handheld micro for anyone from businessmen to the hobbyist. Called New Brain it contains a 16K Compiling BASIC, 2K RAM which is expandable to 4K in static or 16K in dynamic, a full size QWERTY keyboard, single line display with direct video output and enough I/O to make most systems look a bit undernourished. The whole thing is battery powered, with charger capability and uses a COPS chip from National Semi to look after the keyboard and display (which powers down after 60 seconds of inaction). The main computing is provided by a Z80 which only powers up when you actually RUN a program. The machines we were shown at the Press launch were unfortunately only half built and they are not expected to be available until at least September, so we can't get our hands on one yet. When we do we'll tell you what it does but expect the prices to be from £150 (video only) to £250 (full system). One feature that I will tempt you with is the fact that they have committed themselves to Prestel — it has a button on the front marked Viewdata.

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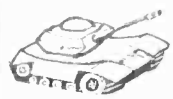

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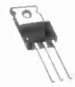

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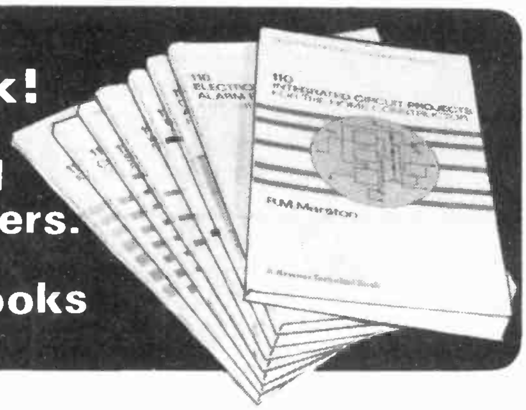

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TECH TIPS

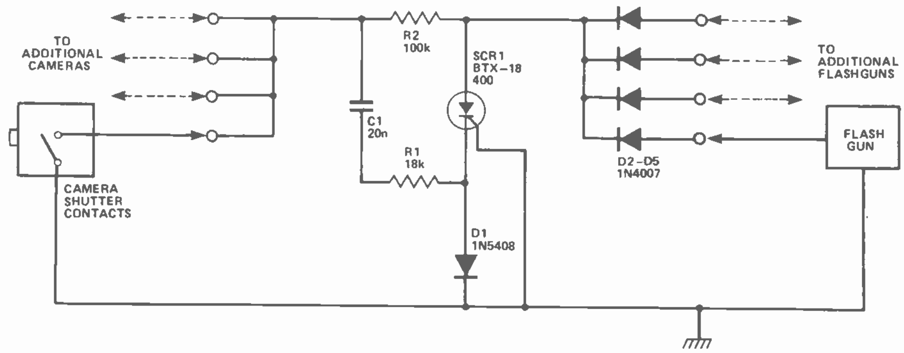
Multi-Flash Trigger

R O'Rourke, Eastleigh

This circuit provides a cheap and safe system for parallel connection for electronic flashguns and prevents damage to shutter sync. contacts.

Electronic flashguns used for photography usually have a voltage of between +200 V and +400 V present at the trigger input connector.

The flash unit operates when the trigger is grounded (by the shutter sync. contacts) and a current pulse of between 1 and 3 amps, lasting about 10 to 30 microseconds is carried by the sync. contacts.



Direct connection of electronic flashguns in parallel can cause two major problems:

(a) Different makes or powers of flashguns may have different operating voltages and may therefore be damaged by parallel connection.

(b) Shutter contacts could be damaged or burned by the excess current of multiple gun operation.

This circuit overcomes these two problems as follows:

(a) Diodes D2 to D5 effectively isolate the hot side of each flashgun from the next and also prevent the high voltage appearing on the unused flashgun contacts.

(b) The SCR trigger circuit operates as follows:

When one or more flashguns are connected to the unit, the cathodes of D2–D5 rise to a high positive value, say +200 V.

C1 is charged via R2, R1 and D1 in a time constant C1 x (R1 + R2) = 0.02 x 118 k = 2.36 mS.

SCR1 is non-conductive at this time as its cathode is slightly positive and its gate is grounded.

When the shutter contacts of a camera connected to the device are closed the R2 end of C1 is grounded and therefore the R1 end is driven negatively to –200 V. This enables a negative current pulse to be delivered to the cathode of SCR1 (D1 allows SCR cathode to go negative) of about 11 mA, for about 360 uS duration, this pulse turns on the SCR which then carries the trigger current of the flashguns.

When the flashguns fire the trigger voltage drops to zero and the SCR turns off. C1 will recharge as the voltage of the flashguns recover ready for the next flash.

As can be seen, the maximum current through the camera contacts is thus reduced even with a flashgun voltage of 400 V, to only 22 mA.

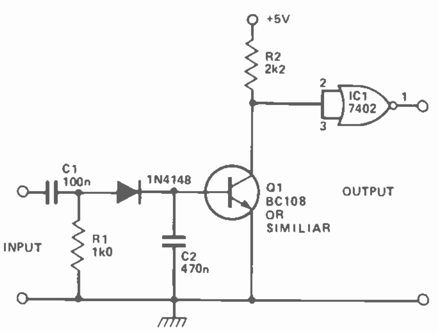
When using more than one flashgun in a direct lighting system, allowance should be made for the increased guide number:—

Effective Guide Number =

$$\sqrt{a^2 + b^2 + c^2 \ldots}$$

Simple Cassette Interface

R Thomas, Port Talbot



The cassette interface on my NASCOM1 has never worked correctly and despite many frustrating fault finding sessions the only solution was to replace it. No originality is claimed for this circuit. Indeed anyone with a basic knowledge of electronics or radio will recognise part of it as an envelope detector or demodulator. No alteration of the cassette output of the NASCOM is required assuming it dumps properly. Take the output of the 7402 to the serial input link LK3.

Component values are not that critical and by inserting another resistor and capacitor of the same value in front of C1 and R1 the response will be improved, although I did not find these necessary. The interface does require a fairly large input signal and the volume setting is rather precise but once set the interface should work perfectly. Although built for the NASCOM, the interface will work with any low speed cassette interface system that switches an audio frequency on or off.

Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items. ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH–TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.

VDU Shift Control

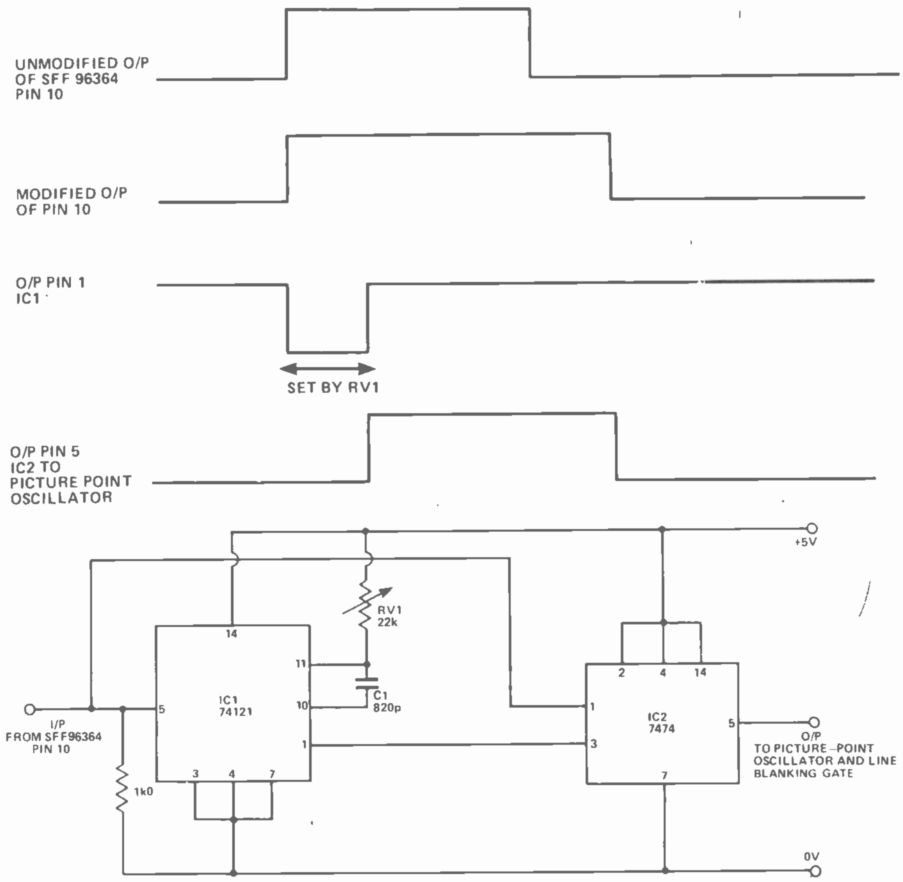
R J Cheason, Fareham

Most low cost VDU boards using the SFF96364 do not have the facility to adjust the monitor/TV picture left or right. This circuit was developed for a VDU board using the 'Triton' design but is suitable for any board using the same controller.

The SFF96364 outputs a pulse on Pin 10 enabling the picture – point oscillator. The counter/divider then outputs a pulse to the controller every character, stepping the character address. After 64 characters Pin 10 goes low.

The modified circuit uses the positive going edge from Pin 10 to trigger a monostable whose pulse length is set by RV1 and C1. When the monostable's output goes high it triggers a flip flop into the high state. After the current line has been output, the input from Pin 10 goes low clearing the flip flop and stopping the picture – point oscillator.

In practice slight jittering was caused by interference on the supply lines, but it was found that a capacitor of about 100 uF across the supply close to IC1 cured this problem.



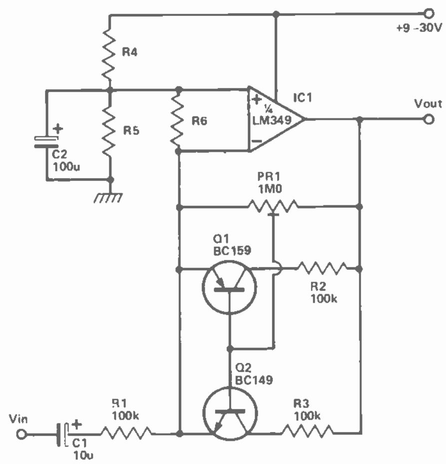
Soft Limiter

J.P. Macaulay, Crawley

One of the fundamental differences between valve and transistor amplifiers is their behaviour when driven into clipping. The valve amps go into so-called soft clipping whilst their transistorised counterparts generate large quantities of harmonic distortion. The circuit shown simulates the soft clipping of valve amplifiers and is intended to be used between the power amplifier's input and the preamplifier's output.

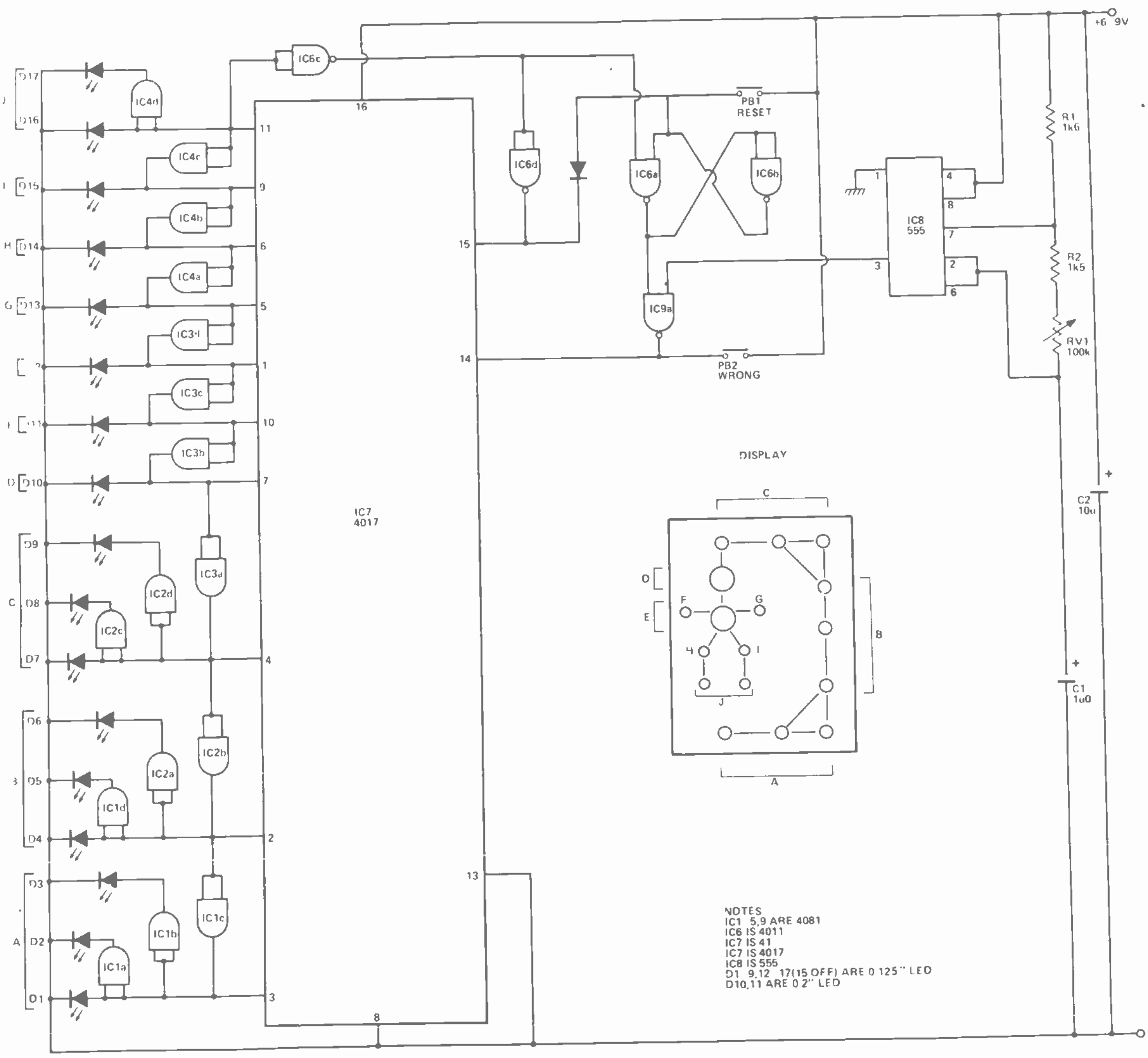
R4 and R5, decoupled by C2 set a half supply reference for the non-inverting input of the op amp. Input signals are fed into the inverting input via the DC blocking capacitor and R1, the latter defining small signal gain and input impedance.

For small signals the amplifier's output is an exact unity gain copy of the input. As the signal level increases, however, the time will come when the voltage across the output and slider of PR1 will be sufficient to bias Q1 or Q2 on. When this occurs the feedback increases due to the shunting effect of R2 and R3.



The net effect is that musical peaks above a certain threshold are reduced in amplitude to prevent the power amplifier going into hard clipping. As a result distortion is noticably decreased, whilst the subjective loudness appears unaffected.

The circuit is adjustable in operation between 130 mV and 10 V rms input sensitivity by means of PR1. To set the circuit up simply set the slider so that it is shorted to the output of the amp. Play some music at high volume through the system and adjust until the harshness just disappears. It's easier to do than describe.



Electronic Hangman

G.N. Durant, Selby

The circuit diagram shows a design for an Electronic Hangman Game. The scoring display is made up of 0.125" and 0.2" LEDs, as shown. The controls consist of two one pole make push-buttons. The first button is pressed every time a letter is wrongly guessed. At the start of the game, the other button is pressed, to reset the display, blanking it. When a letter is wrongly guessed the 'wrong' button is pressed once, and the first part of the display, (A), is illuminated. Every time another wrong letter is guessed, the 'wrong' button is pushed, and the next part of the display is lit up. When the display is all lit up, and the victim is 'hung', the display automatically blanks.

Now this is where the clever bit comes in. To show that the victim has lost, the display is blanked, then the first part of the display lights itself, then the next part and then the one after that. In fact, all the parts light up in sequence, until the last part lights, when the display blanks again, and the whole 'chasing' process starts again. This process repeats itself until the 'Reset' button is pressed, when the display blanks, ready for a new game to begin.

The circuit consists of eight ICs, one of them being a 4017B CMOS device. This device is a ten stage decade counter. Each output is fed directly to its own LED and, because some outputs require more than one LED and there is not enough current from the 4017 to drive more than one, the affected outputs are connected to a CMOS 'AND' gate which is in turn connected to a LED, so the required power is obtained from the power supply and not the outputs of the 4017. The input of the 4017 is triggered by a push button connected to the positive supply rail, so when it is pushed (Wrong button) the IC is triggered and the next part of the LED display is illuminated. The 'lower' LEDs are kept lit by another AND gate, connected as a chain linking each output of the 4017, so their outputs will go high, when a 'higher' LED is lit.

When the top LED is lit, another AND gate (gate 3, IC 6) goes low, locking a latching flip-flop formed by gates 1 and 2 of IC6, a CMOS NAND gate. This latch allows the output of an astable multivibrator to go to the trigger input of the 4017 and to start the automatic sequencing. The reset button makes the input of one of the gates go high, unlatching the flip flop and resetting the display. The small preset varies the clock rate over a wide range, speeding or slowing the sequencing.

If desired, a 'Display PCB' can be designed to ease the LED wiring. When the circuit is known to be functioning correctly, lines can be painted onto the display to join up the LEDs, and to make them appear as a 'picture'.

When all the LEDs are illuminated, the circuit will take a great deal of current, so a mains power supply is advised.

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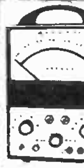

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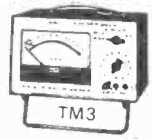

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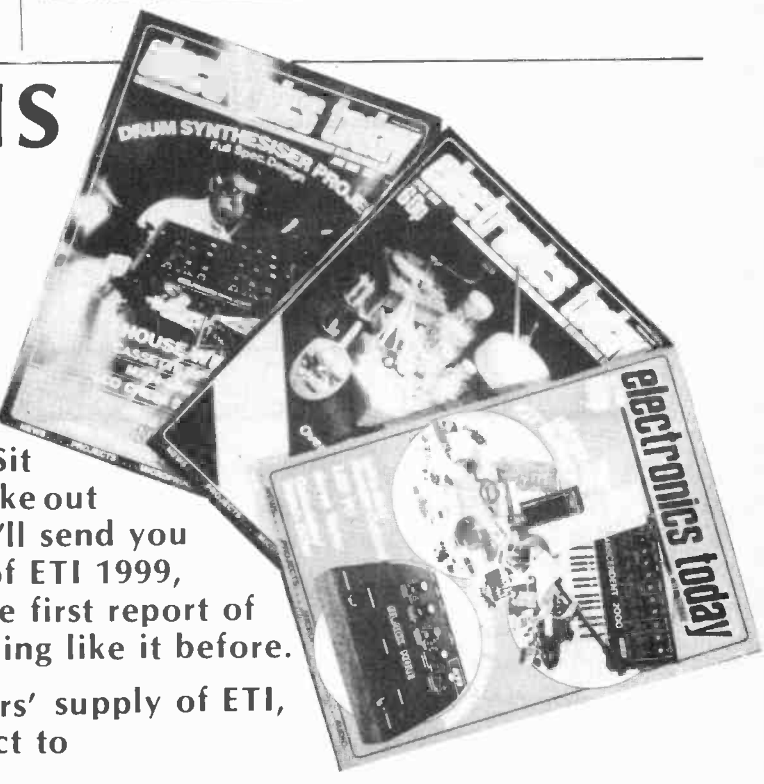

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RAVEN ON

Dave Raven of Metac Electronics reports on a revitalised Swiss watch industry and the programmer catastrophe.

To make a fortune in electronics is not an unrealistic ambition in the 1980's. It compares favourably with the earlier successes of entrepreneurs at the turn of this century, making fortunes from the boom in bicycles and then motor cars. Similarly, young dynamic companies have emerged all over the world feverishly setting up new businesses that are associated with the enormous boom in the microchip industry.

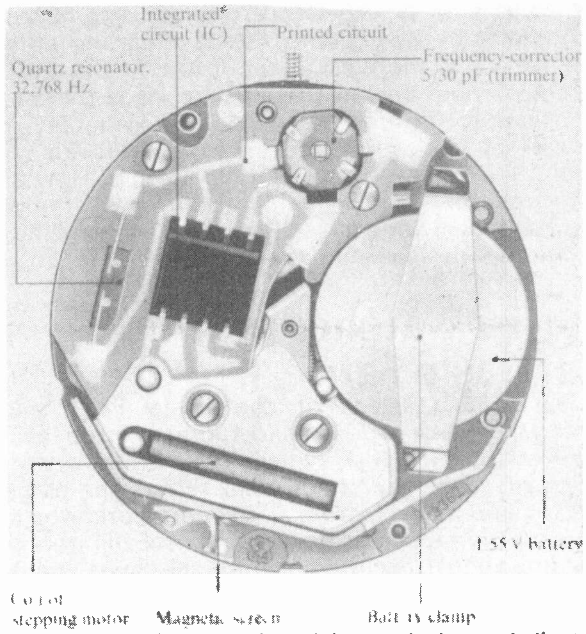
At this time of year students face a major challenge in the examination room which they perceive as directly affecting their future careers. With the right results at hand the next task is to start selecting a suitable job with prospects for the future. If electronics and cash are the big motivators, then much thought must be given, since some areas of this industry will in the next decade be prepared to part with larger sums than others. Supply and demand is still the order of the day, even in science, and if cleaning ladies are in short supply then they will command a higher salary than say a PhD Physicist.

The increasing popularity of microcomputers has placed industry on a direct collision course with a major obstacle. With some careful planning now our intrepid students may find this rich in rewards by the mid 1980's. A software crisis large enough to slow down the whole business of microcomputer expansion is looming high over the horizon. The simple arithmetic which can confirm this shows that although the numbers of microcomputer designs is increasing by 30% a year the cost of implementing the designs will double. In the USA it has been estimated that by 1990 they will require at least one million software engineers and since the electrical engineers graduating at present can be numbered in only thousands it is described as a "programmer catastrophe".

In addition to the limited educational system which is seen as a further major contribution to the potential software crisis, the cost of developing software is also seen as having serious consequences. The cost of purchasing the hardware is expected to change little since this reflects the increased memory capacity of the microchips. However, software costs have risen dramatically. The alternative open to the semiconductor giants is to develop more complex microchips which contain software packages within. Thus a programmer can reduce the time taken to assemble his software. This is similar to the developments of earlier circuit designs which have progressed from single discreet transistor design to designing with complex blocks of circuits. The cost of these new developments are enormous and only a few very large manufacturers can undertake projects on this scale.

Microchip R & D

In the USA the Department of Defence have decided to implement a 200 million dollar programme for the development of very high speed integrated circuits (VHSIC). This money will be granted to companies in private industry to make it easier for them to build the advanced chips the military need and to stimulate the development of "integrated systems". Other American companies such as Intel will spend up to 150 million dollars on capital equipment in 1980 as part of their "integrated systems" programme. For the next decade or so I sincerely hope we don't have cause to fall out with the Americans since, as the decline of our own ability to fabricate microcircuits continues, we will be less able to compete in the manufacture of industrial equipment without supplies of devices from the USA.



The new quartz analogue watch modules now look very similar to their digital counterparts. Typical thickness for these models is about 3.9 mm. Swiss companies have a great deal of experience in producing these and it will present a major challenge to Japanese and Hong Kong assembled watches.

Whilst other major industrialised countries are sinking cash into research programmes the UK Government have just announced that they intend to resist pressure for further state aid. The micro-electronics Industry Support Programme has been cut (not increased) from £70 million to £55 million over a five year period. Also the microprocessor Awareness Programme has retained its budget of £55 million over a three year period. This total cash is less than one medium sized USA company will spend on R & D during the same period. As for spending £55m on making people aware of micro-electronics I would have thought that regular reading of the electronics Press in the UK and USA would wake people up sufficiently to what is happening. This would of course be a lot cheaper and the real spending should be done on making devices. I suspect that most of this money will be spent on making up for the lack of technical education and ignorance that results from the narrow curriculum of the schools and universities where many of the nation's leaders spend their youth.

→

It is easy to grow cynical on matters which are not every day problems to government. However, I am personally convinced that urgent attention must be given to our country's future role in electronics. The solution to our avoiding a software crisis and indeed an industrial crisis in Britain lies here within our shores. We can very soon find plenty of aware people if the cash is available to support them. Personalities like Derek Roberts who currently heads the GEC Hirst Research Centre and John Bass from Plessey, to name but two individuals, must have quite a lot of experience in organising microchip development between them. Instead of carting parties of TUC officials to the West Coast of America in search of awareness about how microchips are made they should take a bus to Towcester, Swindon or Wembley. Here they will see just as much technology and its all British. Forget Inmos factories in Colorado Springs. How about setting up something twenty minutes from Heathrow Airport or at least within easy distance of some of the best microcircuit designers in the world, here in England.

Swiss watches return at Basle Fair.

The annual event of the Basle Fair, held in Switzerland each Spring, incorporates probably the largest exhibition held anywhere in the world for watches and clocks. This very traditional fete is the assembly point for watch buyers from all over the world who place orders for their full year's requirements. Exhibitors at the show are almost exclusively from the Swiss Industries with just a smattering of other European companies. Walking through the lavish exhibits of such famous names as Omega, Tissot and Rolex it was very hard to believe that the Swiss watch industry had just emerged from five years of nightmare competition. This of course was a result of the enormous increase in quartz electronic watches during this period.

The sudden arrival of LED and then LCD watches and the continued rapid developments of microchip technology produced shock waves which must have threatened the existence of many of the smaller watch producers. Hong Kong, who were at the very heart of this watch revolution, increased their market share in watches from being a net importer of watch modules from Switzerland to becoming the world's largest watch exporter and in terms of value of watch exports they now rank third.

The way in which the Swiss watch manufacturers operate must have considerably altered in the past five years, with a number of mergers and trading agreements taking place. The saving grace, however, seems to be the Swiss watch manufacturers' strong financial resources and also their ability to withstand change and rapidly learn new techniques.

The presentation by manufacturers at Basle for both digital and analogue display watches was of a very high standard. My biggest surprise, however, came from the strong contingent of quartz analogue watches. These models, which I previously thought were extinct, have risen once again in quite a different form. The first impression was that this was confirmation of the demise of the Swiss watch industry. Then after closer inspection I realised how much slimmer and neater these little beasts looked. I was left in little doubt that these will be well received in the watch market place despite my own prejudices towards mechanical displays. I feel their

New generation of quartz LCD Watches. Sabre Alarm Chronograph uses standard watch cells and measures only 3.9 mm thickness.

popularity stems from the neater, cleaner looking design and also this new slimline case, which dispels the cause for much complaint in the past. Also quite a number of people, particularly those over a certain age, experience difficulty in seeing the digital display without spectacles. My additional suspicion for the strong emergency of quartz analogue was that the Swiss were probably struggling to keep up with the current level of high technology in the digital quartz. This was also quickly dispelled, I am pleased to report, since the electronic varieties were every bit as advanced as anything yet seen coming out of the Far East.

Quartz analogue watches deserve some further mention in particular because of the technical achievements which have occurred during their redevelopment. The Swiss have of course a long tradition in the manufacture of traditionally designed watches and they also have a large number of credits for new development work in the manufacture of watches. It was here that the thinnest watch ever made was produced in 1975 (1.2 mm). Its conception was quite revolutionary and was described at the time as defying the logical laws of watch mechanics. This same company incidentally has been taken over this past year by one Japanese company called K. Hattori, who, you may or may not know, own the brand name of Seiko.

On the new technology front, Bulova announced their rather unusual watch which drives its energy from the body's own heat. A voltage produced from the thermoelectric elements is transformed through a sophisticated electric circuit to the required voltage necessary to operate the watch. On attaining the required level of voltage, this energy is directed towards an accumulator, which is in effect a rechargeable battery. The average body temperature of 37°C delivers at the case back more than 1000 uW of "heat" power. The power consumed to operate a typical quartz wristwatch containing a tiny battery is approximately 2 uW. the device that Bulova has perfected receives from the thermo-generator approximately 8-12 uW. Therefore, the electric energy produced is four to six times greater than that which is consumed in operating the watch.

One other Swiss company in strong evidence was Buler, whose range of ultra slim analogue and digital models will certainly be serious competition for the Japanese quality watches. The new twelve digit quartz electronic model from Buler must be the most advanced module coming on the market this year and will further increase the market share for Swiss-made electronic watches.

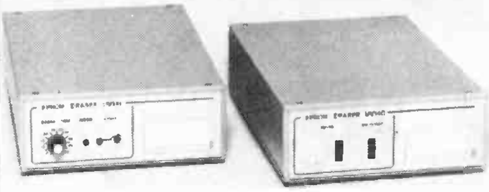
ETI

Greenbank

Greenbank Electronics
(Dept T1E) 92 New Chester Road, New Ferry
Wirral, Merseyside L62 5AG
(Tel: 051-645 3391)

TERMS. VAT. CWO. Cheques etc payable to Greenbank Electronics and crossed. Add VAT to all prices at 15% except where stated otherwise. Post etc: UK 35p (+5p VAT = 40p) per order. Export: NO VAT but add 35p (Eire). 75p (Europe) and £2.50 elsewhere. Access. Barclaycard. Visa. telephoned orders accepted. (Polys. universities. govt depts. etc can telephone their orders for immediate despatch on account.)

UV EPROM ERASERS



Two easy to use units designed for both the professional and amateur UV-prom user.

Features:

- Can erase up to 14 proms.
- Special short wave ultraviolet tube.
- Erase time variable between 5 and 50 minutes in 5 minute steps (preventing pver exposure which may shorten prom life).
- Sliding tray carries proms on conductive foam.
- Safety interlock switch prevents the timing circuit from operating and switching on the tube with the tray open.
- "Mains on" and "Tube On" indicators.
- Smart textured case.
- Complete instructions supplied.

Supplied complete with mains plug and flex.

Model UV141. Price £77.70

Also available without timer as

Model UV140: Price £61.20

PROM WASHING SERVICE: 50p each prom

COMPUTER BOARDS

The following is an extract from our leaflet ref. 'MP4', which is available free on request (a 9" x 6" SAE helps, but is not essential). See Microprocessor section to the right for board prices.

For many people the wide choice of micro-processors now available presents a difficult choice. To understand any particular microprocessor in depth a development system is almost essential, however in the past to understand more than one several separate development systems have had to be purchased.

The reason that separate systems, one for each processor, have been necessary is due to the fact that individual microprocessors have their own individual features in one case to access memory a separate read strobe and write strobe is required, in another a 'read/write' line is used in combination with a combined strobe called 'valid memory address and phi-2'. With some processors, the same address bus can be used for both memory and 'input/output ports', under the control of a 'memory request' or an 'input/output request' control line.

Naturally, if a development system takes advantage of any of the particular unique features of any particular microprocessor, this makes it more difficult to graft some other unrelated microprocessor onto the same bus at a later date.

A Universal Micro System provides a basic bus structure on which any one micro-processor can be connected. The system uses a CPU (Central Processor Unit) card which is separate from the rest of the system, and this allows the same memory and interfaces to be retained when a different MPU is used.

The basic system bus consists of data and address buses together with read and write strobes. By locating the data input (Keyboard) and output (VDU) in the memory space then such chips as the 8080/Z80 family, which normally use input/output ports, can now be used without any fundamental change to the bus (and as a bonus, users of these MPU's have all the ports entirely free for their own purposes).

The range of p.c.b.'s includes boards to implement a memory-mapped VDU, cassette interface, keyboard interface, PROM programmer, and a number of RAM and ROM cards. All the cards are of International Size 114 x 203 mm (4½" x 8") except for the larger power PSU A power supply card. This latter card is sized so that it can be bolted to the side of a standard 4" chassis module which is then compatible with the other cards. The cards have a standard 43-way edge connector, with one position used for polarisation.

We do not propose to defend the (relatively) small ... er of bus connexions (42), against such standards as the 'S100' ... bus. The S-100 bus, as it originated in America, is bigger a... re expensive. In the same way, a Ford 'Granada' i... rd 'Cortina', but it doesn't mean a Cortina ... ws — it may even be better value!

The Inte... t '3U' 19" rack ... nd a variety of ... stomising their ... the firm 'R.S. ... ity.) ... to compete ... e purchaser ...) assembly ... computer ... virtually ... ider ... The ... nt. You choos... will be used, ... 's, or indeed ... s not permit y... re to offer guic... our needs, in ... As mentio... he design of ... e arrangemen... e obsolete ove... have been pro... pattern which ... Often these car... decoding. An ex... regulator, or gat... 'Input/Output Re... already have this facility.

NEW! 'ISBUS-1.1'

Low-cost commercial quality computer back board, 13" x 4 3/8" approx, for the International Standard (114x203mm) cards. Although intended for the 86-way double sided connector, it can be used with the 43-way connector specified for the computer boards we advertise. (Pin 37 is used for polarisation.) Takes up to 13 cards on 1" centres, and provides for 4 power rails, 58 parallel address/data etc. bus lines and 3 'daisy chains'. Epoxy glass, tinned, price £11.50 More details in our free leaflet 'ISB-1/1'. Existing enquirers. Note Leaflets have been delayed, but will follow soon

Of course we know ... uld faint clean away at the thought of cutti... ing extra integrated circuits and bits of wire in the ... e, but it is not for these people that this sort of system has ... u. We would like to think of this system as basis on which you c... uild your own personal design, perhaps as an alternative to the use of 'Veroboard' or etching your own pcb's.

(Further sections give an outline of each card in turn. Although we have in mind all sorts of exotic future developments (e.g. high resolution graphics, floppy disc controllers, dynamic high-density RAM cards, programmable VDU formats, colour displays, Light pens, sound generators etc.) we prefer to keep quiet about them until they actually exist. All of the cards described actually exist, and at the time of writing (September 1979) most are in stock. (We plan it so they are all in stock, but people will insist on buying them, without caring what havoc they wreak in our stock control!!)

CMOS

These cut prices for Amateur Users and Export. Note: industrial users — quantity prices available. Mostly Motorola, RCA

4000	18p	4042	80p	4096	95p	4451	£3.81	4549	£4.38
4001	25p	4043	90p	4097	£3.40	4461	£3.93	4562	£14.85
4002	25p	4044	90p	4098	£1.20	4462	£4.41	4553	£4.50
4006	95p	4045	£1.45	4099	£2.00	4490FP	£4.20	4554	£1.38
4007	18p	4046	£1.10	40100	£2.20	4490VP	£3.14	4555	78p
4008	80p	4047	£1.00	40101	£1.32	4500	£6.95	4556	72p
4009	40p	4048	55p	40102	£1.80	4501	29p	4557	£3.86
4010	50p	4049	45p	40103	£1.80	4502	£1.20	4558	£1.25
4011	25p	4050	49p	40104	99p	4503	70p	4559	£4.38
4012	18p	4051	80p	40105	99p	4505	£5.71	4560	£2.50
4013	50p	4052	80p	40106	90p	4506	50p	4561	81p
4014	84p	4053	80p	40107	60p	4507	55p	4562	£5.60
4015	84p	4054	£1.50	40108	£4.70	4508	£2.90	4566	£1.59
4016	45p	4055	£1.25	40109	£1.00	4510	99p	4568	£2.38
4017	80p	4056	£1.35	40110	£3.00	4511	£1.50	4569	£2.50
4018	89p	4059	£6.00	40114	£2.50	4512	80p	4572	40p
4019	45p	4060	£1.15	40181	£3.39	4514	£2.65	4580	£4.77
4020	99p	4062T	£10.00	40182	£1.40	4515	£3.00	4581	£2.62
4021	£1.10	4063	£1.20	40192	£1.40	4516	£1.10	4582	£1.14
4022	£1.00	4066	55p	40193	£1.40	4517	£4.46	4583	90p
4023	27p	4067	£4.50	40194	£1.18	4518	£1.00	4584	90p
4024	50p	4068	27p	40257	£1.48	4519	80p	4585	£1.27
4025	27p	4069	27p	4160	98p	4520	£1.00	4597	£2.44
4026	£1.30	4070	30p	4161	98p	4521	£2.50	4598	£2.98
4027	50p	4071	25p	4162	98p	4522	£1.11	4599	£6.95
4028	84p	4072	25p	4163	98p	4526	£1.08	4700	£1.75
4029	99p	4073	25p	4174	90p	4527	£1.50		
4030	55p	4075	25p	4175	£1.15	4528	£1.20		
4031	£2.00	4076	£1.07	4194	£1.16	4529	£1.30		
4032	£1.31	4077	29p	4408	£9.37	4530	70p		
4033	£1.80	4078	29p	4409	£9.37	4531	£1.45		
4034	£2.00	4081	27p	4410	£8.55	4532	£1.30		
4035	£1.10	4082	27p	4411	£10.72	4534	£5.60		
4036	£2.95	4085	74p	4412VP	£14.93	4536	£3.69		
4037	£1.15	4086	72p	4415V	£5.24	4537L	£26.10		
4038	£1.20	4089	£1.38	4422	£5.66	4538	£1.20		
4039	£2.95	4093	80p	4433	£12.30	4539	97p		
4040	£1.00	4094	£2.50	4435V	£5.40	4541	£1.19		
4041	80p	4095	95p	4450	£3.81	4543	£1.80		

74C

		74C76	81p	74C163	£1.72	74C904	85p	74C926	£7.26
		74C83	£1.94	74C164	£1.62	74C905	£10.89	74C927	£7.26
		74C85	£1.94	74C165	£1.62	74C906	85p	74C928	£7.26
74C00	33p	74C86	96p	74C173	£1.35	74C907	85p	74C929	£17.90
74C02	33p	74C89	£6.57	74C174	£2.27	74C908	£1.44	80C95	85p
74C04	33p	74C90	£1.28	74C175	£1.27	74C909	£2.45	80C96	92p
74C08	33p	74C93	£1.28	74C192	£2.59	74C910	£10.17	80C97	85p
74C10	33p	74C95	£1.56	74C193	£1.72	74C911	£10.69	80C98	92p
74C14	£2.12	74C107	£1.83	74C195	£1.62	74C912	£10.69	82C19	£6.20
74C20	42p	74C150	£5.72	74C200	£10.17	74C914	£2.12	88C29	£2.90
74C30	42p	74C151	£3.06	74C221	£2.17	74C915	£1.72	88C30	£2.90
74C32	42p	74C154	£5.72	74C373	£2.69	74C918	£1.59		
74C42	£1.38	74C157	£3.30	74C374	£2.69	74C921	£17.07		
74C48	£2.07	74C160	£1.72	74C901	85p	74C922	£5.49		
74C73	81p	74C161	£1.72	74C902	85p	74C923	£5.60		
74C74	72p	74C162	£1.72	74C903	85p	74C925	£7.26		

MODULATORS

UM111: E36 UHF Ch.36 Vision Modulator £2.50
UM1231 UHF Ch.36 Vision Modulator wide handwidth (for computers etc.) £4.70
UM1263 FM Sound Sub-carrier Modulator £2.50

SWITCH MODE PSUs

AC 5221S 5V/10A	£69.90
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AC 5421S 5V/20A	£99.20
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114 x 203 mm fibreglass, with gold plated edge connector.

Buffered SC/MP CPU	£9.40
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VDU 'B' } of	£8.90
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EPROM Programmer (2708s)	£9.40
4k PROM board (5204s)	£9.40
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2k RAM board (2102s) 1k-2k	£9.40
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TAPE interface	£8.90
Keyboard Interface	£8.90
PSU 5v. + 12v. −12v board	£8.90
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Further details on request

Z80

Z80 CPU (2½MHz)	£9.90
Z80-CTC (2½MHz)	£5.95
Z80-P10 (2½MHz)	£6.60

(Add £1 for the 4MHz version of any of the above 3 chips.)

SC/MP 11 RAM 1/O

SC/MP II (4MHz)	£8.82
INS 8154 RAM I/O	£8.18

6800

6800 MPU	£6.55
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6850 ACIA	£3.08
MC6880	£2.64

6502

6502	£12.00
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COSMAC CDP 1802CE	£9.85
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CDP 1864	£7.25

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2114L—1K x 4	£5.50
4118—1K x 8	£20.99

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MK 4116 16K 250nS	£4.95
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2708 1K x 8	£6.75
2716/2516 2K x 8 single 5v	£17.95
.2532 4K x 8 (5v)	£47.00

PROMWASHING each Prom 50p (+30p + VAT)

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UV140	£61.20
UV141	£77.70

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81LS95/6/7/8	£1.40*
75491 LED driver	50p
75492	92p
ZN425	£3.95
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IL74	48p

MOSTEK VDU BOARD

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CRT Controller: Uarts

Thompson CSF SF.F96364E	£11.50
AY-5-1013 UART TR 1602	£4.00
AY-5-1013A	£4.70
AY-3-1014A	£5.60
AY-3-1015	£5.60

CHAR. GEN. KEYBOARD ENCODER

MCM 66760	£9.75
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RO-3-2513 (5v Uppercase)	£6.00
DM 8678 CAB/BWF	£14.27
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2K Tiny Basic for Z80 (2 x 2708)	£25
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KITBUG MM (1 x 2708)	£19.95
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7805	75p
7905	£1.08
7812	97p
7912	£1.08
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60 KHz	£9.95
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2.097152 MHz	£3.23
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2.500 MHz	£3.92
2.56250 MHz	£3.62
3.000 MHz	£3.62
3.2768 MHz	£3.23
3.579545 MHz	£1.95
3.93216 MHz	£3.92
4.000 MHz	£2.90
4.032 MHz	£3.23
4.096 MHz	£3.23
4.194304 MHz	£3.23
4.433619 MHz	£1.25
4.608 MHz	£3.23
4.800 MHz	£3.23
4.915 MHz	£3.23
5.000 MHz	£3.23
5.0688 MHz	£3.23
5.120 MHz	£3.23
5.185 MHz	£3.23
6.000 MHz	£3.23
6.144 MHz	£3.23
6.400 MHz	£3.23
6.55360 MHz	£3.23
7.000 MHz	£3.23
7.168 MHz	£3.23
7.680 MHz	£3.23
7.86432 MHz	£3.23
8.000 MHz	£3.23
8.388608 MHz	£3.23
8.867237 MHz	£3.23
9.375 MHz	£3.92
9.800 MHz	£3.92
10.000 MHz	£3.23
10.245 MHz	£3.23
10.700 MHz	£3.23
10.92 MHz	£3.92
11.000 MHz	£3.92
12.000 MHz	£3.92
14.0 MHz	£3.92
14.31818 MHz	£3.23
16.000 MHz	£3.92
18.000 MHz	£3.23
18.432 MHz	£3.23
20.000 MHz	£3.62
20.1134 MHz	£3.23
27.0 MHz	£3.92
27.648 MHz	£3.92
38.6666 MHz	£3.23
48.000 MHz	£3.23
100.000 MHz	£3.23
116.000 MHz	£3.23

VEROBOARD
0.1" Pitch with copper strips

2½"×1" (pack of 5)	74p
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3¾"×3¾"	62p
3¾"×5"	69p
3¾"×17"	£2.40
4.7"×17.9"	£3.14

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3¾"×2½"	38p
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3¾"×17.0"	£1.56
Terminal pins	£1.50/500
V-Q DIP board	£1.17
DIP breadboard	£2.91
Spot face cutter	93p
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SOLDERCON PINS
100 50p 1000 £3.95

DIL SOCKETS
8/14/16 pin 10p/12p/13p
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24/28/40 pin 30p/40p/50p
24 pin Textool lever type zero insertion force £8.50

TIMER ICs
NE555/556 29p/49p

OP-AMPS (All Mini dips)
CA 3130E 84p
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4 DIGIT LED DISPLAY
Multiplexed, common cathode, prime quality.
NSB 3881 (0.3") £4.25

LED DISPLAYS
DL-704E 99p
DL-727E/728E £2.00
DL-747E/750E £1.80
FND 500/560 £1.20

LIQUID CRYSTAL DISPLAY
4×0.5" Digits 40 pin DIL £9.95

CLOCK CHIPS
AY-5-1224A £2.60
MK 50253 £5.50
MK 50366 £6.50

SIX DECADE COUNTERS
MK 50395/6/7 £9.90
MK 50398/9 £7.50

DATA

Note: in this section all data books are subject to 0% VAT. For postage see 'Terms' at top of page.

113 page Electronic Projects Index 72-77 (North Tyneside Libraries)	£1.50
c650 page COSMOS Databook (RCA)	£4.95
c31 page 'A Guide to SC/MP Programming' by Dr. Drery (Kemitron)	£3.75
c20 page 'A Guide to Kitbug' (Kemitron)	75p
c24 page NIBL Reference Guide (National)	£3.45
Data for 4116 (Mostek)	50p
c6 page data for Mk 4118	25p
16-page data for IMS 8154 (ISP-8A/650) (National)	50p
20-page data for SC/MP II (National)	50p
c100 page CDP 1802 MPU User Manual (RCA)	£4.50
c45 page Fixed Point Binary Arithmetic Routines for COSMAC	£4.50
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c21 page COSMOS Digital Integrated Circuits (RCA)	75p

REVISED Z80 DATA PACK £14.95
The contents of this data pack have changed. It now includes data in bound volumes, and also covers some other microprocessors as well. Regrettably the books cannot be supplied separately, as we are forced to buy the packs complete. Contents:
c275-page Z80 Programming Manual
c525-page Microcomputer Component Data Book
c25-page Z80 Micro Reference Manual (pocket size)
c130-page Microcomputer Systems Data Book

c50-page Finite State Fantasies (Cartoons putting programming on human level) (Matrix Press)	£2.00
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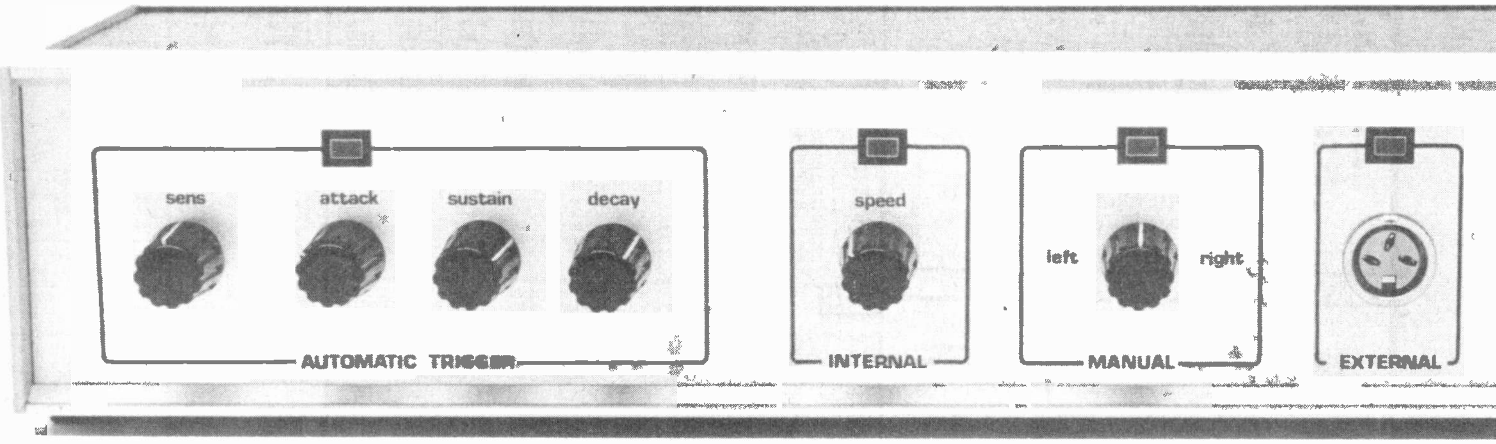
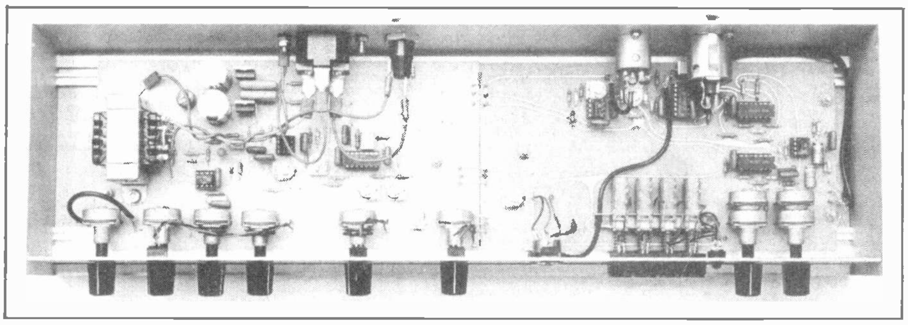
STEREO IMAGE CO-ORDINATOR



Following his article on the 1537A VAC, Keith Brindley comes up with a complete application using this most resourceful chip.



Perhaps an explanation is required! What, you may ask, is a Stereo Image Co-ordinator? Briefly it's a panning control – simple? – well, not so simple. Panning is an effect whereby you apply a single mono sound source and derive two independent adaptations of that original sound, which together form the inputs to a stereo (or 2 x mono) amplifier. By varying the amplitude of these two adaptations, the stereo image they produce can be altered providing an apparently moving sound source. It is an effect used quite often in recording studios usually with modern rock and pop music. Commercial units are now available (though not as effective or as good as the ETI Stereo Image Co-ordinator), which produce the effect live, for stage work, but in the past panning has been predominantly a studio technique.

Not Only But Also

The ETI Stereo Image Co-ordinator produces the usual effect of panning using a manually turned pot, but added to this are the exclusive facilities of automatic control over the image produced. The use of these facilities obviously allows the musician to concentrate on the music rather than the equipment.

Control over the stereo image is provided by four methods:

Manual – a single pot positions the image wherever required.

Sweep – the image is swept from one channel to the other at a variable rate, automatically.

Automatic Trigger – the instant a note is played or sung the image is swept from one side to the other at a completely variable rate.

External – control is accorded by an externally applied voltage eg from a foot pedal.

The unit utilises the 1537A Voltage Controlled Attenuator which as ETI readers will know is the high quality (good enough for studio applications), recently introduced, integrated circuit for VCA use. All other active components used in the audio section of the circuit are high quality, low noise types which coupled with the considerations of careful PCB design should allow the builder to construct a device which is at home in the studio as well as in live stage work.

This box of tricks gives you the opportunity to try out what has up to now been an effect used predominantly in the studio. The stereo sound image can be controlled automatically or manually. You can position the image in one place and keep it there or continually sweep the image between channels .... and more.

Any input signal within the range 10 mV to 10 V AC should successfully operate the device, although obviously the best signal to noise ratios will be obtained with the larger values of input signal.

The overall signal gain of the Image Co-ordinator is approximately 6 dB, which allows for a unity gain output signal when the level pot is at approximately three-quarters of its rotation.

Construction

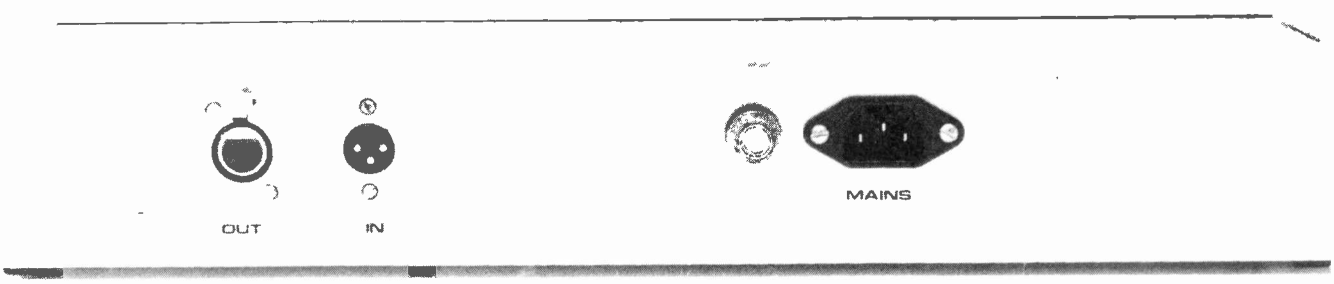
The project consists of two printed circuit boards which together hold all components, switches, pots, etc apart from the nine LEDs. This makes construction a proverbial "doddle" and ensures high standards and a good chance of first time success.

Roughly speaking, the, right hand board includes all components to the right hand side of the circuit diagram and similarly the left hand board includes all left side components. The left hand board also contains the PSU.

PCB mounting pots and switches are used throughout eliminating the use of flying leads, therefore cutting down the possibility of pickup in the audio section. Any jumpers or wires only carry DC control voltages or power and are, therefore, of no problem. There is one exception, however, and that is the connection between the Auto Trig output on the right hand board and the Auto Trig input on the left hand board. This should be screened lead taken neatly, either under or over the boards, keeping it away from the PSU section.

The right hand board is double sided whilst that of the left hand is single sided with jump leads. Neither are too difficult to construct, although it is worthwhile when building up the project to construct each stage separately, testing as you go along eg start with the PSU then the automatic trigger, then the sweep, etc, etc. In this way any faults which develop can be traced to one particular area very quickly. Actually this constructional method is highly recommendable with any project! Test procedures are described in the section on Setting Up.

IC sockets are advisable though not necessary, likewise cermet presets, although more expensive, present easier setting up and a high quality than their cheaper carbon colleagues.



The simple layout of the rear panel -- mains in, signal in, signal out.

HOW IT WORKS

The main function of the unit is to create an impression of a stereo image from a single signal from a musical instrument. This is done by feeding the signal via IC4 (a quad op-amp) to 2 parallelled VCAs whose output amplitudes are controlled by an external control voltage. These VCAs form the output channels and are buffered by IC8a and b, providing drive for a stereo power amplifier. The stereo image is created simply by allowing the signal output from one channel to be greater than that from the other channel. The origin of the sound thus appears closer to the first side of the sound field than it does to the latter.

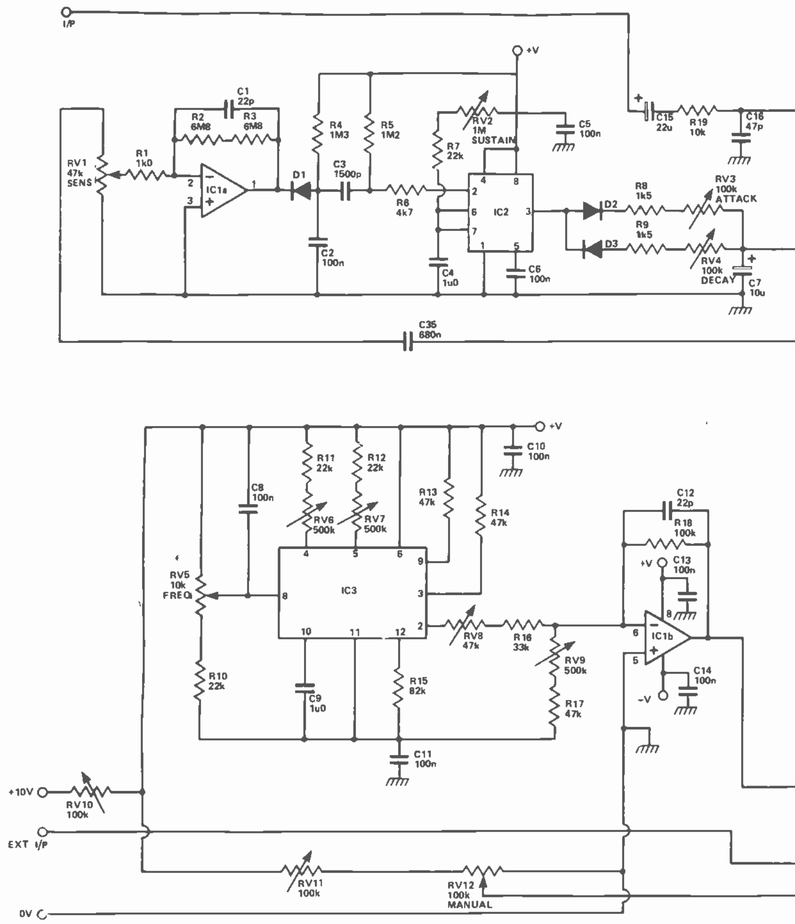
Interested readers who wish to know more about the VCA chips in question should refer to the March 1980 edition of ETI for a detailed discussion of the 1537A VCA.

IC5 provides phase split control voltages of 0 to −10 volts DC and −10 to 0 volts DC from a single input voltage of 0 to +10 volts DC. RV15 provides a depth control which simply limits the effect of the control voltages applied to the VCAs. IC5a inverts the DC control whilst IC5b inverts and also offsets it so that both outputs are in the range 0 and −10 volts, although 180° out of phase. IC5a also is a fairly high impedance buffer so as not to load the source.

SW1a gives selection of whichever source is required, there being three internal, sweep, manual and automatic trigger and one external method of controlling the stereo image. The corresponding LEDs are also switched in via SW1 allowing an indication of which function is in use at the switch and also at the function controls — see photographs. LED 1 is a special type of LED with an integral IC to provide an intermittent, flashing display. As this is in series with two other LEDs (2 and 6, 3 and 7, 4 and 8, or 5 and 9, dependent on SW1) then all three LEDs will flash on and off simultaneously.

External control of image is provided so that, for example a foot pedal can be used to control positioning of the applied signal within the stereo field. RV10 adjusts for various values of pots inside the pedal, although 100k lin is the nominal value.

RV12 acts as the manual pot in an identical fashion to an external control pedal pot but positioned on the front panel.



The signal switches which comprise SW1 a and b might be slightly difficult to get hold of so it is worthwhile taking your PCB along with you to make sure you get the right ones. Also see Buylines. Various other types are around but in our (dare we say it?) vast experience, these switches are by far the most superior for signal switches, which demand low resistance contacts and low noise levels. If you use the same push-fit knobs for the switches ie coloured transparent fronts you may like to do the same as us with the consecutive function marker LEDs and glue them into position inside the switch knobs so that the flashing indication is visible through the front of the switch. The square type of LEDs now available are ideally suited for this application. Alternatively the LEDs can be panel mounted vertically above the switch front. If LED 1, a flashing LED with integral IC, cannot be obtained an ordinary LED can be used in its place — but replace ZD1 with a suitable limiting resistor eg 560R.

The control marking LEDs should be positioned close to the corresponding controls in order that the user can clearly see which function is in use.

Finally use PCB pins for external connections so that when the two boards are fixed in their case side by side the nine links can be soldered into position along with input and output connections, without removing the boards.

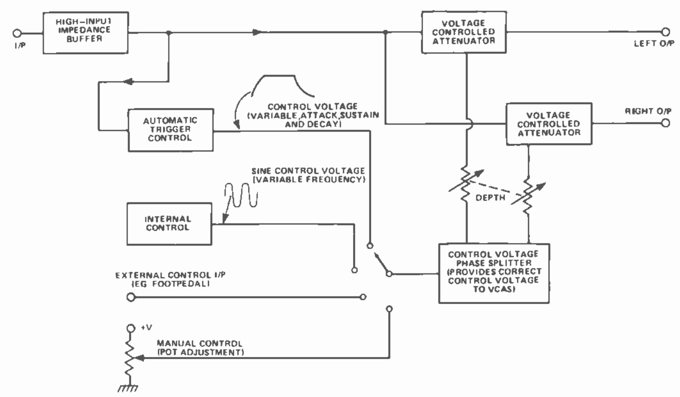


Fig.1. Block diagram of the Stereo Image Co-ordinator.

Setting Up

After the PSU section is complete, it can be tested to make sure that the correct supply rails, +15 V, 0 V and −15 V are obtained.

The components around the automatic trigger should be inserted next (R1–9, C1–7, IC1 and 2, RV1–4 and D1–3). This can be tested by applying an AC signal of about 500 mV at its input on the left hand board whilst watching the voltage across C7. (All four pots should be mid-position). This voltage should increase from 0 V to about +12 volts then after a short time decrease back down to 0 V DC.

The sweep generator circuit can be built up next (R10–18, C8–14, IC3 and RV5–9) and tested. Set all pots and presets to mid-position. The DC output voltage at pin 7 of IC1 should be a low frequency near sine wave oscillation approx-

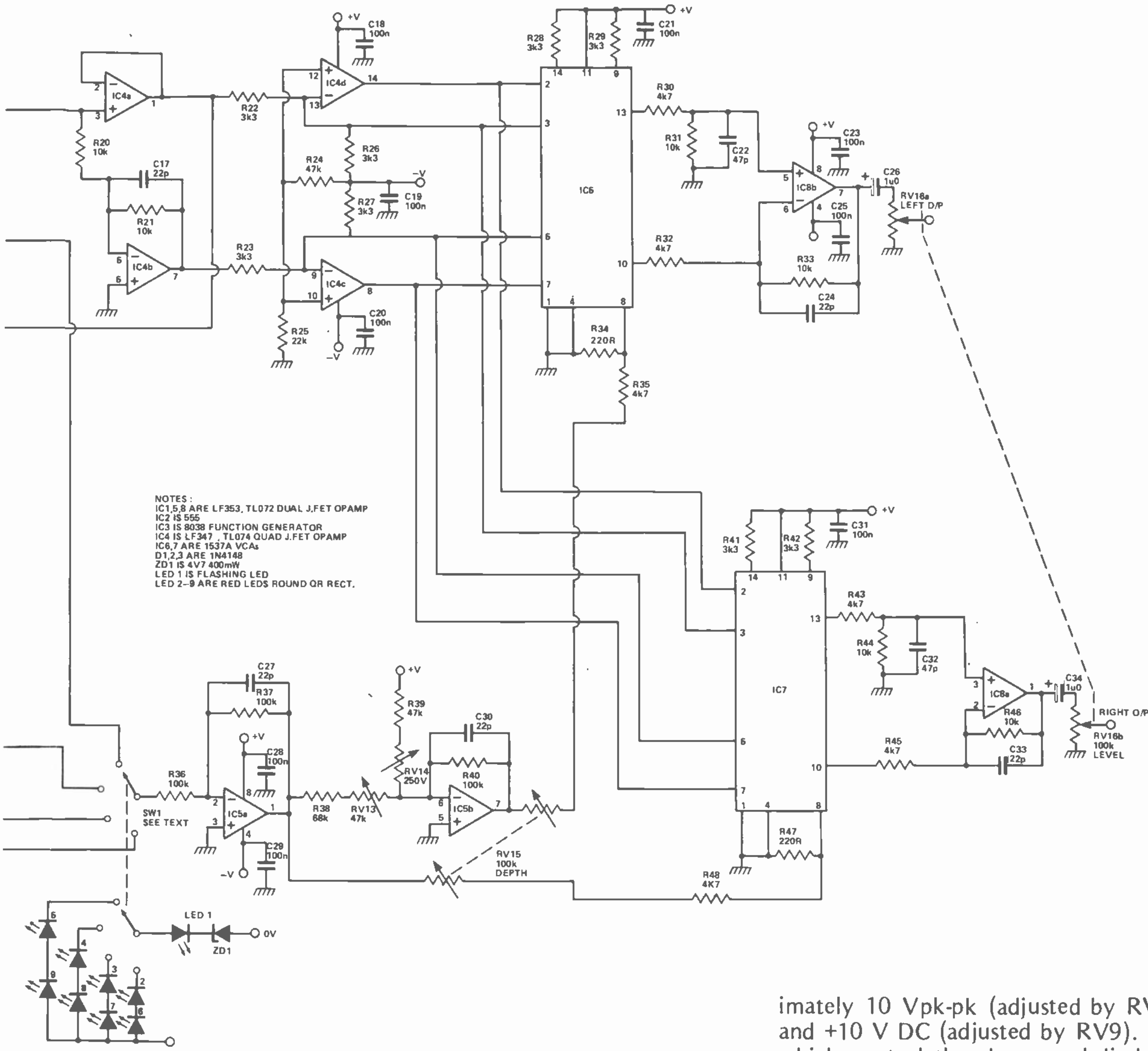
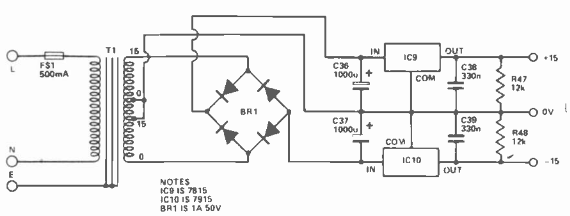


Fig.2. (left) Circuit diagram. Note the orientation of LEDs connected to signal switch SW1.

Fig.3. (below) Power supply producing +15,0,-15 volts output.



BUYLINES

The dual and quad op amps are available from the better mail order companies, if you cannot obtain them from your local stockist. Electrovalue supply the printed circuit mounting pots.

The signal switches were RS Components stock and these may have to be ordered through a retail stockist. They are worth the bother of obtaining.

The case is a West Hyde Developments type CL2CDJ. Finally the 1537A VCA chips can be obtained from Aphex Audio Systems UK Ltd., 35 Brittania Row, London N1 8QH.

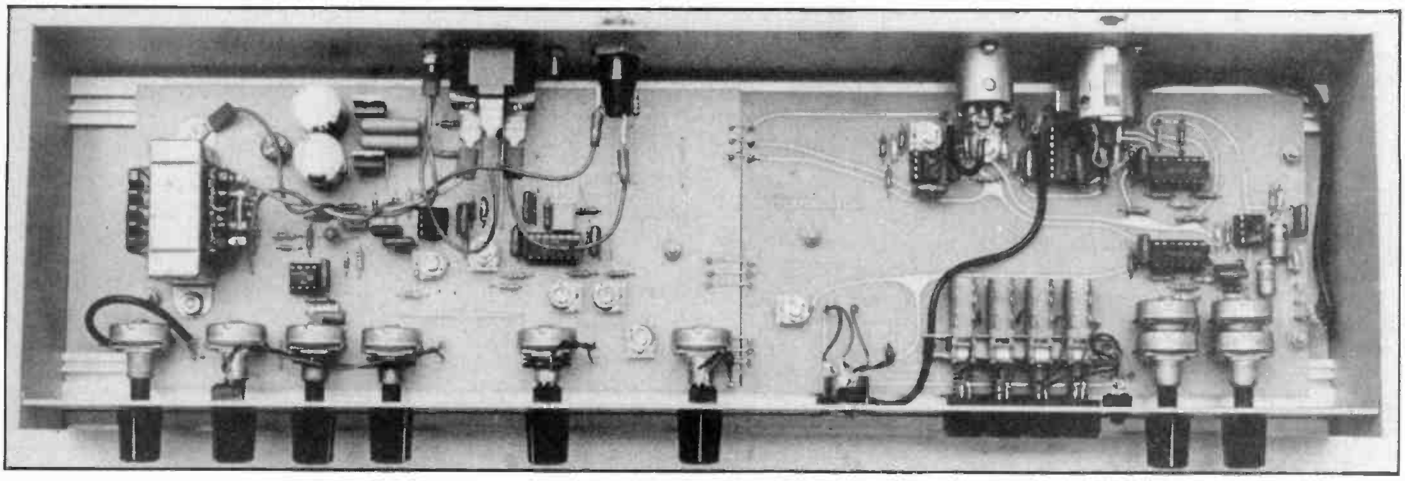
imately 10 Vpk-pk (adjusted by RV8 and varying between 0 and +10 V DC (adjusted by RV9). By altering RV6 and RV7 which control the charge and discharge rates of capacitor C9 (which in turn controls the overall frequency and shape) the best setting can be found whereby RV5 controls the frequency of the sine wave between approximately 0.1 Hz and 10 Hz. Fairly careful adjustment of these two presets is necessary and it is a distinct advantage if a scope is available with a slow time base so that the waveform can be studied for purest sine wave.

The manual control function circuitry is simple consisting of only two components RV11 and RV12. The DC voltage at the wiper of RV12 should vary between 0 and 10 V dependent on wiper position and is adjusted by RV11.

The external control circuit is equally as simple but an external pot is necessary in the shape of a foot pedal. RV10 adjusts for a wiper voltage of 0 to 10 V DC for different values of pot. Alternatively a control voltage of 0 to 10 V DC relative to chassis can be fed in from some external control circuit.

The control voltage phase splitter is next to be assembled and set up (R36–40, C27–30, IC5 and RV13,14). With a known input voltage of 0 to +10 V DC (derived best from the manual pot by pressing the manual switch and varying the pot) the voltage at pin 1 of IC5 should be 0 to –10 V DC the op amp being a simple unity gain inverter. The output at pin 7 should be the same size pk to pk (adjusted by RV13) but 180° out of phase ie –10 to 0 V DC (adjusted by RV14).

There is no further setting up to be undertaken so the rest of the circuit can be installed and testing of the whole job undertaken.



Construction should pose no problems. The two PCBs hold almost all of the components and controls.

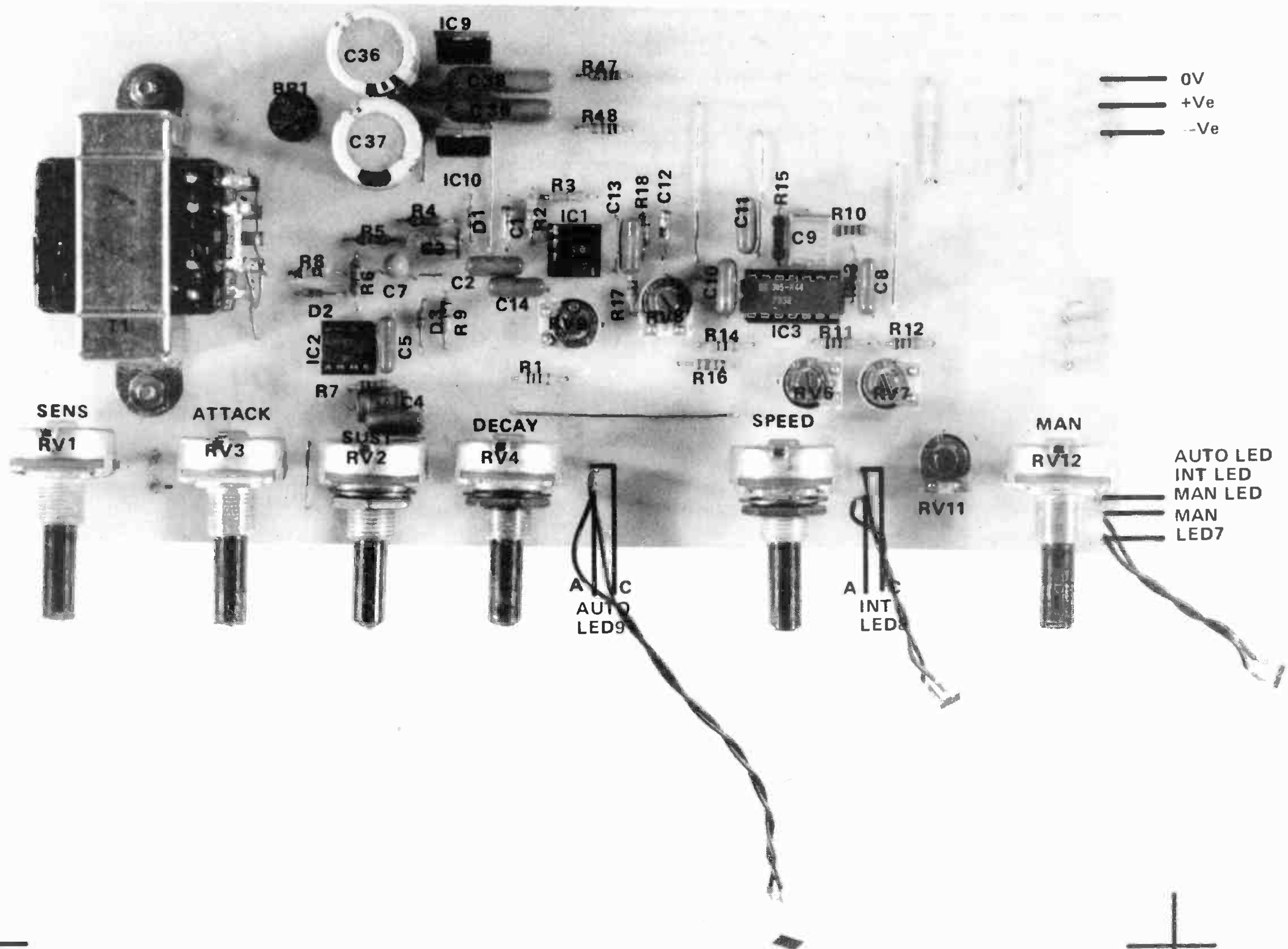


Fig.4. Component Overlay for the single sided board, which carries the power supply.

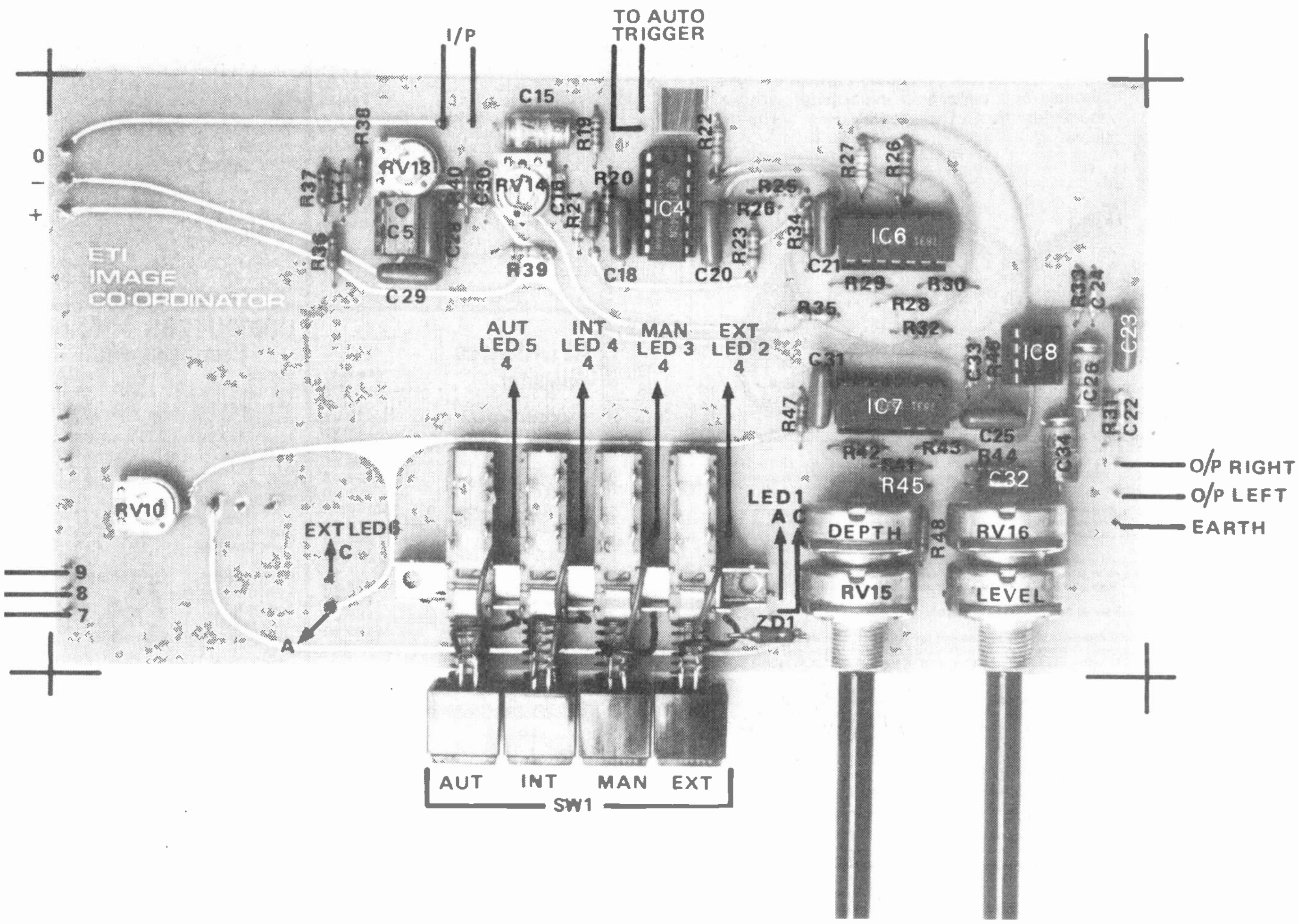


Fig.5. Component Overlay of the double sided board.

PARTS LIST

RESISTORS All ¼W, 5%

R1	1k0
R2,3	6M8
R4,5	1M2
R6,20,32,35,43,45	4k7
R7,10,11,12,25	22k
R8,9	1k5
R13,14,17,24,39	47k
R15	82k
R16	33k
R18,36,37,40	100k
R19,20,21,31,33,44, 46	10k
R22,23,26,27,28,29, 41,42	3k3
R34	220R
R38	68k
R47,48	12k

POTENTIOMETERS

RV1	47k log PCB mounting pot
RV2	1M0 lin PCB mounting pot
RV3,4,12	100k lin PCB mounting pot
RV5	10k lin PCB mounting pot
RV6,7,9	500k min horiz cermet preset
RV8,13	47k min horiz cermet preset
RV10,11	100k min horiz cermet preset
RV14	220k min horiz cermet preset
RV15	100k lin dual PCB mounting pot
RV16	47k log dual PCB mounting pot

CAPACITORS

C1,12,17,24,27,30,33	22p polystyrene
C2,5,6,8,10,11,13,14, 18,19,20,21,23,25,28, 29,31	100n polyester
C3	1500p polystyrene
C4,9,26,34	1u0 25V electrolytic
C7	10u 16V electrolytic
C15	22u 25V electrolytic
C16,22,32	47p polystyrene
C35	680n polycarbonate
C36,37	1000u 25V PCB electrolytic
C38,39	330n polyester

SEMICONDUCTORS

IC1,5,8	LF353, TL072 etc dual op amp
IC2	555
IC3	8038
IC4	LF347, TL074 etc quad op amp
IC6,7	1537A
ZD1	5V1 zener 400mW
LED 1	Flashing red LED
LED 2–9	Red LED
D1–3	1N4148

MISCELLANEOUS

SW1a and b	4 off push button signal switches 2 pole C/O + appropriate hardware (see text)
T1	15-0-15 6VA mains transformer
FS1	500mA fuse + panel mounting holder

Mains connector, input and output sockets case (see Buylines).

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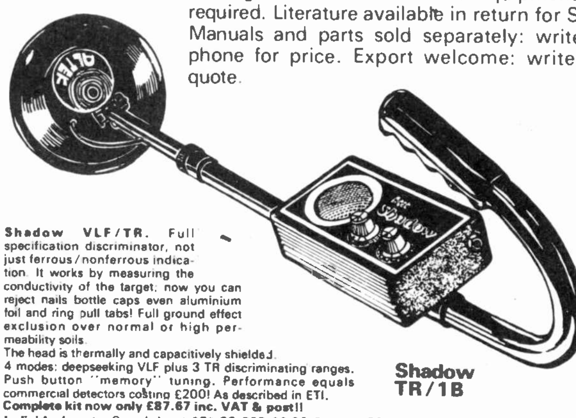

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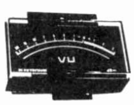

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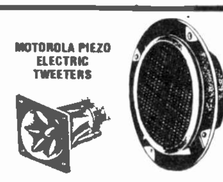

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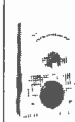

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Construction

Fit all the components except C3, which is fitted after testing. The board is designed to fit into a MK type 2140 surface mounting wall box. The LDR may be mounted into the blanking plate MK type 3827, as shown in Fig.2, or remote from the unit.

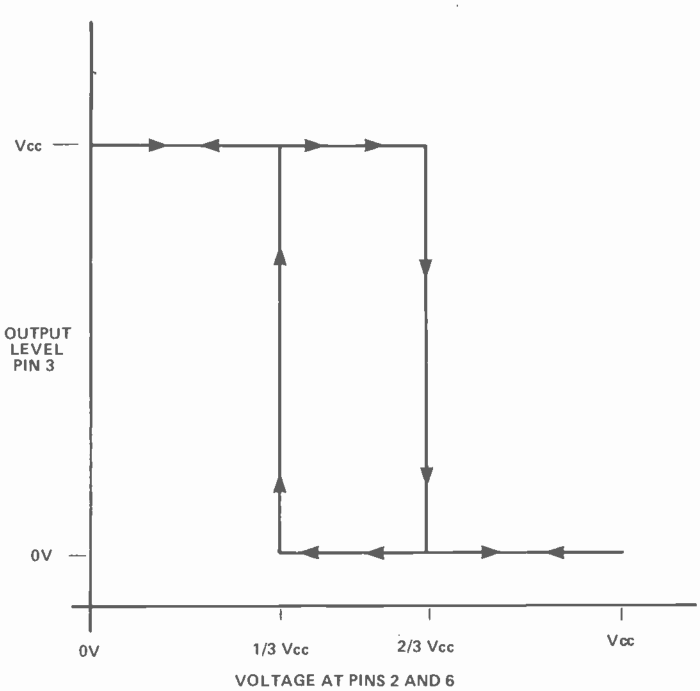

Fig.1. IC1 is used as a level dectector with hysteresis.

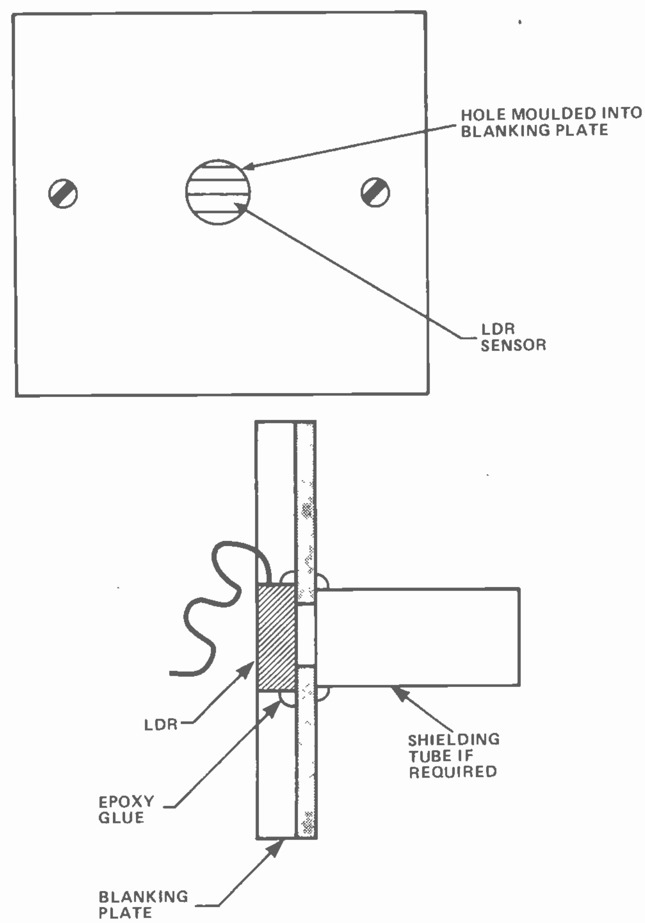

Fig.2. The LDR is mounted in the blanking plate (top). A shielding tube may be fitted if necessary (above).

Setting Up and Testing

Having built the board, check for solder splashes and dry joints. Set RV1 to mid-position, connect a lamp, the LDR and the mains. A WORD OF CAUTION, there is mains and rectified mains on the board, also the tab of the thyristor is connected to its anode. Be careful where you put fingers and voltmeter.

Now switch on. If the LDR is in a light area, nothing will happen. Darken the LDR and the lamp will light. Increase the light around the LDR and the lamp will extinguish. The exact setting of RV1 will depend on the

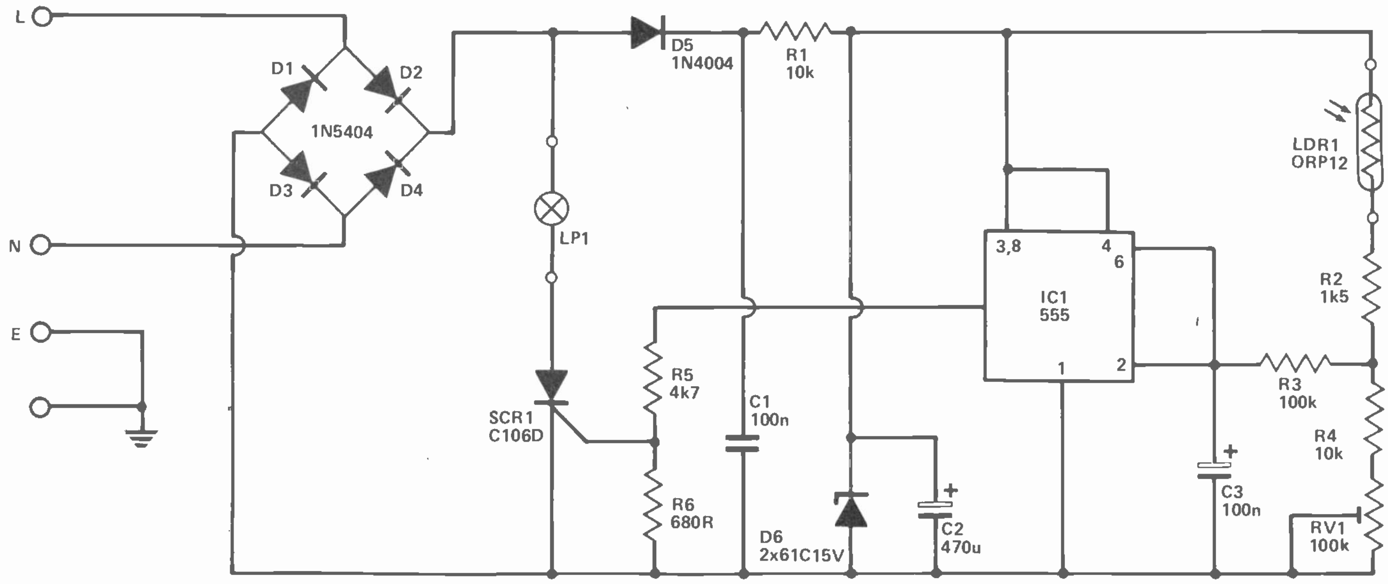

Fig.3. Circuit diagram. A common or garden 555 is at the heart of the unit.

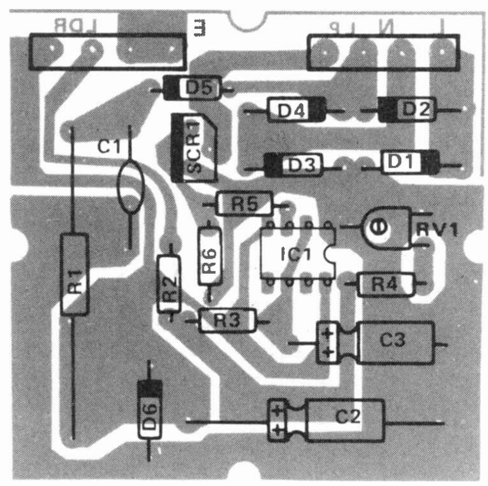

Fig.4. Component overlay. THERE IS MAINS AND RECTIFIED MAINS ON THIS BOARD.

HOW IT WORKS

Figure 3 shows the full circuit diagram of the unit. Light Dependent Resistor LDR1 is the sensor for the system. Its resistance depends upon the amount of light falling on it, the more light the lower its resistance. IC1 is used as a level detector with hysteresis. The 555 has inbuilt resistence levels of ⅔Vcc and ⅓Vcc. When the voltage on pins 2 and 6 rises above ⅔Vcc the output, pin 3, swings low, and as the voltage falls below ⅓Vcc the output goes high as shown in Fig.1.

RV1 is adjusted so that the unit switches on at the required light level. R3 and C3 form a 10 S time constant. This is the time it takes for the voltage on pins 2 and 6 to rise to ⅔Vcc, asuming C3 charges from 0 V, and is included to reduce the possibility of false triggering, eg passing car headlamps, or children with torches! The supply for the circuit is via D1-D5, R1, and regulated by D6. C2 is supply smoothing.

The external lamp is switched by the thyristor SCR1. A thyristor was chosen because it is easier to trigger than a triac, and does not have a radio frequency interference problem in this configuration. The disadvantage of this method is that a diode bridge, D1-D4, is required, and the bridge must be capable of handling the lamp current.

It was found with early prototypes that mains transients could cause the lamp to flicker when nearing the lower (switch on) threshold level. A comprehensive filter circuit has been included, comprising D5, R1, C1 and C2.

Any high frequency spikes on the mains supply will pass via D1-D5 and be decoupled to the negative side of the supply by C1. The impedance of C1 being smaller than the value of R1. Should the mains voltage fail or fall for a few cycles, C2 would try to discharge through R1 and the lamp circuit. D5 and C2 hold the supply high for this short period, D5 being reversed biased.

The thyristor used is the C106D sensitive gate type. This requires 0V8 cathode to gate, and 200 V gate current. It is triggered from the output of the 555. R5 and R6 form a potential divider to give approximately 2 V cathode to gate, sufficient to ensure reliable triggering. R5 also ensures the gate returns to the same potential as the cathode when the output of the 555 goes low, thus ensuring the thyristor remains untriggered.

The circuit may be modified for 115 V operation by reducing the value of R1 to 4k7 (2 W). The other components remain the same. However, because of the reduction in the supply voltage, the maximum wattage that can be switched is reduced to 250 W the current through the diode bridge D1-D4 and thyristor SCR1 being 2 A maximum.

BUYLINES

All components used are standard and should be readily available from most mail order stockists.

PARTS LIST

Resistors All ¼W except where stated	
R1,4	4k7 4W (2W for 115V)
R2	1k5
R3	100k
R5	4k7
R6	680R
Potentiometers	
RV1	100k
Capacitors	
C1	100n 400V polyester
C2	470u 25V electrolytic
C3	100u 25V electrolytic
Semiconductors	
D1-D4	1N5404 or similar
D5	1N4004 or similar
D6	BZX61 C15V
SCR1	C106D or similar
IC1	NE555
LDR1	ORP 12

Miscellaneous
PCB, PCB mounting terminal block RS No. 423-762, Surface mounting box MK list No. 2140, Blanking plate for box MK list No. 3827, 2 screws M3.5 Pan Head, Small heat sink (aluminium 1mm x 25mm x 10mm).

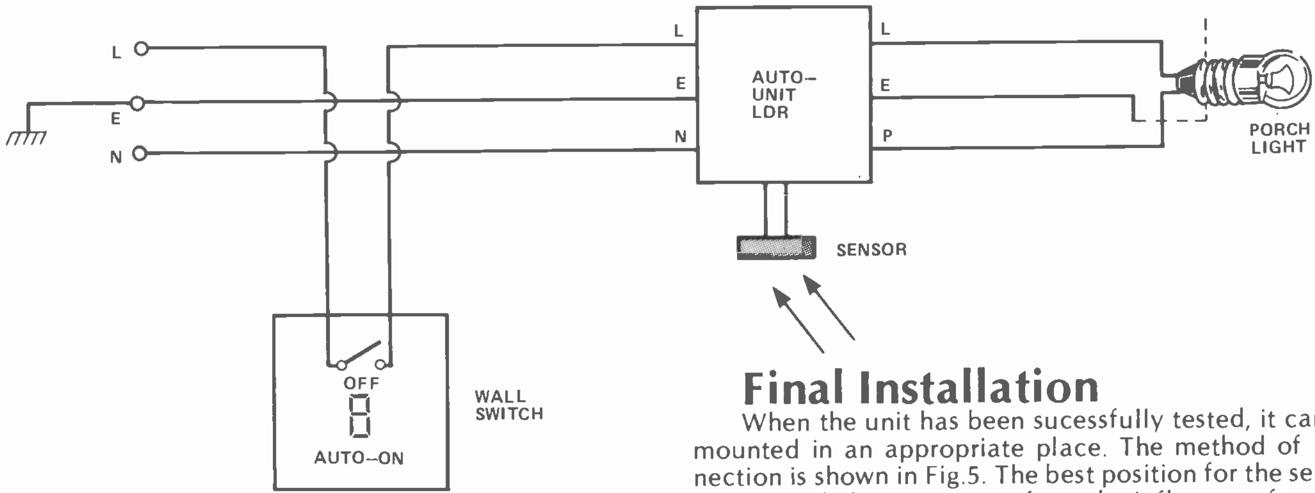

Fig.5. Method of connection of the unit to the house mains wiring.

location of the sensor, and is best set when the unit is finally installed. RV1 and R4 values give ample adjustment for most situations. If however, the adjustment of RV1 is insufficient in the clockwise direction, the value of R4 can be increased to 47k. When all is satisfactory, fit C3. Recheck that the unit does not respond to short dark or light periods.

Final Installation

When the unit has been sucessfully tested, it can be mounted in an appropriate place. The method of connection is shown in Fig.5. The best position for the sensor is an outside location away from the influence of traffic, street lamps and neighbours' lights. If a suitable location cannot be found, a small tube to shade the sensor can be fitted which will increase its directivity, as shown in Fig.2. This completes the construction of the unit.

If the completed unit is mounted externally, some form of weather proof seal must be made between the box and the blanking plate. The best type of sealer to use is silicone bath sealer. Spread a small amount on the mating surfaces of the box and tighten down the plate. The sealer will harden and prevent water entering. **ETI**

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VMP4	N	60	2.0	25	2.0	380-50E	**1250p**
VN10KM	'N	60	0.5	1.0	4.0	T092†	**55p**
VN64GA	N	60	12.5	80	0.3	T03	**750p**
VN67AF	'N	60	2.0	15	2.0	T0202	**75p**
2SJ49	P	140	7.0	100	1.0	T03	**395p**
2SK134	N	140	7.0	100	1.0	T03	**395p**

'I/p protected †our selection. VN/VM. 96-page Design Cat. **20p. Heat clips** T0202 **12p**, T092 **8p.**

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NE555	**25p**
SAD1024	**1050p**
SD532	**30p**
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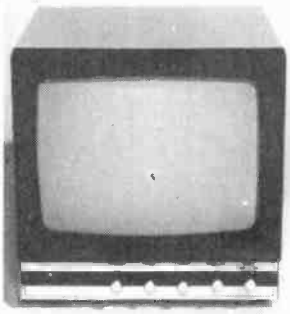

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CA3130E	**90p**
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LM318H	**120p**
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LM339N	**52p**
LM348N	**90p**
LM377N	**175p**
LM380N	**90p**
LM381N	**120p**
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4029	**82p**
4030	**★35p**
4035	**107p**
4041	**75p**
4042	**70p**
4043/4	**88p**
4047	**92p**
4048	**55p**
4049	**35p**
4050B	**44p**
4066	**50p**
4069	**★16p**
4070B	**20p**
4071/2	**20p**
4073	**20p**
4081/2	**20p**
4086	**80p**
4510	**100p**
4511B	**'70p**
4516/8	**100p**
4520/8	**100p**

TTL

7400/1	**13p**
7402/3	**13p**
7404/5	**13p**
7406	**18p**
7407	**25p**
7408	**16p**
7409	**13p**
7410	**13p**
7411	**18p**
7412	**15p**
7413	**23p**
7414	**39p**
7416	**20p**
7417	**28p**
7420	**15p**
7421	**15p**
7422	**17p**
7427	**20p**
7428	**25p**
7430	**14p**
7432	**17p**
7433	**24p**
7437/8	**13p**
7440	**10p**
7441	**55p**
7442	**★32p**
7443	**50p**
7444	**90p**
7445	**64p**
7446	**65p**
7447A	**45p**
7448	**62p**
7450	**10p**
7451/3	**13p**
7454	**10p**
7460	**13p**
7470	**20p**
7472	**19p**
7473	**★16p**
7474	**★17p**
7475	**26p**
7476	**25p**
7480	**32p**
7485	**80p**
7486	**18p**
7490	**★22p**
7491	**57p**
7492	**30p**
7493	**★20p**
7494	**30p**
7495	**40p**
7496	**45p**
7497	**200p**
74100	**60p**
74105	**43p**
74107	**22p**
74109	**40p**
74110	**40p**
74118	**90p**
74121	**22p**
74122	**30p**
74123	**45p**
74125/6	**37p**
74132	**48p**
74141/5	**46p**
74150	**55p**
74151	**47p**
74153	**43p**
74154	**66p**
74155	**46p**
74156	**42p**
74157	**38p**
74160	**70p**
74161	**55p**
74162	**60p**
74163	**45p**
74164/5	**56p**
74166	**85p**
74173	**70p**
74174/5	**55p**
74177	**60p**
74180	**35p**
74181	**80p**
74182	**45p**
74190	**50p**
74191/2	**50p**
74193/4	**50p**
74195/6	**70p**
74197	**54p**
74198	**100p**
74199	**90p**

TRANSISTORS

AC126/7	**22p**
AC128	**20p**
AC153	**25p**
AC176	**22p**
AC187/8	**22p**
AC187K	**30p**
AD149	**65p**
AD161/2	**40p**
AF114	**30p**
AF124	**35p**
AF125/6	**35p**
AF127	**35p**
AF139	**40p**
AF239	**44p**
BC107/8	**10p**
BC109	**10p**
BC117	**23p**
BC142/3	**30p**
BC147/8	**10p**
BC149	**10p**
BC157/8	**12p**
BC159	**12p**
BC167	**14p**
BC169C	**13p**
BC171	**10p**
BC173	**8p**
BC177/8	**16p**
BC179	**16p**
BC182B	**10p**
BC182L	**★7p**
BC183B	**10p**
BC184	**10p**
BC186	**25p**
BC207/9	**13p**
BC212	**10p**
BC212L	**★7p**
BC213L	**10p**
BC214	**10p**
BC214L	**★8p**
BC238	**18p**
BC261B	**14p**
BC301/3	**32p**
BC328	**17p**
BC338	**17p**
BC461	**40p**
BC477	**23p**
BC478	**23p**
BC261B = SUPER BC478	
BC479	**23p**
BC547/8	**12p**
BC549	**12p**
BC557/8	**14p**
BC559	**14p**
BCY70	**18p**
BCY71/2	**18p**
BD115	**58p**
BD121/3	**75p**
BD124	**81p**
BD131/2	**35p**
BD135 to BD140	**35p**
BF178	**30p**
BF180	**34p**
BF181	**8p**
BF183	**34p**
BF184/5	**25p**
BF194	**12p**
BF195/6	**12p**
BF197	**12p**
BF224B	**14p**
BF244B	**35p**
BF258	**28p**
BF259	**40p**
BFR39	**28p**
BFR79	**32p**
BFX29	**25p**
BFX84	**25p**
BFX87/8	**25p**
BFY50/1	**20p**
BFY52	**22p**
BRY39	**50p**
BSX19	**12p**
BSX20	**22p**
BU205	**150p**
BU208	**210p**
MJ2955	**110p**
MJE340	**52p**
MJE2955	**110p**
MJE3055	**80p**
MPF102	**45p**
MPF103/4	**40p**
MPF105	**40p**
MPF106	**45p**
MPSA06	**26p**
MPSA56	**26p**
MPSU06	**60p**
OC28	**92p**
OC35	**92p**
TIP29	**40p**
TIP29B	**42p**
TIP30	**40p**
TIP30B	**42p**
TIP31/2	**40p**
TIP33	**65p**
TIP33C	**70p**
TIP34A	**75p**
TIP35B	**200p**
TIP36A	**200p**
TIP36B	**210p**
TIP41A	**60p**
TIP42A	**60p**
TIP2955	**70p**
TIP3055	**55p**
ZTX107/8	**12p**
ZTX109	**12p**
ZTX300/1	**14p**
ZTX302/3	**18p**
ZTX304	**23p**
ZTX311	**18p**
ZTX341	**22p**
ZTX500/1	**15p**
ZTX502	**20p**
ZTX503	**17p**
ZTX504	**24p**
2N696/7	**20p**
2N698	**20p**
2N706	**14p**
2N914	**20p**
2N918	**35p**
2N1131	**20p**
2N1302/3	**35p**
2N1304	**35p**
2N1306	**30p**
2N1613	**25p**
2N1711	**13p**
2N1893	**25p**
2N2217	**18p**
2N2219	**23p**
2N2222A	**23p**
2N2369	**17p**
2N2484	**25p**
2N2646	**46p**
2N2904/5	**21p**
2N2906/7	**21p**
2N2926G	**10p**
2N3053	**20p**
2N3054	**40p**
2N3055	**45p**
2N3055B	**50p**
2N3442	**140p**
2N3702 to 2N3711	**11p**
2N3772	**120p**
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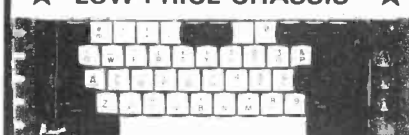

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STATE VARIABLE FILTER

Choose one of seven filter responses with this voltage controlled state variable filter design by R.C. Blakey for your Project 80 modular synthesiser.

The Voltage Controlled State Variable Filter has low pass, high pass, band pass and notch filtering capabilities. The first three responses are available as both two pole (12 dB/octave) and four pole (24 dB/octave) filters. Manual and external control of resonance is included.

Design Features

The state variable filter using three operational amplifiers, as shown in Fig.1, is probably familiar to most readers.

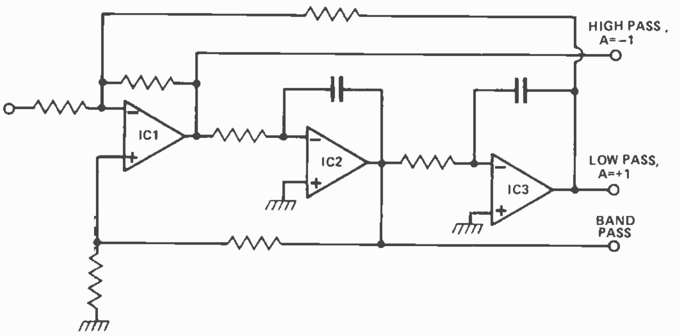


Fig.1. Circuit diagram of a state variable filter using three op amps.

A simple way to convert this into a voltage controlled filter is to interpose operational transconductance amplifiers (eg CA3080) prior to the two integrators around IC2 and IC3. Voltage control of Q (or resonance) can also be obtained by using an OTA in the feedback to the non-inverting input of IC1. This is the basis of the present design. Such a filter gives 12 dB/octave low and high pass responses and second order band pass response. By placing two such filters in series it is possible to increase the roll-off characteristics by a factor of two. In practice, however, this is often difficult due to component mismatching which results in uneven roll-off characteristics. The problem has been minimised in this design by using a customised integrated circuit from Solid State Micro Technology for Music, namely, the SSM2040. This device contains four closely matched transconductance amplifiers and an exponential generator which is common to the four cells. For resonance control the relatively new LM13600, dual transconductance amplifier, is used in the feedback of the two stages of state variable filters. Both manual and external voltage control of resonance is provided and while these controls are additive the maximum useful range is our standard 0 to 10 volts into 100k.

Seven filter responses are available, one at a time, via a selector switch — low pass (12 and 24 dB/octave); high pass (12 and 24 dB/octave); band pass (2nd and 4th orders); and notch. The low pass and high pass outputs are 180° out of phase and so combining these outputs results in a notch. A notch filter is of limited use in synthesis since the ear only responds to frequencies present and not to frequencies which are absent. The latter may sound rather obvious but since the notch filter allows most frequencies to pass the ear cannot detect the difference between the original and filtered signals, except in some exceptional circumstances or unless the notch is fairly wide.

The filter has three signal inputs and the combined signal should not exceed 10 volts peak to peak. An attenuating potentiometer has been provided on one of the inputs and if mixing of signals is required then external attenuating controls can be used. The filter has approximately unity gain at maximum resonance feedback.

Frequency response control is obtained using the exponential converter within the SSM2040 and an attenuating network, with adjustment, allows the 1 V/octave characteristic to be obtained. Initial frequency (zero control voltage) is set to approximately 20 Hz and the filter has a 1,000:1 control range. Control Input 1 is used for keyboard input; Control Input 2 has an attenuating potentiometer for use in conjunction with an envelope shaper, etc; a Coarse control provides manual sweep over 10 octaves and a Fine control is included for more accurate initial setting and has an adjustment range of one octave. Temperature stability should not be

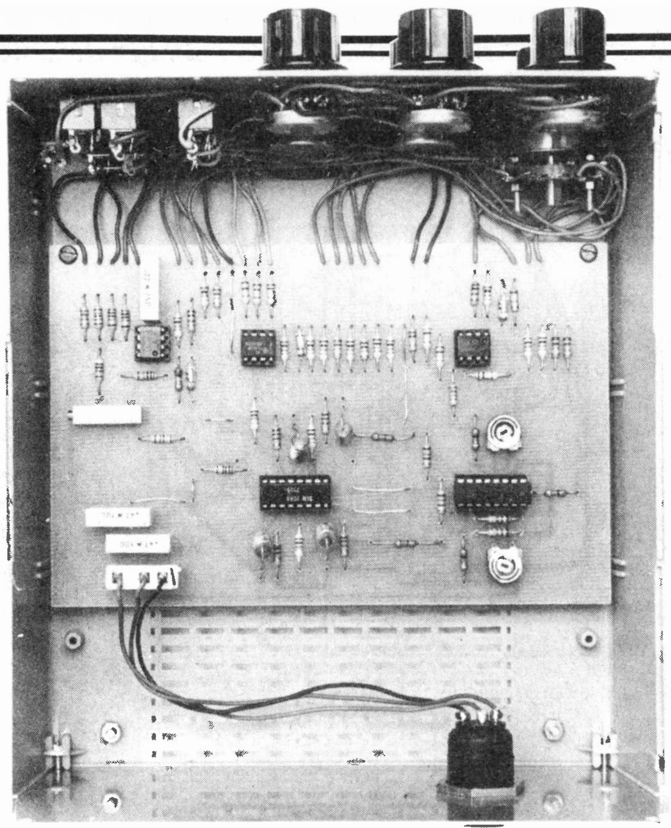


Fig.2. The voltage controlled state variable filter can be built into this Teko Alba case (see Buylines) as a 'stand alone' project.

a problem under normal circumstances. If required, however, R47 may be replaced by a Q81, 1k0, 1% temperature compensating resistor.

Construction

The first point to note is that the SSM2040 outputs (OUT, CAPACITOR and IN) are not short circuit protected and shorting any of these to either supply will generally blow the circuit, although connections to ground can be tolerated for several seconds. Some additional resistors have been used to provide additional safeguard in the latter circumstances. Take particular care on both the orientation of this IC and when any probes are connected to components on the PCB, for whatever reason.

Identify and solder the seven wire links before installing components. The capacitors around the SSM2040 will accept both preformed (as illustrated) and normal polystyrene capacitors. When all components have been installed, the two holes remaining around IC1 are for installing a Q81 temperature compensating resistor, when required. The manual resonance control (RV2) may be wired via the jack socket used for the external resonance control such that the former is disabled when external control is in use. The manual and external controls may also be wired up independently but no increase in gain will be achieved when their combined voltages exceeds the equivalent of about 10 volts into 100k, eg manual control half way and five volts external input. In fact the resonance will begin to decrease somewhere above 10 volts.

The most complicated task is wiring up the switch but this should not pose any problems if reference is made to both the circuit diagram and the PCB layout.

Setting Up And Calibration

First adjust the module to achieve the seven filter responses. These can be readily observed on an oscilloloscope by using the VCLFO and VCO as a sweep frequency generator, as described for the 80-6 filters. There are, however, only two adjustmenst to make in order to ensure that the seven responses are present (assuming no wiring errors) and these can be made by ear with the aid of an amplifier, as shown below.-

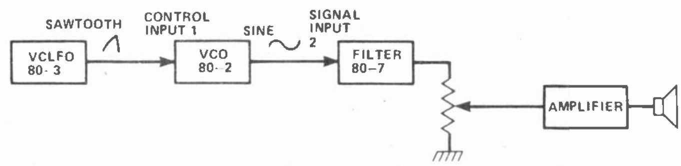
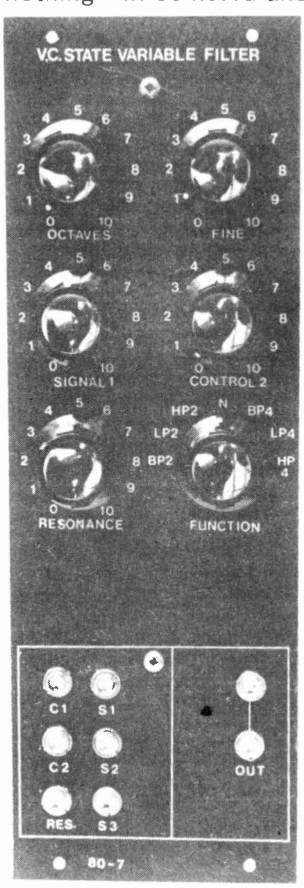


Fig.2. The seven filter responses can be inspected with the circuit shown above.

Set Coarse frequency controls on VCLFO and filter 80-7 to mid position and to zero on the VCO. With the edge connections of the filter facing you and the components uppermost set the wipers of both PR1 and PR2 to about the 9 o'clock position. Put selector switch on BP2 output and slowly turn PR1 anti-clockwise. Initially there may be no output but then a low pass output will be heard. Further rotation of PR1 will result in a fairly abrupt change from low pass to band pass and this is audibly obvious. PR1 should be left at this setting. Now switch to LP4 output and turn PR2 slowly clockwise. Initially nothing will be heard and then a low pass response. PR2



If you wish to build all of the Project 80 modules and install them in a single case with keyboard, mount the PCB on this front panel. At the end of the series you'll have a matching set.

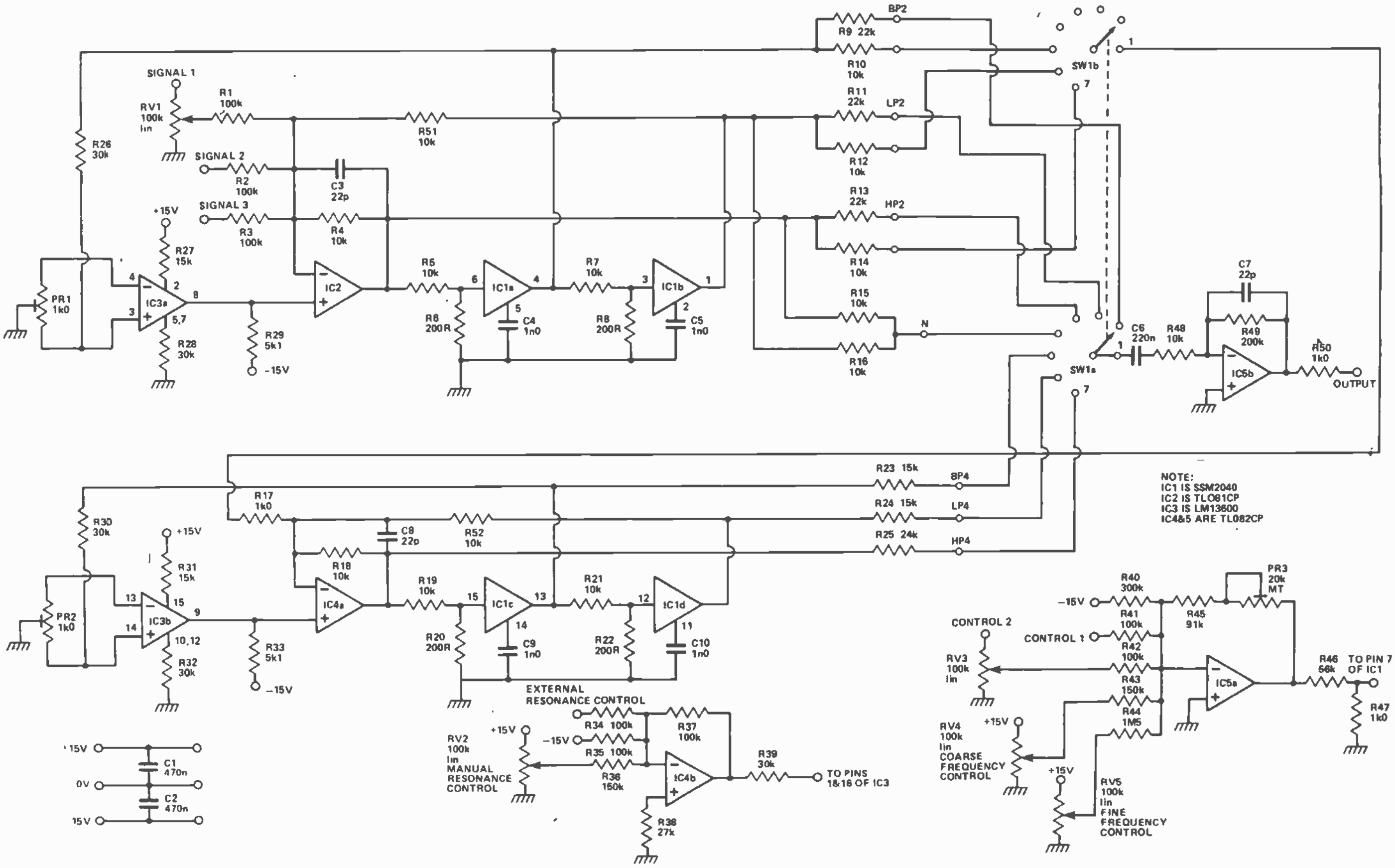


Fig.2. Circuit diagram of the state variable filter.

HOW IT WORKS

The SSM2040, VCF produced by Solid State Micro Technology for Music, contains four independent filter sections which may be interconnected to provide a wide variety of filter responses. Each section contains a transconductance amplifier followed by a buffer and by using two of these sections with an external op amp a state variable filter may be realised as shown below.

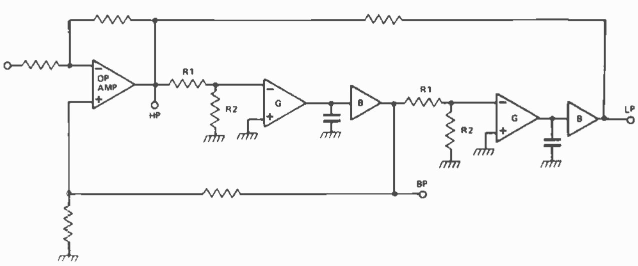


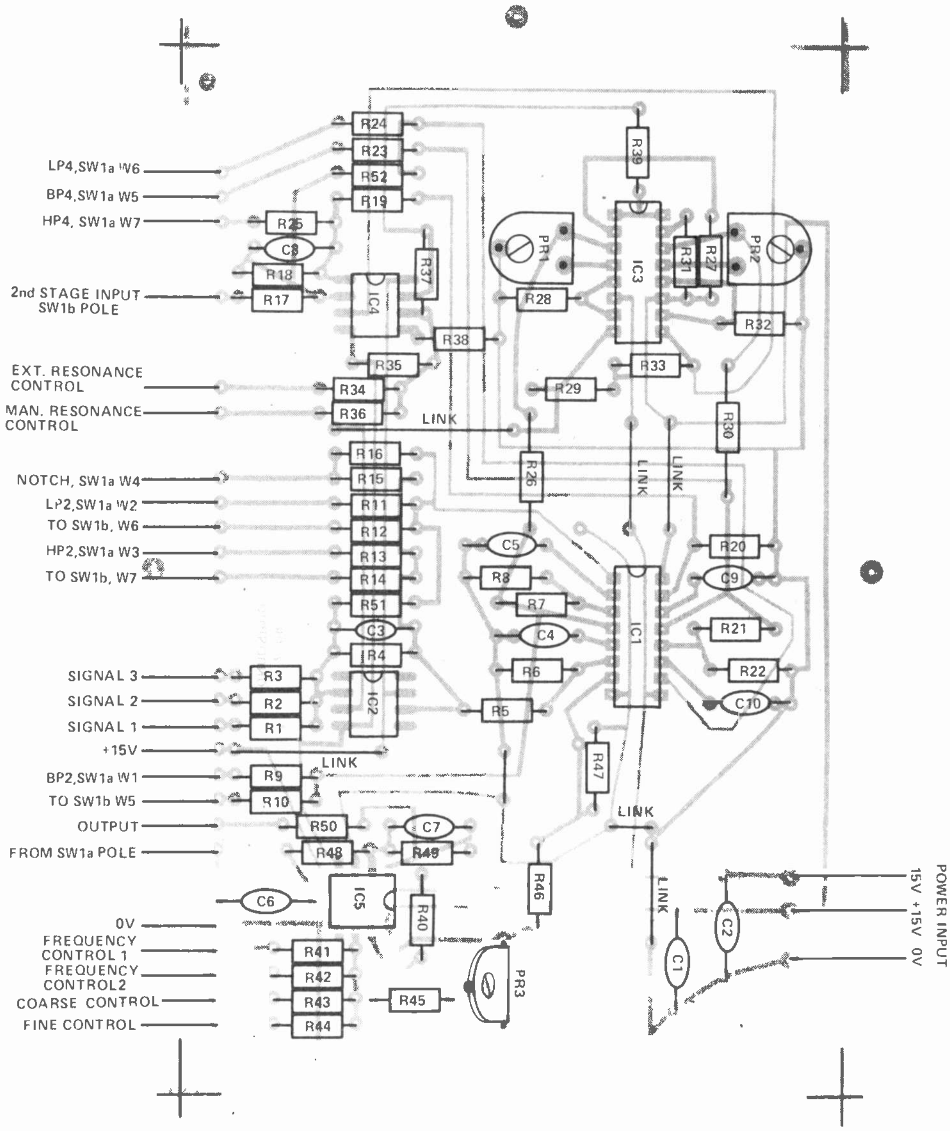
Fig.3. Using the sections of the SSM 2040 and an op amp to form a state variable filter.

The signal levels into the gain cells should be limited to 2mV RMS and since R2 should be 200 R for optimum control rejection then R1 is 10k with a 1 V signal at the op amp output. The equivalent input noise for the SSM2040 is 0.5 uV RMS at 20 Hz to 20 kHz so a signal to noise ratio of about 90 dB is achieved. In the first state variable filter section around IC3a, IC2, IC1a and IC1b a 10 V signal into R1, 2 or 3 is reduced by IC2 and R4 to produce the 1 V into attenuating resistor network R5, 6. The two pole low pass, high pass and band pass filter responses are derived and a notch produced by combining the low and high pass outputs which are 180° out of phase. These four outputs are connected to the rotary switch, SW1a and the signal restored to its original level by R49, R50 and IC5b. The signals are AC coupled into IC5b to remove any DC offsets.

The low pass, high pass and band pass outputs from the first stage are also separately connected to rotary switch, SW1b and fed into the second stage formed around IC3b, IC4a, IC1c and IC1d. The four pole outputs derived in this section return to switch SW1a and are available via IC5b, as before.

Resonance control is provided by an LM13600 (IC3), dual transconductance amplifier, interposed between the band pass output and the non-inverting input of the filters external op amps (IC2 and IC4a). The amount of feedback is controlled by the current developed across R39 and this has been commoned for both halves of the LM13600. Manual control is obtained via RV2 and R36 into IC4b and external voltage control via R34 into the same input summing node. The control voltage should be limited to an equivalent of 10 V into 100k.

Frequency control is common to all four amplifiers in the SSM2040 and best results for a 1,000 to 1 sweep in the range 20 Hz to 20 kHz is obtained with +90 V at pin 7. Resistor R40 connected to − 15 V provides approximately +90 mV and a lower frequency limit of about 20 Hz. A 0 to +10 V control voltage into Control Inputs 1 or 2 will then allow frequency adjustment over a range of ten octaves. Manual adjustment over a ten octave range is provided by the Coarse Control (RV4 into R43) and Fine Control over a range of one octave by RV5 into R44. Precise adjustment of the 1 V per octave response is achieved by adjusting the gain of IC5a using PR3.



PARTS LIST

Resistors ¼W, 5% carbon film except where stated

R1,2,3,34,35,37	100k
R4,5,7,10,12,14, 15,16,18,19,21, 48,51,52	10k
R6,8,20,22	200R
R9,11,13	22k
R17,50	1k0
R23,24,27,31	15k
R25	24k
R26,28,30,32,39	30k
R29,33	5k1
R36	150k
R38	27k
R40	300k, 1% metal film
R41,42	100k, 1% metal film
R43	150k, 1% metal film
R44	1M5
R45	91k, 1% metal film
R46	56k, 1% metal film
R47	1k0, 1% metal film
R49	200k

Potentiometers

RV1,2,3,4,5	100k linear
PR1 2	1k0 carbon
PR3	20k cermet multiturn

Capacitors

C1,2	470n polyester
C3,7,8	22p polystyrene
C4,5,9,10	1n0 polystyrene
C6	220n polyester

Semiconductors

IC1	SSM2040
IC2	TL081CP, or equivalent
IC3	LM13600
IC4,5	TL082CP, or equivalent

Miscellaneous

SW1	2 Pole 7 (or more) Way Rotary Switch

should be left at the setting where the low pass output commences. The selector switch can then be turned through its seven outputs to check that the appropriate response is present and these can be clearly identified by ear. If an oscilloscope is available then switching to BP2, LP4 and HP4 outputs and making minor adjustments to both PR1 and PR2 may result in some improvement to the filter responses.

The final step is to calibrate the filter for 1 V/octave frequency control. The 80-7 filter will not oscillate at maximum resonance feedback and so the best approach is to observe the maximum signal amplitude using an oscilloscope. Connect the sinewave output from a VCO to Signal Input 2. Connect the LP4 output to an oscilloscope, set VCO frequency to about 250 Hz and adjust RV4 (Coarse Control) and RV5 (Fine Control) to obtain maximum signal amplitude. Increase voltage on Control Inputs 1 of both VCO and VCF by exactly 1 V and adjust PR3 until maximum amplitude is restored. Repeat the above steps until calibration is achieved. If an oscilloscope is not available then an alternative approach is to set all VCF controls to zero and apply about 4 V to Control Input 1 and measure the voltage at the junction of R46 and R47, using a high input impedance voltmeter. Increase the control voltage by exactly 1 V and then adjust PR3 to obtain an 18.0 mV change at the junction of R46 and R47. Again repeat the procedure until an 18.0 mV change is obtained for a 1.000 V change in control voltage.

BUYLINES

An 80-7 State Variable Filter module kit (PCB plus components) is available for the inclusive price of £20.10 from Digisound Ltd, 13 The Brooklands, Wrea Green, Preston, Lancs PR4 2NQ.

The modules are cased in Teko Alba A23G cases (order code TEK A23G), available from West Hyde Developments Ltd, Unit 9, Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET at £4.43 each all inclusive.

ENVELOPE SHAPER

Tamper with your time constants. This Project 80 design by R.C. Blakey gives full control of Attack, Decay, Sustain and Release.

The envelope generator is based on the SSM2050, a voltage controlled transient generator produced by Solid State Micro Technology. Using this IC all that is necessary to vary the time constants for the Attack (A), Initial Decay (D) and Final Decay or Release (R) is a voltage applied to the appropriate pin via a scaling resistor. A minimum range of 2 mS to 20 S is available for each of the three timing functions. The voltage response is exponential which means that the most useful time range utilises the highest proportion of the associated control potentiometer. The attack output is nominally 0 to 10 V and the Sustain level (S) is simply a voltage applied to Pin 12.

It has separate gate and trigger inputs whereby a combined gate and trigger pulse will initiate a full ADSR response; a trigger applied after the first one and while the gate pulse is still present will restart the attack response and a gate pulse on its own will generate an AD contour. When the gate pulse is released the final decay commences, as is usual with ADSR and AD envelope shapers.

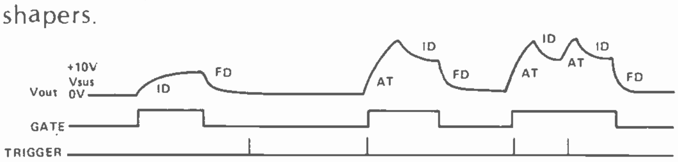
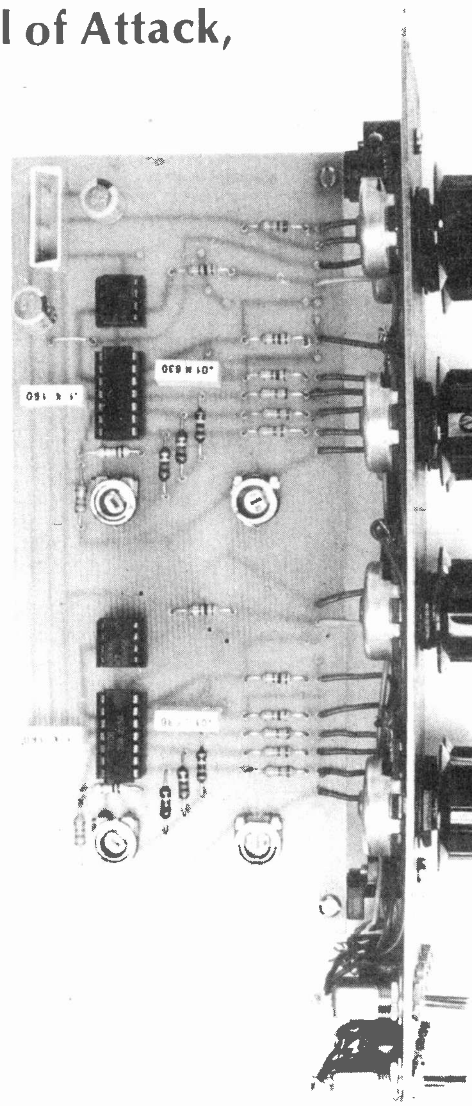


Fig.1. Wave forms associated with envelope processing.



The time constants may be trimmed so that any number of ADSR's can be adjusted to exactly the same scale. Also an adjustment to ensure that the sustain voltage accurately matches the peak attack voltage is provided. The output buffer in the SSM2040 is adequate for most practical purposes but to retain our 'plug in anything to anywhere' philosophy an external buffer has been added. Other features included are external initiation of the ADSR or AD contours, for example, from a manual push button, as well as provision to use gate and trigger pulses derived from TTL logic.

Construction

The PCB is designed to take two envelope generators and as usual will fit either a panel or the TEKA ALBA A23G case. If the latter is used then there is only sufficient panel space to sensibly install a single envelope generator.

Construction is very straightforward and the only points to note are the single wire link and the opposed orientation of the SSM2050 and the 741 buffer.

An on-off switch, SW1, is connected across the inputs marked 'TRIGGER (CMOS)' and 'GATE (CMOS)' so that when only single pulses are available, eg, manual gating, then both the ADSR (SW1 closed) and AD (SW1 open) responses can be obtained. The manual gating can be added by connecting a push to make switch between the PCB connections marked 'OUTPUT FOR MANUAL GATE' and 'MANUAL GATE'. The push button may be panel mounted but the preferred approach is to take the former connection to a jack socket and to use an external hand, or foot, switch connected to two jack plugs. These jack plugs go to the Gate (G) input and the Manual input (from R11). The option and type of switch is left to the constructor.

Resistors R12, R13 and R14 are not part of the basic kit but are to be installed by constructors who are using TTL logic to derive gate and trigger pulses. Also in this case the switch, SW1, is connected across the PCB con-

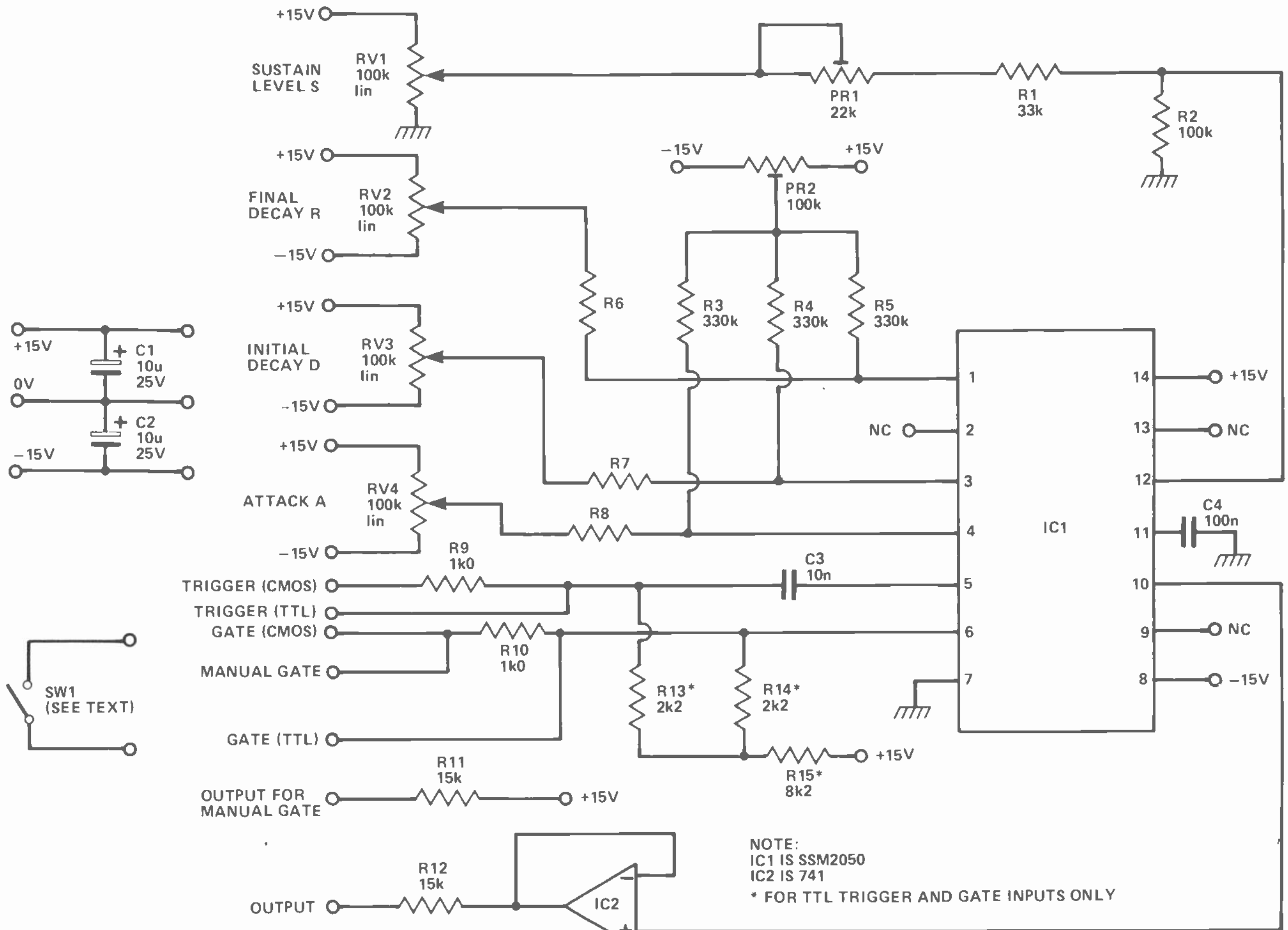


Fig.2. Circuit diagram of the Envelope Shaper.

HOW IT WORKS

The SSM2050 Voltage Controlled Transient Generator contains a voltage controlled resistor to generate the nominally exponential slopes and various logic devices to define the states. An attack flip-flop (AF/F) is set by the trigger pulse and reset by either NOT GATE or the attack comparator determining that the output has reached +10 V. Thus ATTACK = GATE and AF/F; INITIAL DECAY = GATE and NOT AF/F; FINAL DECAY = NOT GATE. Each state is characterised by a nominally exponential approach to a characteristic voltage; these being +13 V, sustain voltage and 0 V for attack, initial decay and final decay respectively.

The input stages of the SSM2050 logic inputs have a lateral PNP structure which protects them from excess voltages. Their sensitivity is 750 uA or 1V5 max., these being the minimum current and voltage required to trigger the SSM2050. For 5 V, 10 V and 15 V CMOS gate and trigger inputs these requirements are met using 1k, 10k and 15k resistors respectively to these inputs.

The attack, initial decay and final decay inputs have a nominal impedance of 3k1 and a time constant sensitivity of 18 mV/octave with a 100n timing capacitor (C4). An increasing positive voltage increases the time constant. Thus R6, 7 and 8, connected to +15 V via the rotary controls RV2, 3 and 4, will have nominal values of about 300k to achieve a five decade timing range from 2 mS to 20 S. The input impedance, however, varies by up to +25% between devices. Fortunately the impedance may be measured with a high input impedance ohmmeter as the resistance between pins 1 and 7 and so the appropriate scaling resistor may be selected by multiplying this resistance by 100 and adding 10k. The nearest E24 resistor is chosen and more precise adjustment of timing is achieved by injecting a small offset voltage via PR2 and R3, 4 and 5. The attack voltage may vary between 10 and 11 volts and PR1, R1 and R2 provide a means of matching the maximum sustain voltage to the peak attack voltage. The sustain level can then be varied from 0 to 100% of attack voltage using RV1.

As an additional safeguard the output of the SSM2050 has been buffered by IC2 configured as a voltage follower.

nections marked 'TRIGGER(TTL)' and 'GATE(TTL)' to provide the same function as before. For manual gating with TTL a push to break switch should be connected between 'GATE(TTL)' and OV, since the gate and trigger pulses are held high by the additional resistors.

Setting Up And Calibration

Provide a means of manually gating the envelope generator as described in the previous section and the switch may be constructed from two strips of metal, if necessary. Connect the output to a voltmeter set to a DC range of 15V and turn Attack control (RV4) to about 3 o'clock position and all other external controls to zero. Put SW1 in the ADSR position (gate and trigger commoned), turn PR1 fully anti-clockwise and PR2 about mid position. Apply power to the module, depress the manual button and keep held down while observing the voltmeter. The voltage should steadily rise and will probably take between 5 and 20 seconds to reach about 10V. Since the module is not calibrated the time taken may be outside of the range stated. The important point is that the voltage increases to a maximum of about 10V and then drops sharply to zero. If this response is observed then set Sustain control (RV1) to mid position and RV2, 3 and 4 to about the 3 o'clock position (a little less if the time to reach 10V was greater than 10 seconds in the previous step or a little more if the time was less than 5 seconds). Press button and hold down as before. The voltage should now rise to about 10V and then decay at the same rate to a voltage of approximately 5V and remain steady. On releasing the button there will be a final decay to about 0V. Finally, open switch SW1 to check

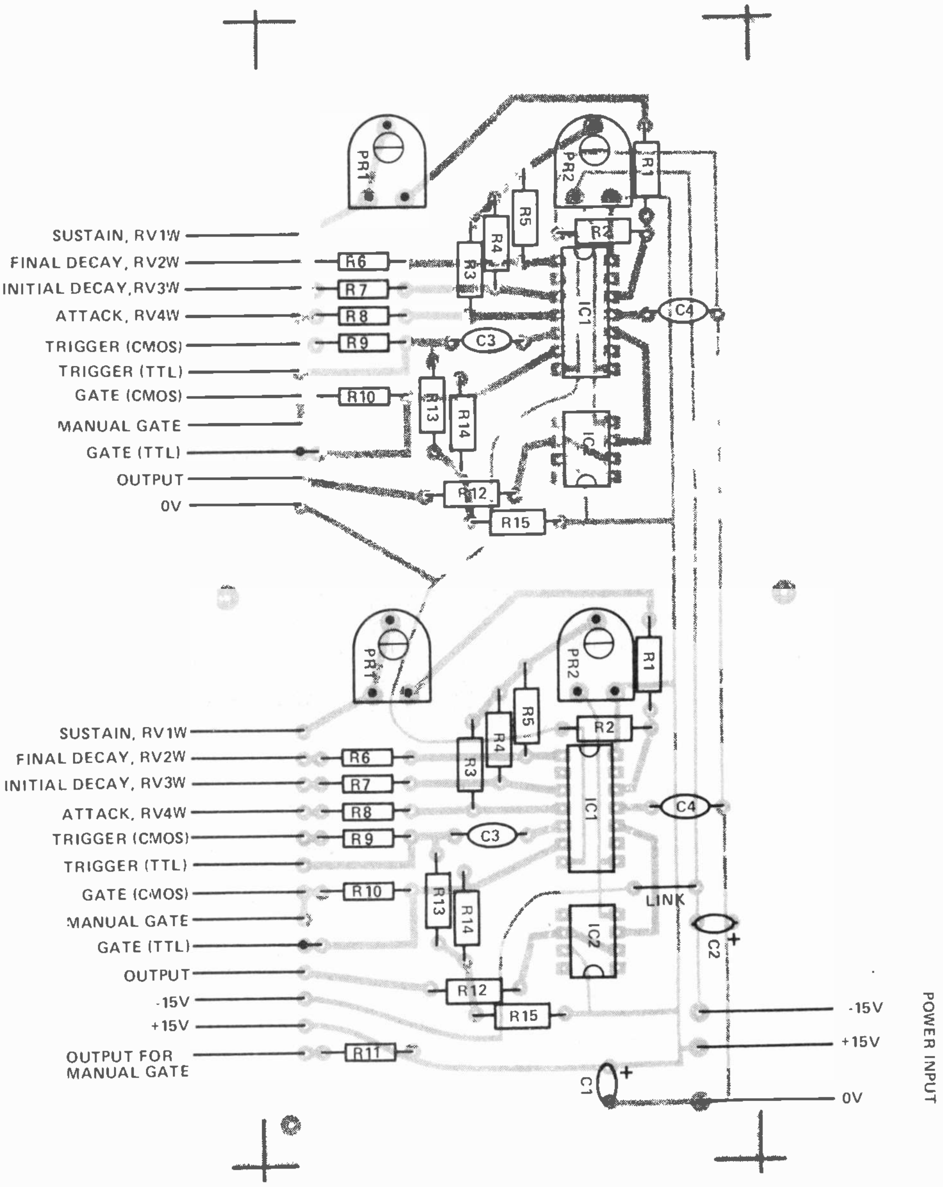


Fig.3. Component overlay.

PARTS LIST

Resistors ¼W, 5%	**Carbon film**
R1	33k
R2	100k
R3,4,5	330k
R6,7,8	see text
R9,10,11	1k0
R11	15k
Potentiometers	
RV1,2,3,4	100k linear
PR1	22k carbon
PR2	100k carbon
Capacitors	
C1,2	10u 25V electrolytic
C3	10n polyester
C4	100n polyester
Semiconductors	
IC1	SSM2050
IC2	LM741CN, or equivalent
Miscellaneous	
SW1	Sub Min SPST (or SPDT) switch

the AD response and repeat the last step. This time the voltage should rise to about 5V and maintain this value until the button is released which will initiate the decay to about zero. Note that in the AD mode the Initial Decay control (RV3) determines the attack time and the Sustain level controls the amplitude of the AD contour. The above demonstrates that all functions are operational.

The next step is to adjust the sustain voltage to match the peak attack voltage. Close SW1; set RV4 to about 3 o'clock; RV1 fully clockwise; RV2 and RV3 to the zero. Depress the manual button, observe the voltmeter and note whether there is a discernible drop in voltage after the attack has reached its peak. If so, turn PR1 clockwise and repeat the last step. Repeat until peak attack voltage and sustain level are matched. The adjustment to PR1 must be made in small increments so as to avoid having a higher sustain voltage than the attack voltage, otherwise malfunction of the SSM2050 can occur. It is therefore better to err on the safe side and wait until the envelope shaper is connected to the VCA at which time any mismatch between the two voltages can be checked by ear and a minor adjustment made to PR1 to correct it, if necessary.

The final step is to adjust the time constants and this calibration is only required for the Attack time control (RV4). The module should be in the ADSR mode (SW1 closed) and all other control pots set to zero. If an oscilloscope with a triggered sweep is available then the gate and the oscilloscope can be simultaneously triggered and PR2 adjusted to give an attack time of 2 mS when RV4 is at zero. An alternative method is to time the attack period, for example, by observing a voltmeter connected to the output and measuring the time between pressing the manual push button and the voltage dropping sharply. With the latter method adjust RV4 so that there is 10V0 at its wiper, trigger the module and adjust PR2 until the time taken is 9 S (slightly more than less). When this time is obtained turn RV4 to zero and check that a fast response time is obtained.

BUYLINES

A single 80-8 module with PCB and all components shown on the circuit diagram for CMOS inputs is available from Digisound Limited for £9.83 and a dual unit for £17.02, both inclusive of postage and VAT.

ETI

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042A	300W Amp Module	Apr 80
033	Fuel Level Monitor, Alarm, Screen Controller Dynamic Noise Reducer	Sep 79
042B	Touch Dimmer, Battery Charger, RC Guardian (Top, Bottom) 1 & 2	Apr 80
043	IR60 Preamps, Receiver, PSU, Servo Tester VU–PPM	May 80
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040A 042B	Touch Dimmer, Battery Charger RC Guardian (Top,Bottom) 1&2	Apr 80
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044A	IR60 Function Board (Top & underside) Control Circuit, Line Transmitter, Tape Response Meter Ohmmeter	June 80
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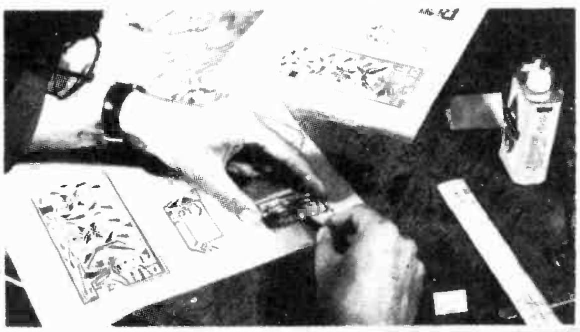
HOW IT WORKS



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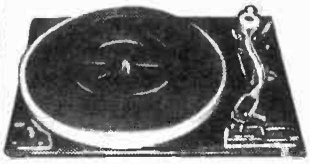

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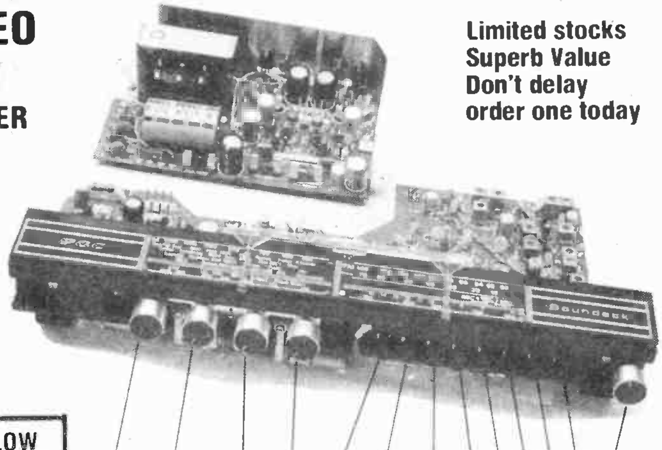

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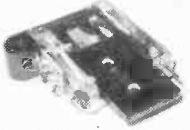

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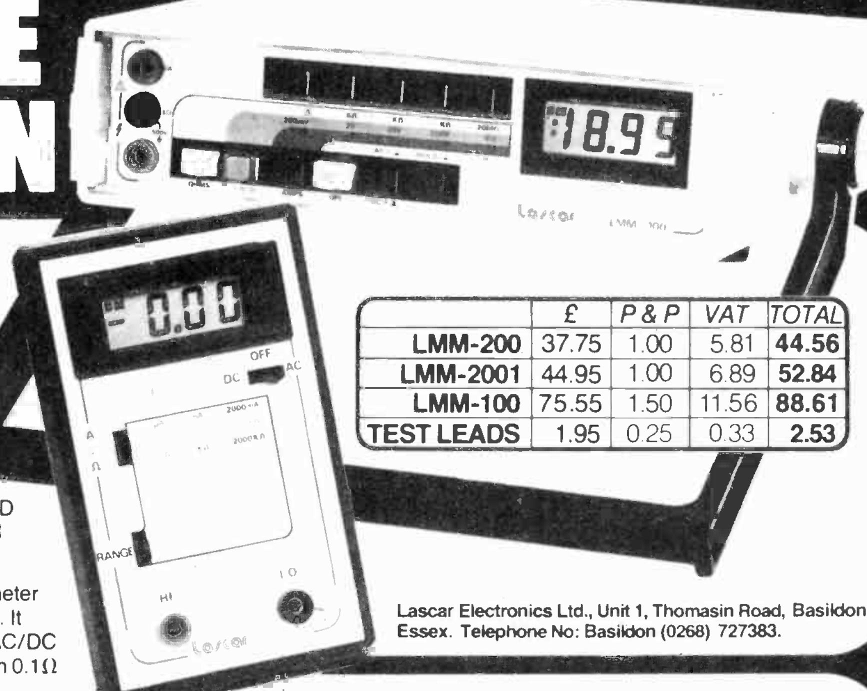

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LOUDSPEAKER PROTECTION MODULE

Make your loudspeakers immune to everything except music and the End of The World with our comprehensive protection circuit.

Modern transistor power amplifiers use the technique of DC coupling between the low level amplifier stages and between the output stages and the loudspeaker. This has the advantage of removing coupling capacitors from the signal path, decreasing parts count and improving performance at low frequencies.

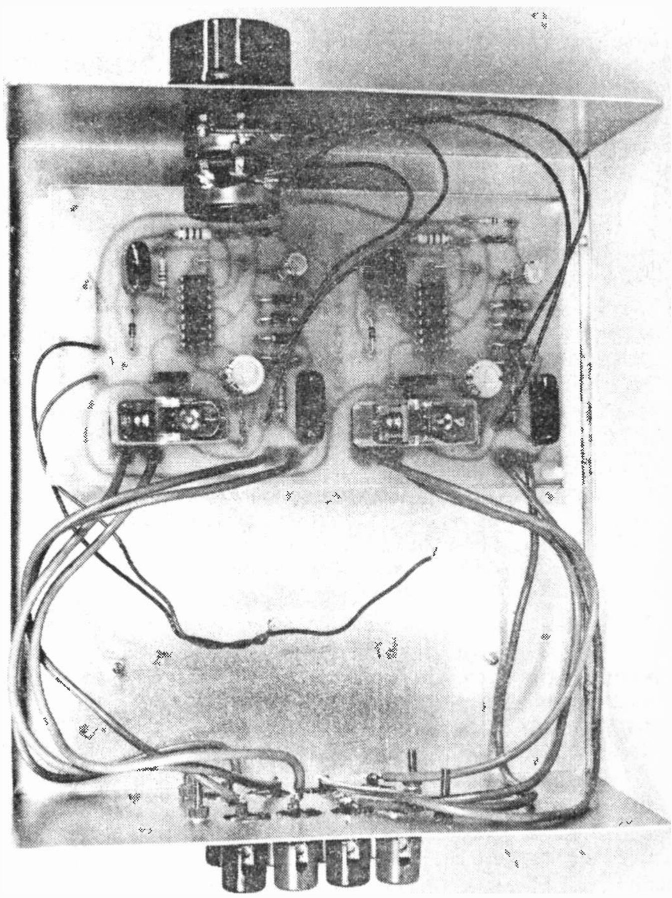
Older transistor amplifiers used a single supply rail so the transistors operated between the supply voltage and ground. Since an AC signal has both negative and positive excursions the power amp was designed so that a DC voltage was present on the output stage. Positive excursions would cause an increase of this DC voltage while negative excursions decrease the voltage. Since DC cannot be applied directly to a loudspeaker it was necessary to insert a capacitor, called a blocking or output capacitor, between the output stage and the loudspeaker. The load impedance of the loudspeaker is around 8R so the capacitor has to be 5000 uF to 10,000 uF before an acceptable low end performance can be obtained.

The solution to these problems was DC coupling. The power amp is run from a 'split supply' so that the output transistors are supplied from a positive and negative supply voltage. The average of these supply rails is zero volts, so the output can be connected directly to the loudspeaker. Both positive and negative excursions are possible due to the split power supply.

Coupling Fault

Unfortunately, DC coupling also has its disadvantages. The biggest of these is the possibility of damage to the loudspeakers in the case of power amp failure. Since all the stages are DC coupled, a fault anywhere in the power amp can cause the output stage to swing hard against one of the supply rails. The most common power amp fault is a condition in which one or several of the output or driver transistors is destroyed, and this almost always causes the full DC voltage from one of the supply rails to be applied directly to the loudspeaker. The loudspeaker cone is slammed against the suspension and the power dissipation in the voice coil causes a rapid increase of voice coil temperature. In this condition most woofers will survive for only a few seconds.

This type of fault is all too common and is the most expensive fault likely to occur in a modern hi-fi system. Some top line amplifiers have built in protection circuits with relays that disconnect the loudspeakers should this condition occur, but these are the minority.



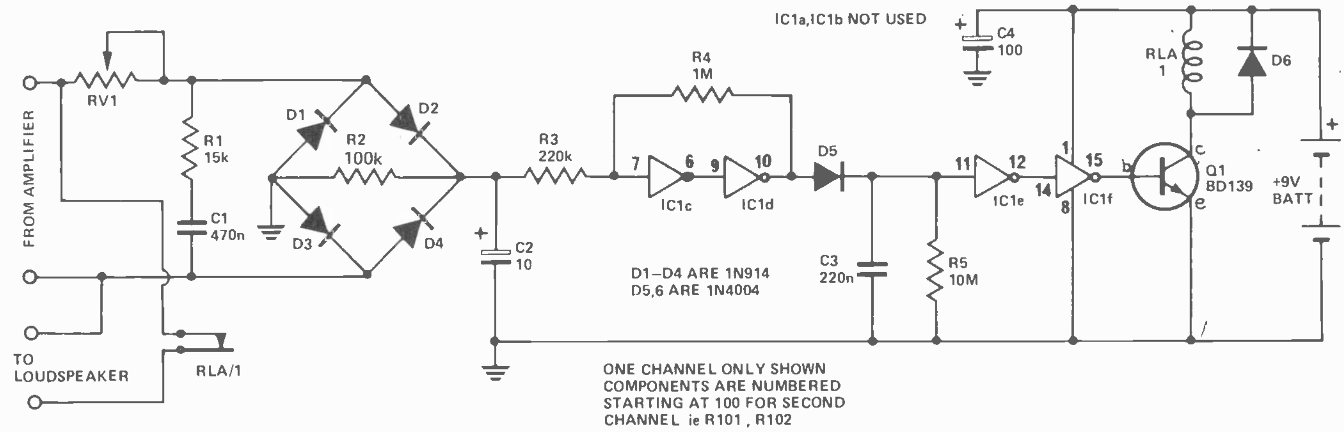


Fig.1 (above) The circuit diagram for the loudspeaker protection unit. Note that one channel only is shown and that on the PCB components for the second channel are numbered from 100 to avoid confusion. Relay RLA1 should be a 12 V type with the facility for one, at least, pair of changeover contacts. This project has been designed such that it does not place a significant load upon the amplifier itself during usage, such that the damping to the speaker is unaffected. Secondly the high input impedance of the protector ensures that a load-sensitive amplifier is unlikely to be pushed into colouration by your decision to save your loudspeakers from destruction if it cracks up.

Remedy

This circuit 'looks' at the loudspeaker wires and protects the loudspeakers in two ways. The presence of any DC automatically trips the relay and disconnects the loudspeaker. The protector also looks at the amount of power applied to the loudspeaker. It allows high power transients but will disconnect the loudspeaker if the applied power exceeds the loudspeaker rating for more than about 50 milliseconds. In this way the advantage of the improved high power amplifiers is not lost but the loudspeaker is still protected. The circuit includes a two-second monostable delay circuit so that the loudspeaker is automatically reconnected approximately two seconds after the 'fault condition' has been removed.

The project is designed around two standard CMOS ICs. This ensures a very low current consumption and obviates the need for a power switch. This is important since a fault with an amplifier could well occur at the moment of turn-on and it is essential that the loudspeaker protector is already on. When the relay trips, the circuit pulls around 50 mA for each relay so it is important that battery is capable of supplying 100 mA during relay operation. There should be no problem with the battery lasting for its shelf life, providing the relays are not tripped more than very occasionally.

Construction

Solder the resistors, capacitors, diodes and relay first. The diodes and electrolytic capacitors must be inserted the right way round as shown on the pc board overlay. Lastly, solder the transistors and ICs on the board. Again, these devices must be oriented correctly.

The prototype was constructed in a general purpose steel box but this is not critical. The front panel is fitted with a stereo 100k potentiometer. This sets the trip point of the protector so that it can be adjusted for your particular loudspeakers. The rear panel holds the terminals for the wires from the amplifier and loudspeakers. The wiring to the rear panel and to the front potentiometer is shown in the wiring diagram.

Finally, make the connection to the battery.

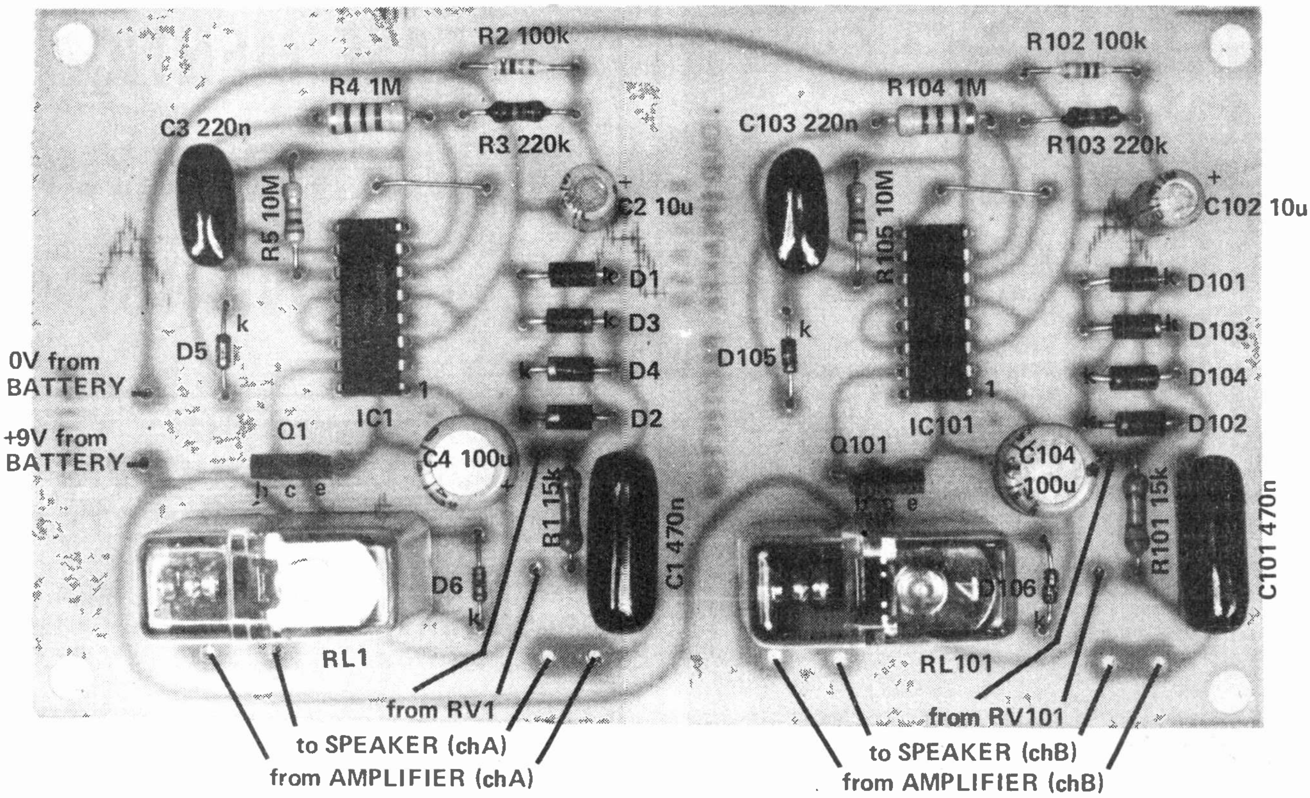
HOW IT WORKS

The signal voltage from the amplifier is rectified by a full-wave bridge consisting of diodes D1, D2, D3 and D4. The potentiometer RV1 and the resistor R1 and capacitor C1 form a potential divider that determines the sensitivity of the circuit. At normal signal frequencies C1 has a relatively low impedance and the resistance across the diode bridge becomes that of resistor R1, i.e: 15 k. As the frequency approaches DC however, the impedance of this capacitor increases, increasing the sensitivity of the circuit. If a DC voltage is presented to the input C1 acts as an open circuit and the protector is therefore at its most sensitive.

Signal voltages from the full wave rectifier are averaged by the capacitor C2 and R2, and then applied to a Schmitt trigger. The Schmitt trigger is formed from the resistors R3, R4, IC1c and IC1d. This circuit will only respond to a voltage level greater than a preset amount. When this voltage is exceeded (around 6V5 in this case) the output goes positive charging C3 through diode D5. This diode prevents C3 from being discharged by the Schmitt trigger when its output goes low again so the capacitor can only be discharged by the 10 M resistor R5. This takes about two seconds to this circuit is in reality a simple and effective monostable. Another two stages of the IC drive the transistor which is in series with the relay coil. Diode D6 protects the transistor from large back-EMF voltage spikes produced when the relay is turned off.

Testing

Check the orientation of all polarised components including the transistors and ICs. If all is well cut two short lengths of speaker cable and connect the output of the amplifier to the input of the loudspeaker protector. Connect the speaker cables to the output of the protector. Now switch on the hi-fi system. Choose music with reasonably even amplitude for this test. Turn the front panel level control on the loudspeaker protector for the lowest power and slowly increase the amplifier volume.



PARTS LIST

Two of each of the following is required for stereo.

Resistors all ½W, 5%
R1 15k
R2 100k
R3 220k
R4 1M
R5 10M

Potentiometers
RV1 100k lin. (dual)

Capacitors
C1 470n polyester
C2 10u 25V electrolytic
C3 220n polyester
C4 100u 25V electrolytic

Semiconductors
Q1 BD139
D1-D4 IN4002, or similar
D5, D6 IN914 or similar
IC1 4049B

Fig.2. (above) The component overlay for a stereo version of the loudspeaker protection module. Note the '100 upwards' component numbering of the second channel. Apart from the battery connections, the PCB is, in fact, symmetrical. Mains power was not employed because it is important that the module is operating at amplifier power up and the best way to ensure this is to use battery power! In normal use the battery (PP6) will last well-nigh its normal shelf-life as it draws virtually zero power until tripped. If you run the circuit so that it continually operates something is amiss — so stop it!

BUYLINES

Nothing unusual used in this circuit, so your local neighbourhood component emporium should be able to supply with no problems.

One thing we have heard in the past is that high value 5% resistors are not easy to obtain. In this design lower values of R4 and R5 must not be substituted.

When the power to the loudspeakers exceeds that set by the potentiometer the protector should trip in and disconnect the loudspeakers.

Turn the amplifier down, and the loudspeakers should be reconnected after about two seconds. Since loudspeaker power figures are a rather dubious quantity, it is probably best to establish the correct setting for the loudspeaker protector experimentally rather than just setting it to the rated power handling of your loudspeakers. Your ears are the best indication that the system is being strained. Set the loudspeaker protector so that it trips just below that volume where distortion starts to occur.

We have done extended tests on the protector, even to the point of connecting expensive loudspeakers and inducing power amp faults that would otherwise destroy a loudspeaker in seconds. In all of these tests the loudspeaker protector has performed well and it is a comforting thought that should a power amp fault occur, it will not take your loudspeakers with it. **ETI**

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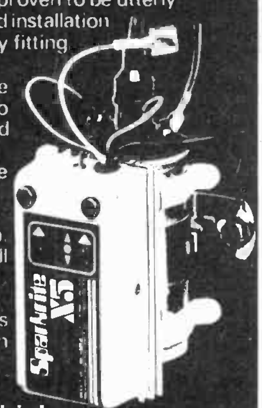

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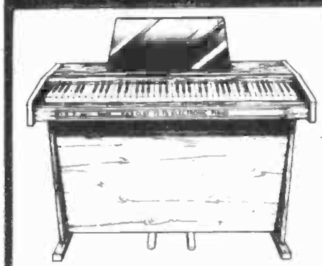

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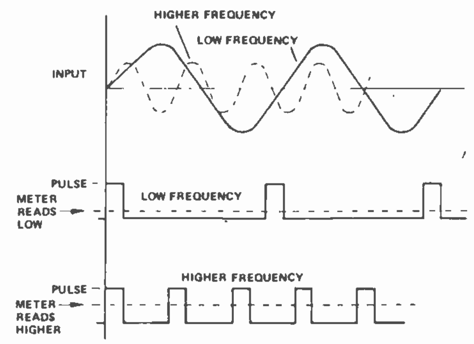
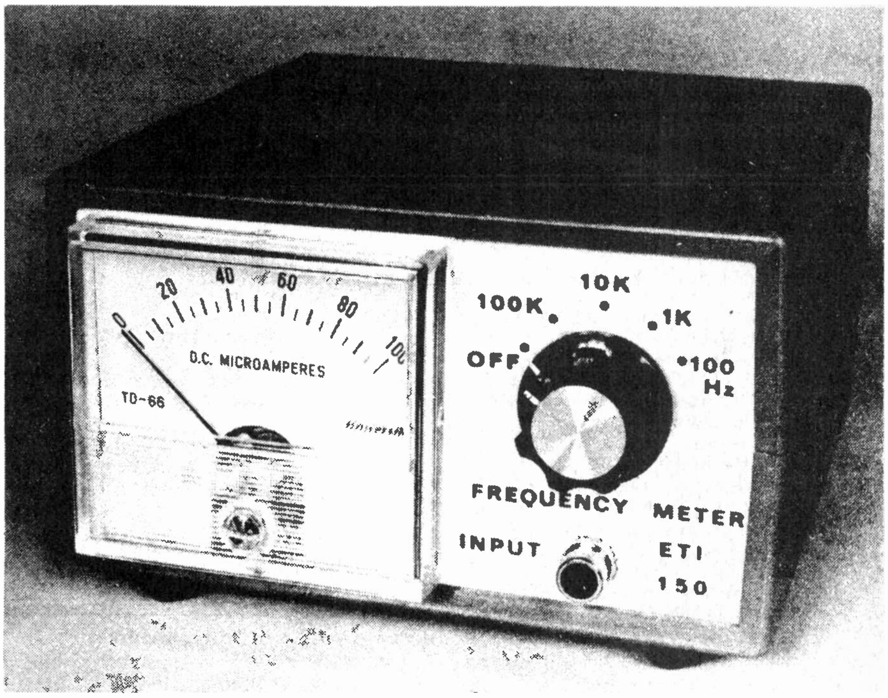


Above: waveform diagrams which indicate two possible sources of incorrect reading using a DFM. The drawings are self-explanatory on the whole.



There are many applications in the home workshop where simple audio frequency measurements are required. When experimenting with oscillators, building or repairing function generators etc, it is often handy to have some means of measuring frequency — accuracy to the last Hertz is not always required and thus a full-blown digital counter is not warranted.

This project will enable you to measure frequency from around 100 Hz right up to 100 kHz with an accuracy of a few percent. It is inexpensive to build but performance is quite adequate to meet a large number of needs in any hobbyist's workshop. Accuracy is unaffected by the waveshape of the signal being measured and the unit will accept signal levels as low as 200 mV. The input is fully protected against high signal levels and against DC voltages up to the rating of the input capacitor, C1. The input is also fully floating above earth — a useful feature.

The frequency meter may be powered from an internal 9 V battery or from a battery eliminator. A suitable socket may be installed on the rear of the cabinet.

Circuit Features

The circuit generates a series of short pulses at the same frequency as the input. These pulses drive a moving-coil meter the current through which will be the average amplitude of the pulse waveform; that is, it will integrate the pulses. This average will be proportional to the ratio of time the pulse is on to the time it is off. The time the pulse is on, that is — the pulse width, is fixed. At low frequencies, the time the pulse is off will be much, much longer than the time the pulse is on. Thus, the average current through the meter will be quite low. At higher frequencies, the time between pulses will be quite short and the average current through the meter will be quite a bit higher (as shown in the diagram). Thus, as the frequency of the pulses is proportional to the input frequency, the pulse on/off ratio, and therefore the meter current, will be proportional to the input frequency. The meter can be calibrated directly in frequency as the relationship is a linear one. We have used a 100 uA movement for convenience as it does not have to be rescaled.

→

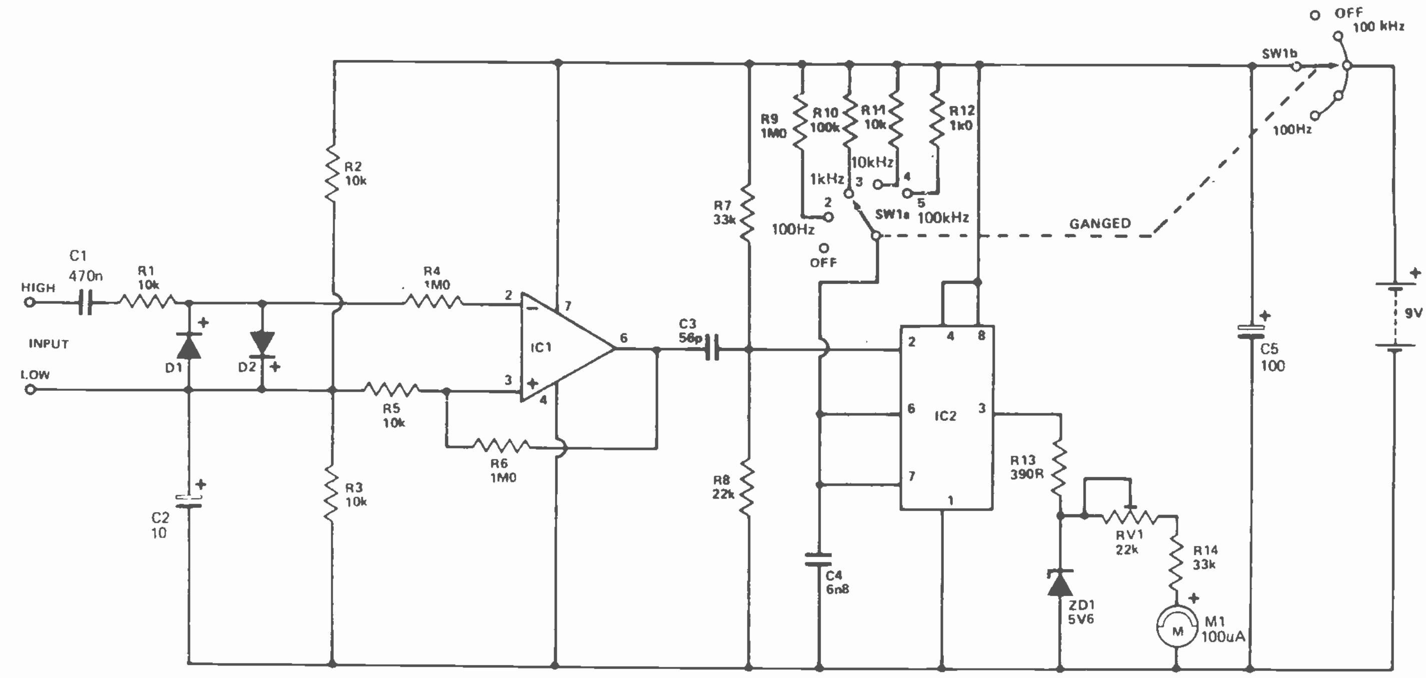


Fig.1. A full circuit diagram for the linear frequency meter.

HOW IT WORKS

The circuit consists of an op-amp operated as a Schmitt trigger to amplify and square the input signal, followed by a 555 timer wired as a monostable, giving a short output pulse of fixed width for each cycle of input signal. This pulse drives a moving-coil meter, the reading being an average of the pulse amplitude, which is proportional to the pulse frequency. As the pulse frequency is directly related to the input frequency, the meter reading is directly proportional to the input frequency.

The input signal is coupled into IC1 via C1, which provides DC blocking. Protection from overload caused by high amplitude input signals is provided by a diode clipper consisting of D1, D2 and R1. The diodes are connected in an inverse-parallel arrangement so that both positive and negative peaks, above the diode forward conduction voltage, are clipped.

IC1 is a fast op-amp connected as a Schmitt trigger with amplification, as mentioned above. Resistors R5 and R6 provide hysterisis, a 'dead band' in the action of the Schmitt, centred on zero input level. This dead band ensures that the Schmitt ignores noise pulses.

As the unit is required to operate from a single supply, for convenience, R2 and R3 bias the input of IC1 at half the supply voltage.

The output of IC1 is a train of square waves at the same frequency as the input. The output of IC1 is differentiated to provide short trigger pulses for the 555 timer, IC2. The differentiating network consists of C3, R7 and R8. This network is arranged to provide a trigger pulse that is always shorter than the output pulse of the 555. Capacitor C3 is selected to give the shortest possible pulse to the 555 consistent with reliable triggering.

The output of the 555 monostable will be a pulse of fixed width, determined by the range resistors, R9 to R12, and capacitor C4. The ranges are arranged to give a 75% output duty cycle at frequencies of 100 Hz, 1 kHz, 10 kHz and 100 kHz on the input.

The output pulse from the 555 is clipped at 5V6 by a zener diode, ZD1, to avoid inaccuracies caused by falling battery voltage (as the battery ages). The meter responds to the average value of the clipped pulses. As the frequency increases, the duty cycle (on/off ratio) of the pulse train increases, increasing the average voltage and thus the meter current in direct proportion. Thus the reading on the meter will be linearly related to frequency.

The lowest range is 100 Hz full-scale deflection, the highest, 100 kHz.

Only two cheap IC's are used in the whole design, a 3140 op-amp and a 555 timer. The 3140 amplifies and squares the input signal and was selected for its high slew rate, wide frequency response and high input impedance. The output of this stage will be a square wave of the same level for all input signal levels and waveforms.

The pulses are generated by a 555 timer connected as a one-shot monostable giving a single pulse output for each input cycle. The monostable has four ranges giving decade scales on the meter. A fifth position on the switch is used as a power switch.

Regulation of the output pulses by a zener diode preserves the accuracy of the unit with falling battery voltage.

Construction

As mentioned previously, we constructed our prototype in a plastic box. This has the advantage that the unit can be operated fully floating from earth — handy in some situations. Check placement of components on the front panel and the positioning of the PCB inside before commencing major assembly. It's probably best to assemble the components on the board first. Take care with the orientation of the ICs, diodes and tantalum capacitor.

The input capacitor, C1, can be obtained in several voltage ratings. Polyesters are available in ratings of 100 V, 250 V and 630 V. If all your work is with solid-state circuitry, a 100 V type will be more than adequate. If you anticipate using your unit with say, valve equipment, the highest rating type for C1 is recommended. The rating applies to the combined voltage that may be present on the input, *plus* the possible peak value of the input signal.

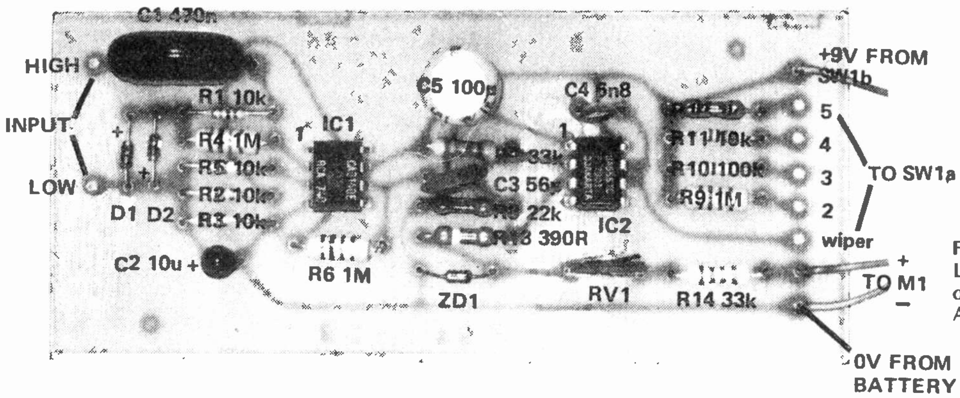


Fig.2. Component overlay for the ETI Linear Frequency Meter. Note the input and output connections from the PCB carefully. A couple of crossed wires here and . . .

PARTS LIST

Resistors All ½W, 5%	
R13,5,11	10k
R4,6,9	1M0
R7,14	33k
R8	22k
R10	100k
R12	1k0
R13	390R
Potentiometer	
PR1	22k Trimmer
Capacitors	
C1	470n polyester
C2	10u tantalum
C3	56p ceramic
C4	6n8 polyester
C5	100u 25V electrolytic
Semiconductors	
D1,2	1N914 or similar
ZD1	5V6, 400mW zener diode
IC1	3140 op amp
IC2	555 timer
Miscellaneous	
M1 100uA meter, SW1 two pole five position wafer switch.	

BUYLINES

As one of the criteria in designing the project was that it would be assembled from easy to obtain bits and pieces, it is (or should be)unlikely that any problems will be encountered in that area!

Boxing is not critical at all and the ever-present Vero range would serve as well as the one we employed here.

SPECIFICATION

Frequency	10Hz to 100kHz in four decade ranges
Minimum input	200 mV RMS
Maximum input	250 V peak AC or DC (dependent on voltage rating of C1)
Supply voltage	9 V

A 630 V rated capacitor will be physically larger than a 100 V type and the leads may have to be shaped to fit the capacitor on the board.

Once the board is assembled, the major components can be assembled onto the front panel of the case. We made up an overlay for the front panel.

The board may be mounted anywhere convenient in the case and wires run to the front panel for the input and switch connections. Make sure the board does not get in the way of the meter when the front panel is in place.

The unit may be powered from an internal battery, which makes it a handy portable unit. If you wish to operate the unit from a plugpack battery eliminator, then we recommend you purchase a unit giving a nominal 6 V DC output. The current requirement for the project is quite modest and the output of these small battery eliminators is dependent on the load. A 6 V unit will typically deliver 9 V or so under a light load.

If you do decide to use one of these units, a socket matching the unit's plug will have to be mounted on the rear panel and leads run to the supply rail pads on the board. If you wish to have the option of both battery and mains operation, then a small SPDT toggle switch should be mounted on the rear panel also and wired into the circuit.

Calibrating It

Calibration of the frequency meter is very easy, aided by the fact that it has a very high input impedance.

With the unit switched to the 100 Hz range, touch your finger to the input. There will usually be enough 50 Hz field from the electrical wiring in a building to drive the input. This will cause a deflection on the meter and RV1 should then be adjusted to give a meter reading of 50 (half scale). Move the unit near house wiring to increase the amount of signal to the input if a reading cannot be obtained.

If a signal generator of known accuracy is available the instrument can be calibrated on any range. Only one range need be calibrated as the others will automatically fall into line.

If it is impossible to obtain any reading on the meter, the coupling capacitor (C3) may have to be increased in value to say 100pF or 150pF. This component has been selected to give a very short trigger pulse into the 555 and has been found to work correctly, using the value shown in the circuit, with several different ICs.

Selecting the 100 kHz range will connect power to the unit and the unknown signal can then be applied to the input. Set the reading and switch to a lower range if required.

ETI

1

GENTS QUARTZ LCD, 5-function. Hours, minutes, secs, month, date, backlight.
ONLY £4.95

2

GENTS QUARTZ LCD. SAME AS 1 – Alternative style.
ONLY £4.95

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4

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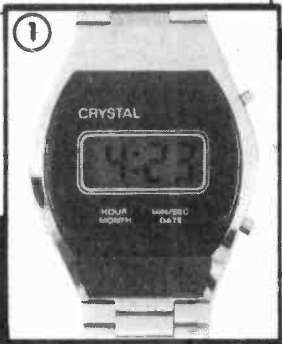

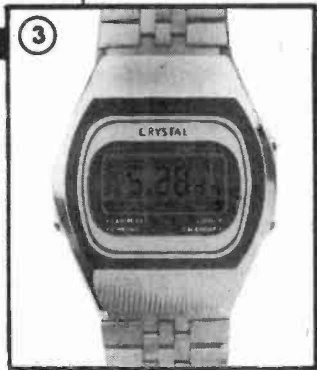

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QUARTZ LCD Musical Multi-Alarm/ Chronograph. 6-digit. Hours, mins, secs, day, date, 1/100 second stopwatch, split and lap modes, 24 hour alarm, countdown timer/alarm, dual time zone.
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CREDIT CARD CALCULATOR. Very slim with standard 4 functions plus memory, percentage and square root. Complete with a mock leather wallet with credit card pocket.
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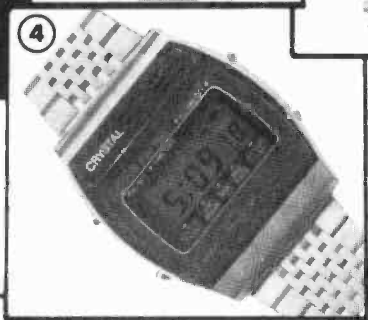
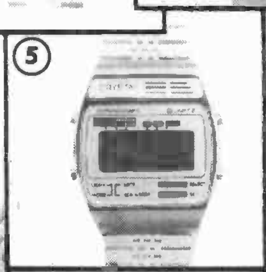
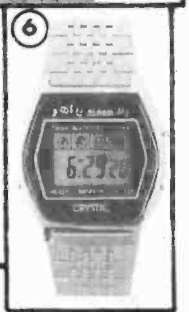

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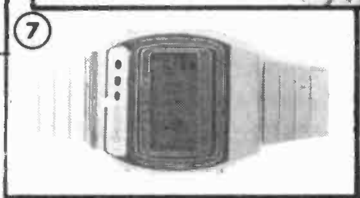
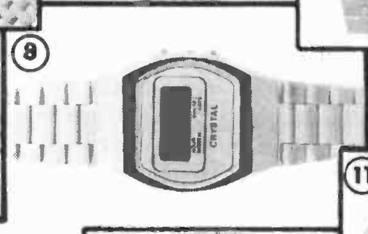

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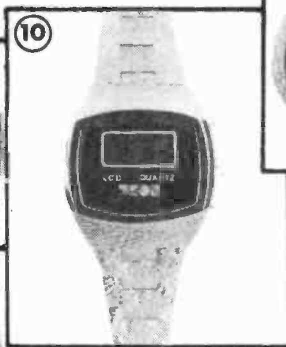
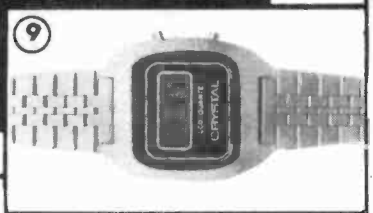

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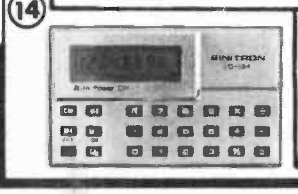

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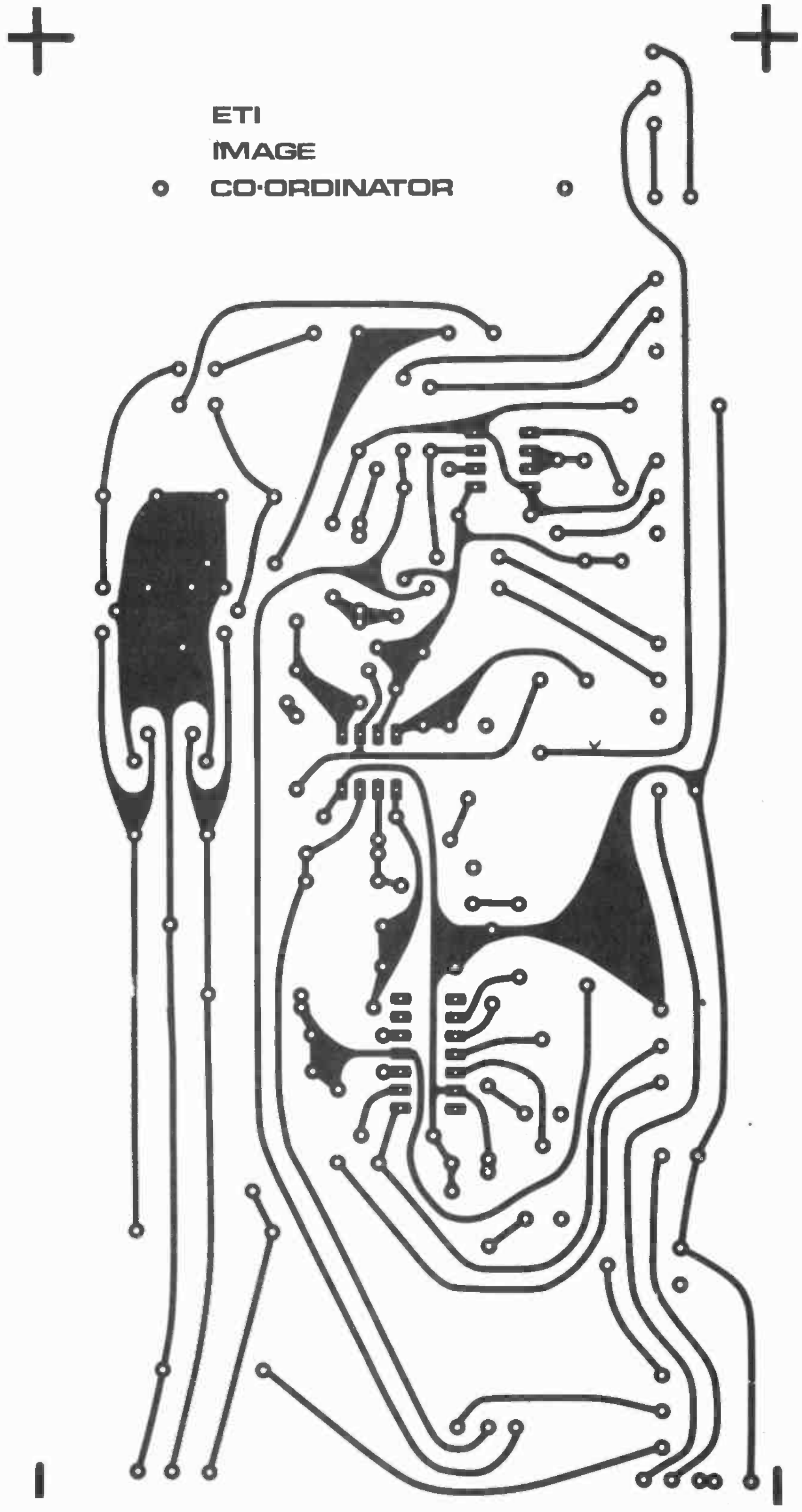
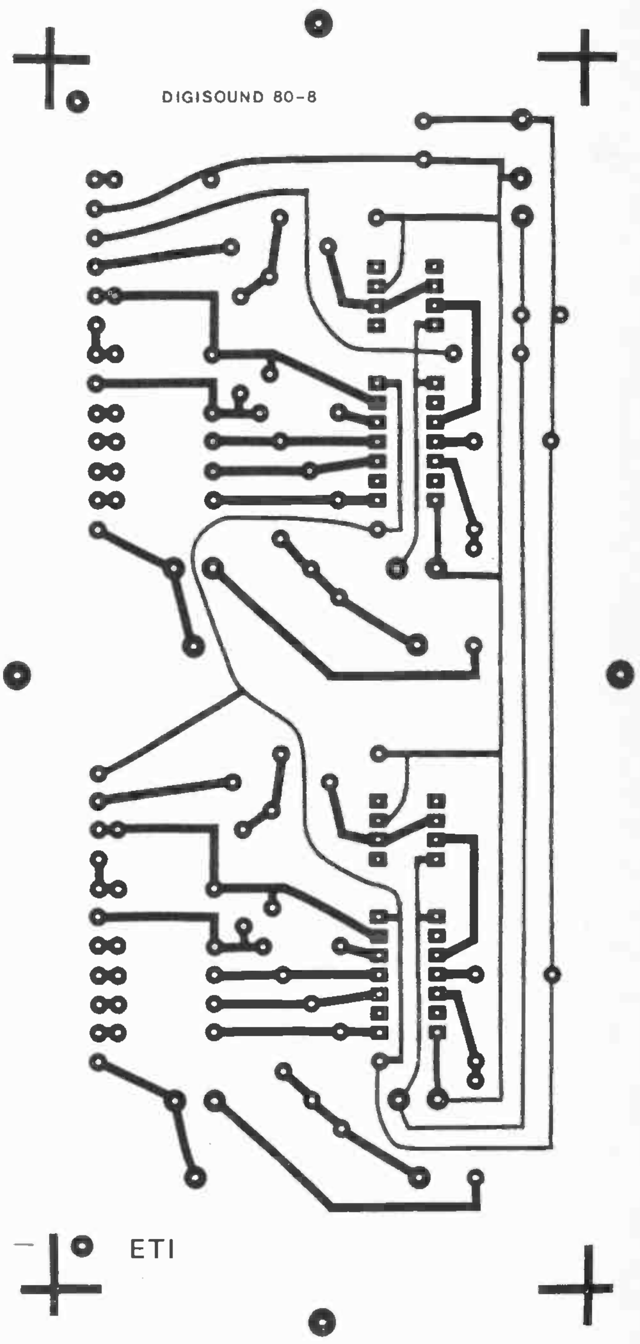
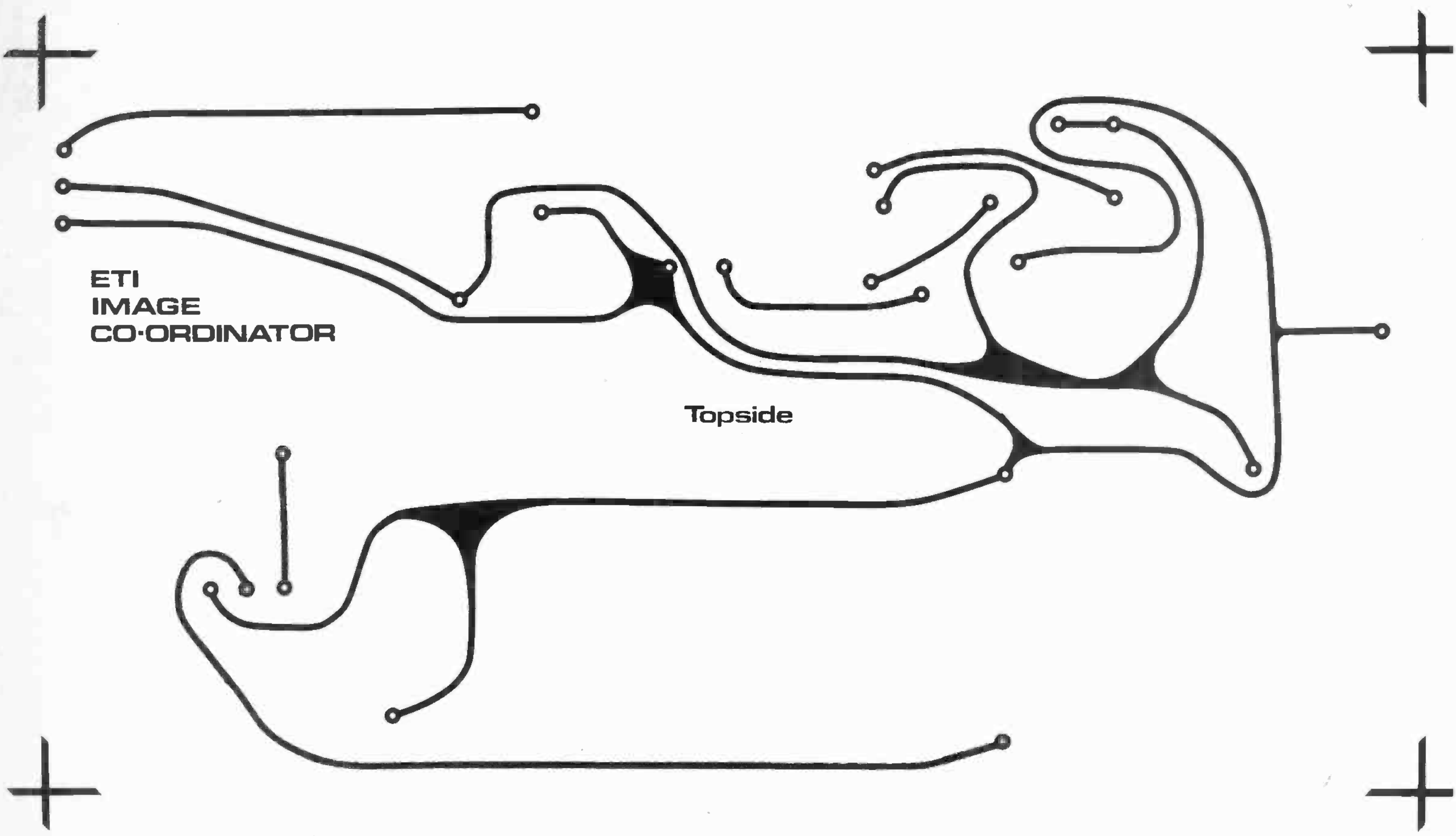
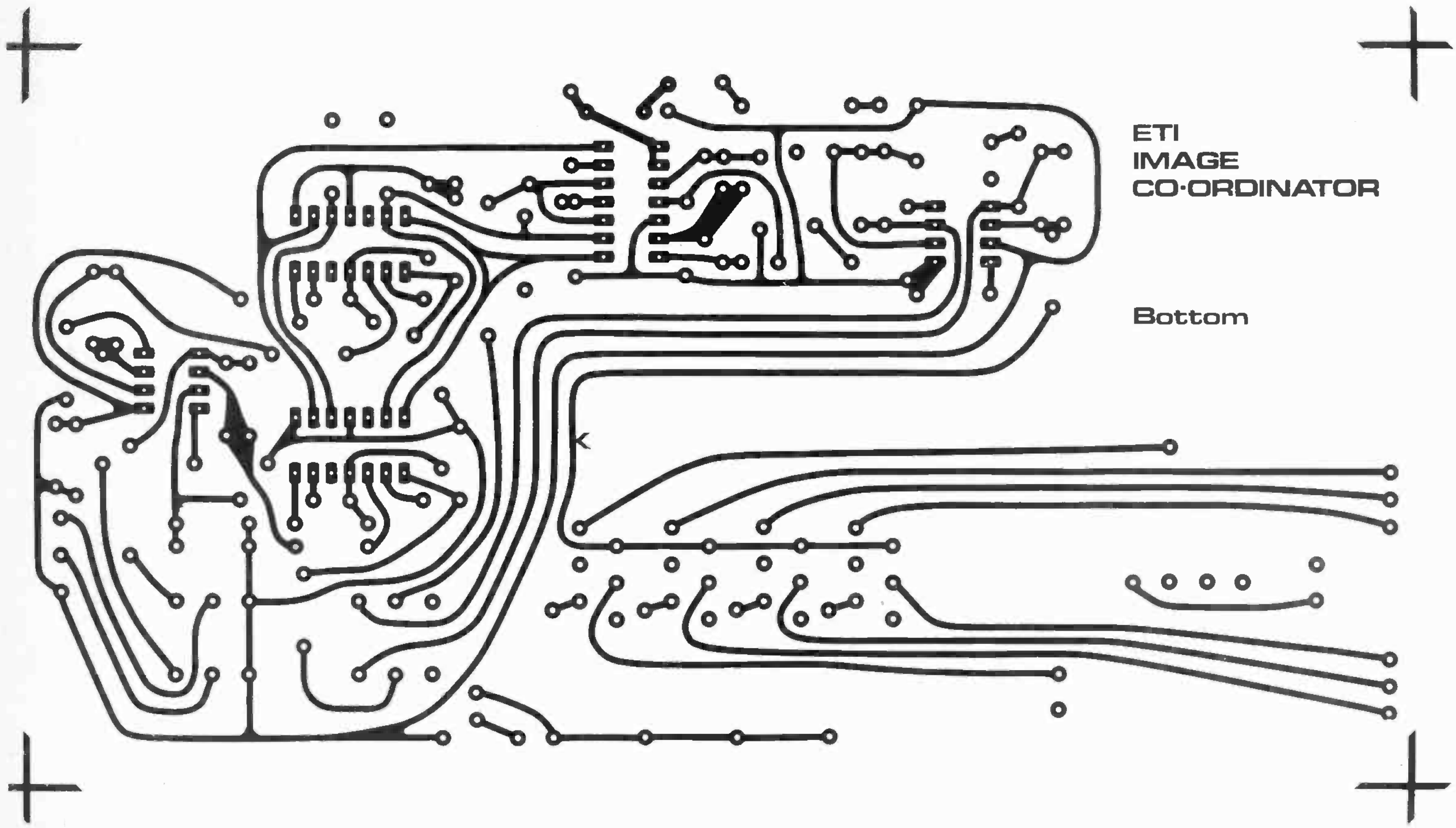
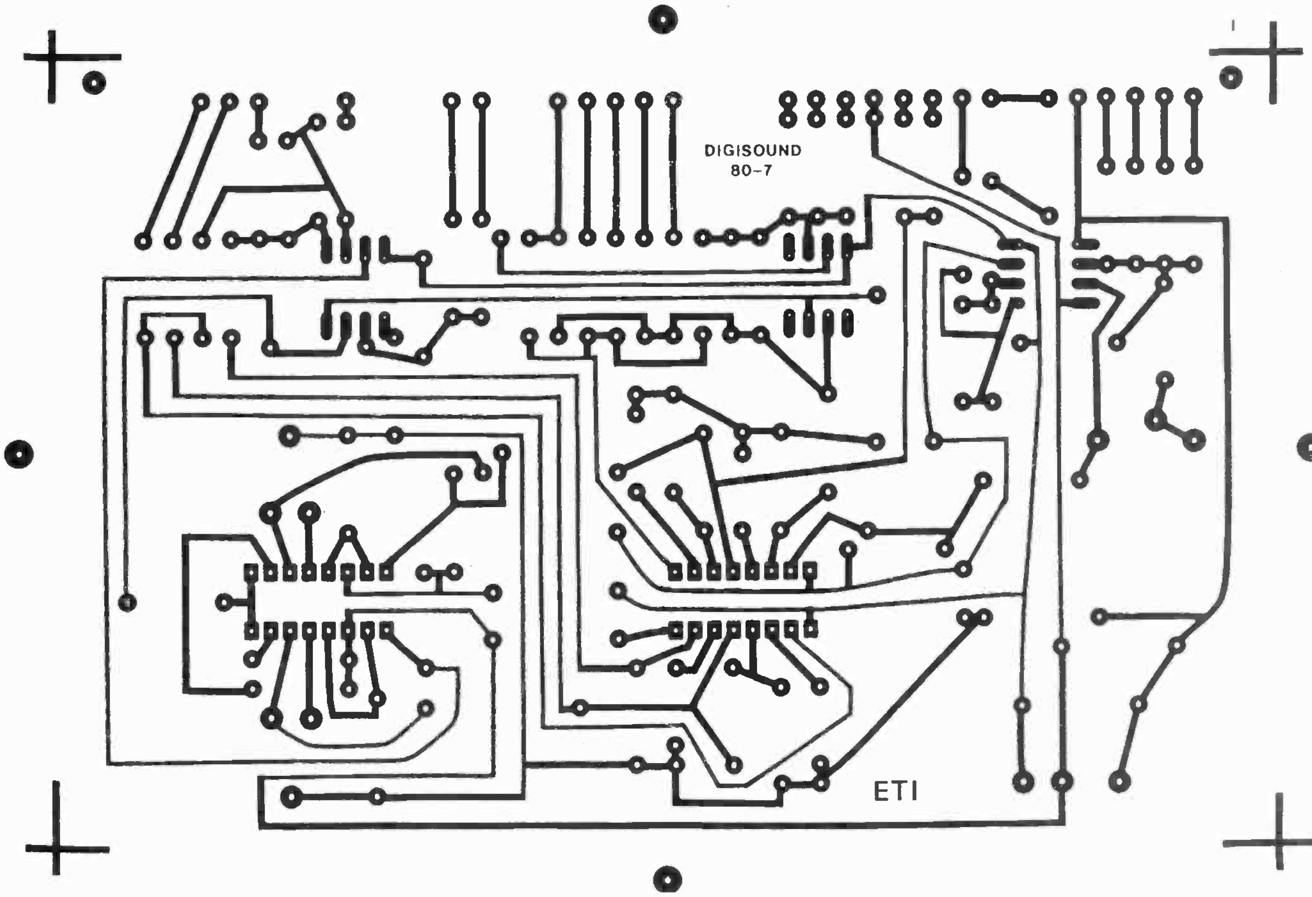
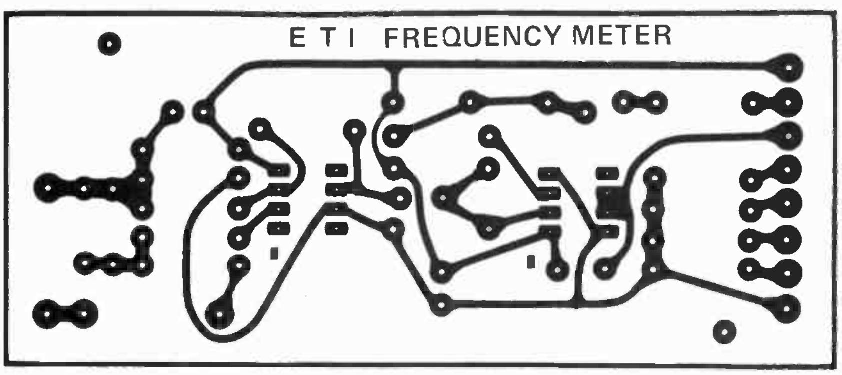


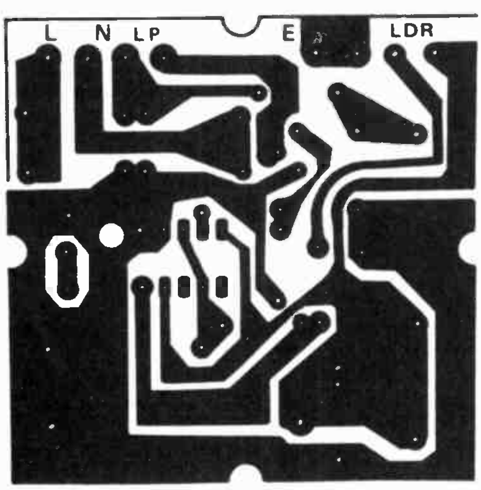



ETI
IMAGE
CO-ORDINATOR
Topside


ETI
IMAGE
CO-ORDINATOR
Bottom







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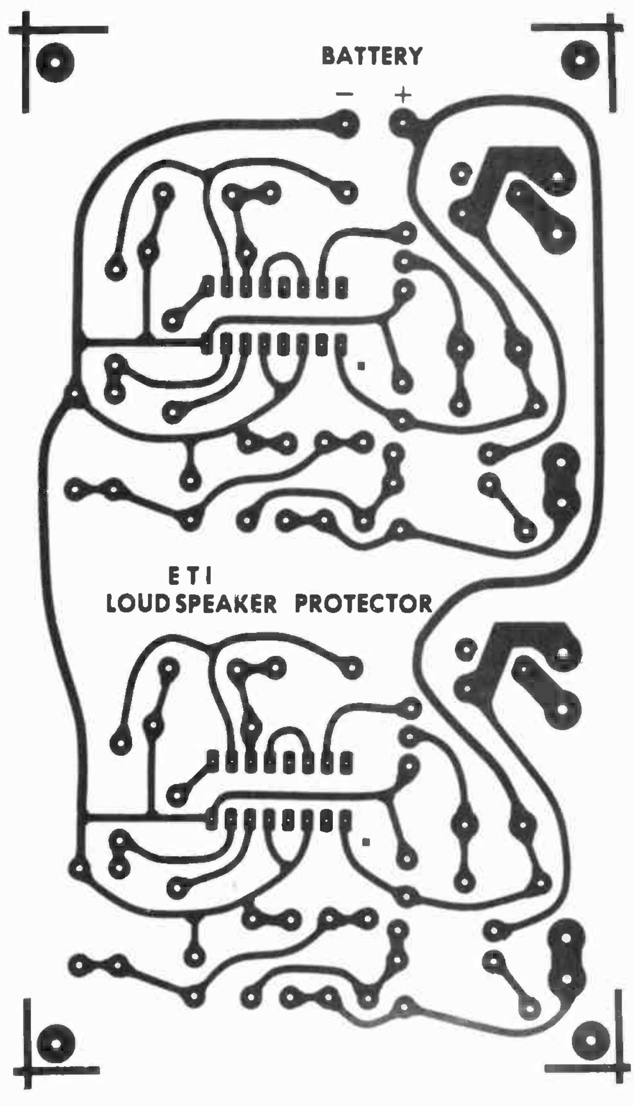

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- Excellent string-handling capability – takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input – to request a line of text when necessary. Strings do *not* need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up 26.
- Variable names of any length.
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The display shows 32 characters by 24 lines.

And Benchmark tests show that the ZX80 is faster than all other personal computers.

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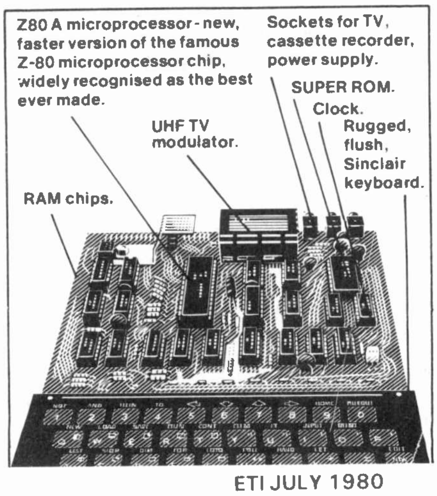

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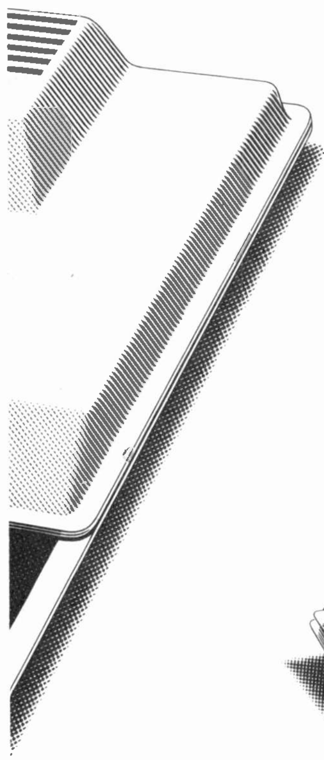

ZX80 software – now available!

See the advertisements in Personal Computer World (June) and Electronics Today International (July).

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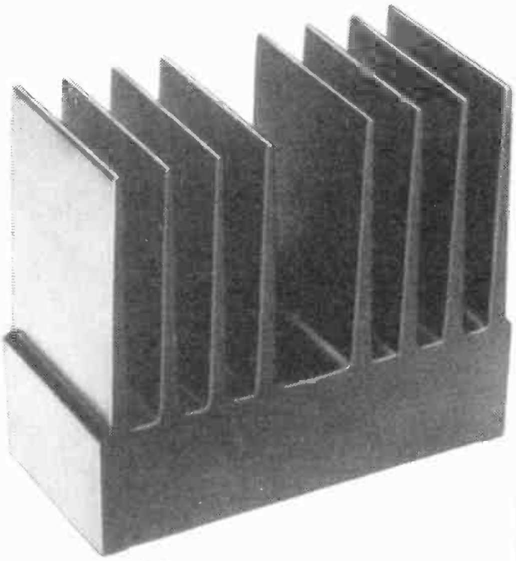

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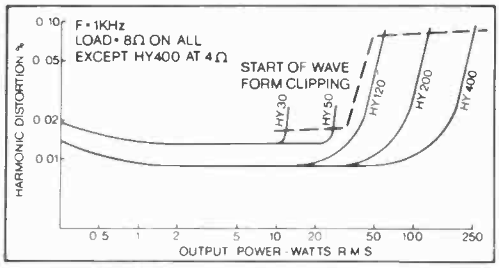

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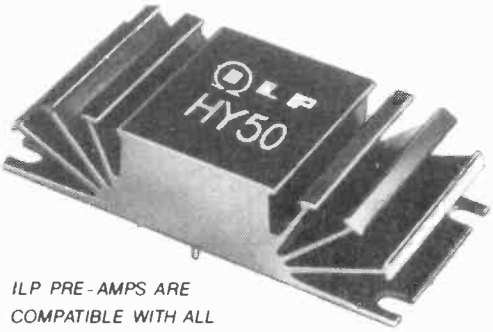

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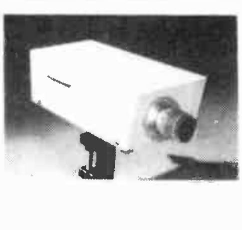

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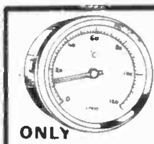

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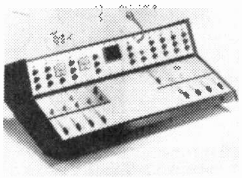

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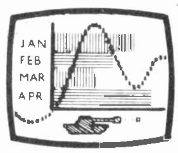

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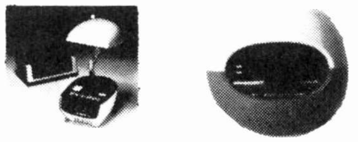

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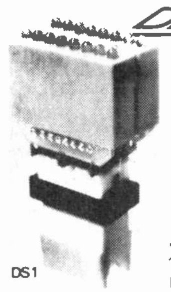
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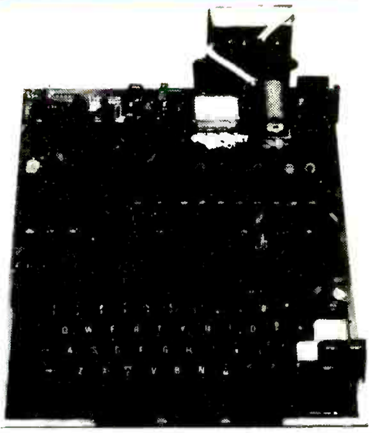

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