ISSN. 0142-7229

electronics today

INTERNATIONAL

JANUARY 1981 60p

ELECTRONICS IN PHOTOGRAPHY
an in-camera examination

High-Quality FM Tuner Project

Universal Digital Tacho

Computer Interface - Micro to Mainframe!

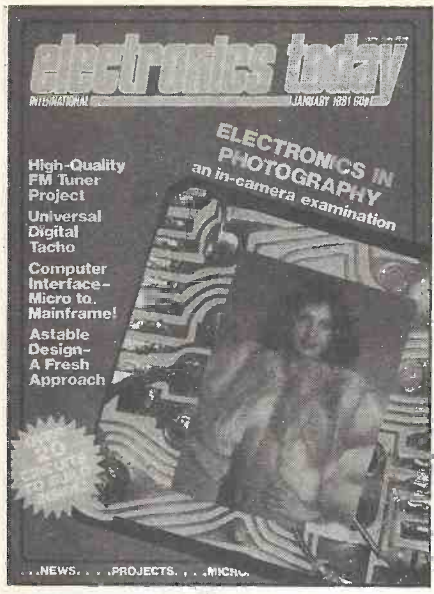
Astable Design - A Fresh Approach

OVER 20 CIRCUITS TO BUILD INSIDE!

. . .NEWS. . . .PROJECTS. . . .MICRO

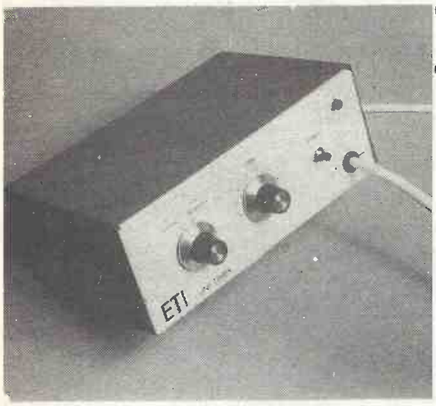
electronics today INTERNATIONAL

JANUARY 1981 VOL 10 NO 1



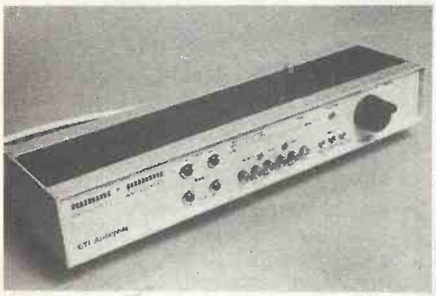
Watch the birdie p.88

FEATURES



Once upon a time p.36

PROJECTS



Spot the tuning p.62

INFORMATION

The hi-fi supermarket p.29

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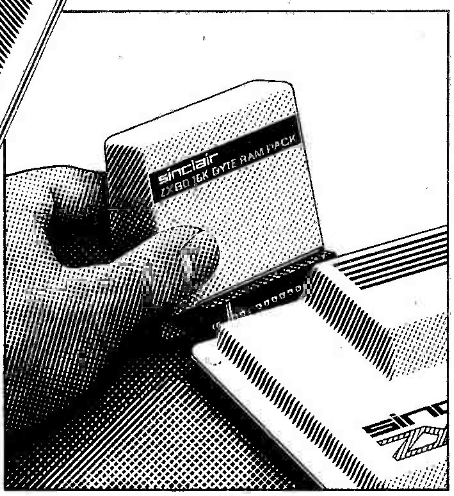
personal computer.

Now available for the ZX80...
New 16K-BYTE RAM pack



Massive add-on memory. Only £49.95.
The new 16K-BYTE RAM pack is a complete module designed to provide you – and your Sinclair ZX80 – with massive add-on memory. You can use it for those really long and complex programs – or as a personal database. (Yet it can cost as little as half the price of competitive add-on memory for other computers.)

For example, you could write an interactive or 'conversational' program to show people what your ZX80 can do. With 16K-BYTES of RAM, they could be talking to your computer for hours!

Or you can store a mass of data – perhaps in a fairly simple program – such as a name and address list, or a telephone directory.

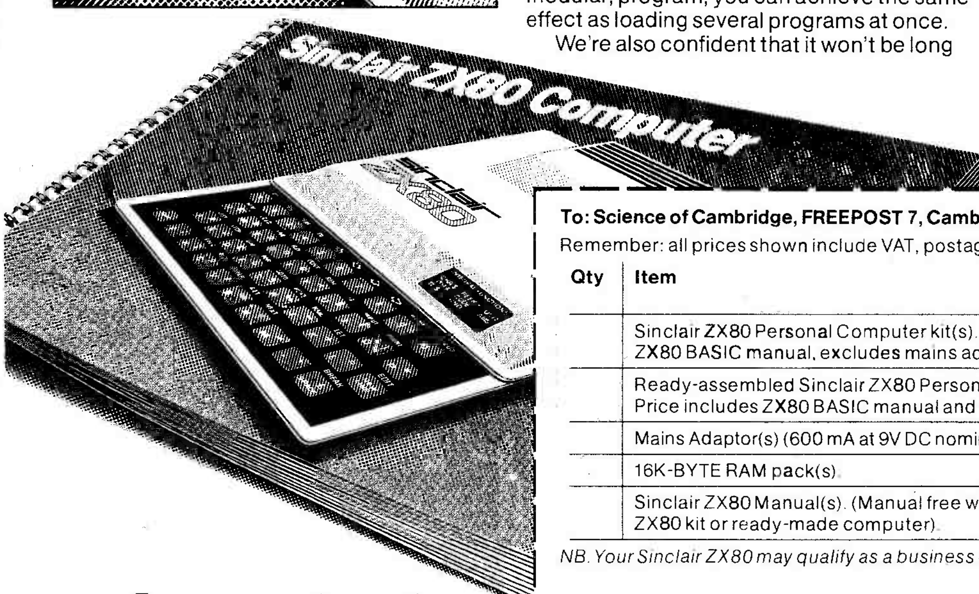
And by linking a number of separate programs together into one giant, but modular, program, you can achieve the same effect as loading several programs at once.

We're also confident that it won't be long before you can buy cassette-based software using the full 16K-BYTE RAM. So keep an eye on the personal computer magazines – and brush up your chess perhaps!

The RAM pack simply plugs into the existing expansion port on the rear of the ZX80. No wires, no soldering. It's a matter of seconds and you don't need another power supply. You can only add one RAM pack to your ZX80 – but with 16K-BYTES who could want more!

How to order

Demand for the ZX80 exceeds all other personal computers put together! So use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. We'll acknowledge each order by return, and tell you exactly when your ZX80 will be delivered. If you choose not to wait, you can cancel your order immediately, and your money will be refunded at once. Again, of course, you may return your ZX80 as received within 14 days for a full refund. We want you to be satisfied beyond all doubt – and we have no doubt that you will be.



sinclair ZX80

Science of Cambridge Ltd.

6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Tel: 0223 311488.

To: Science of Cambridge, FREEPOST 7, Cambridge CB2 1YY.

Remember: all prices shown include VAT, postage and packing. No hidden extras. Please send me:

Qty	Item	Code	Item price £	Total £
	Sinclair ZX80 Personal Computer kit(s). Price includes ZX80 BASIC manual, excludes mains adaptor.	02	79.95	
	Ready-assembled Sinclair ZX80 Personal Computer(s). Price includes ZX80 BASIC manual and mains adaptor.	01	99.95	
	Mains Adaptor(s) (600 mA at 9V DC nominal unregulated).	03	8.95	
	16K-BYTE RAM pack(s).	18	49.95	
	Sinclair ZX80 Manual(s). (Manual free with every ZX80 kit or ready-made computer).	06	5.00	

NB. Your Sinclair ZX80 may qualify as a business expense. **TOTAL: £**

I enclose a cheque/postal order payable to Science of Cambridge Ltd for £ ______
Please print
Name: Mr/Mrs/Miss ______

Address ______

______

FREEPOST – no stamp needed. ETI/1

WATFORD ELECTRONICS

33/35 CARDIFF ROAD, WATFORD, HERTS, ENGLAND
MAIL ORDER, CALLERS WELCOME
Tel. Watford (0923) 40588/9

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/ P.Os OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 40p TO ALL ORDERS UNDER £10. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE. ACCESS ORDERS WELCOME.

VAT Export orders no VAT. Applicable to U.K. Customers only. Unless stated otherwise, all prices are exclusive of VAT. Please add 15% to all prices.

We stock thousands more items. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/BR Station: Watford High Street. Open Monday to Saturday. Ample Free Car Parking space available.

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, **80p**; **40V:** 2, 33, **8p**; 100, **12p**; 2200, 3300, **85p**; 4700, **98p**; **35V:** 10, 33, **7p**; 330, 470, **32p**; **25V:** 10, 22, 47, 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, **22p**.
TAG-END TYPE: 450V: 100µF **180p**; **70V:** 4700, **165p**; **64V:** 3300 **150p**; 2500 **110p**; **50V:** 4700, **150p**; 3300 **135p**; 2200 **99p**; **40V:** 4700 **130p**; 4000 **92p**; 3300 **98p**; 2500 **90p**; **30V:** 4700 **110p**; **25V:** 15000 **195p**; 6400 **120p**; 4700 **100p**; 3300 **85p**; 2200 **60p**.

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 **80p**; 1µF **175p**.

POLYESTER RADIAL LEAD CAPACITORS: 250V:
10n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n **10p**; 220n, 330n **13p**; 470n **17p**; 680n **19p**; 1µ **22p**; 1µ5 **30p**; 2µ2 **34p**.

TANTALUM BEAD CAPACITORS
35V: 0.1µF, 0·22, 0·33, 0·47, 0·68, 1·0µ, 2.2µF, 3·3, 4·7, **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 **20p**.

POTENTIOMETERS: Rotary, Carbon, Track. 0.25W Log & 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**. **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	**36p**

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 **30p**

COMPUTER ICs

2114-450n	240
2114-300n	295
2708	445
27L08	995
2716-5V	750
4116	495
4047	750
6502	650
6520	350
6522	650
6530	1350
6532	850
6545	1450
6551	850
6592	2572
6800	700
6810	360
6821	500
6850	485
6852	485
8080A	499
8085A	1195
81LS95	135
81LS96	135
81LS97	140
8251	700
8253	1275
8T26A	235
8T28A	280
8T95N	160
8T97N	150
AY-3-1015	550p
AY-5-1013	395
AY-5-2376	980
DM8123	195
MC1488	90
MC1489	90
MC14411	1020
MC14412	1520
MK4027-2	450
MK4027-3	365
MK4027-4	350
MM5208D	TBA
MM8116N	TBA
MK4118-4	2099
RO-3-2513L	690
RO-3-2513U	650
SFF96364E	1050
SFC71301	820
TMS2516	850
TMS2716	1050
TMS4027	325
TMS4035	250
TMS4039	250
TMS4045	720
TNS4047	1083
TMS6011	365
Z80 CPU 2.5M	850
Z80A CPU4M	999
Z80 CTC	580
Z80A CTC	695
Z80 P10	610
Z80A P10	725

JACKSONS VARIABLE CAPACITORS

DILICON 100/300pF	**205p**	0 2 365pF with slow motion Drive	**450p**
500pF	**250p**	0 0 208/176	**350p**
6:1 Ball Drive 4511/DAF	**145p**	,, ,, with slow motion drive	**410p**
Dial Drive 4103 6:1/36:1	**775p**	C804-5pF: 10: 15: 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 (copper clad)	0.1 (plain)
2½ x 3¾	66p	59p	47p
2½ x 5	75p	69p	—
3¾ x 3¾	75p	—	—
3¾ x 5	86p	93p	72p
2½ x 17	225p	—	—
3¾ x 17	296p	260p	210p
4¾ x 17	390p	—	—

Pkt. of 36 pins **20p**. 'VQ' Board **150p**
Pin insertion tool **150p**. DIP Board **330p**
Spot face cutter **110p**. Veroblock **375p**
Spare spool **65p**. Combs **7p**

VERO WIRING PEN + Spool **350**
Spare Spool **85**
Combs **7**

DALO ETCH RESIST PEN + Spare tip **90**

FERRIC CHLORIDE
1 lb bag Anhydrous 225p + 40p P&P

ULTRASONIC TRANSDUCER
40KHz **350p pr**

COPPER CLAD BOARDS

	Fibre Glass Single-sided	Double-sided	SRBP 9.5"×8.5"
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 **295p**.

Ribbon Cable
10 way & 20 way available

Soldercon pins: 100 **60p**; 500 **275p**.

DIL SOCKETS (TEXAS) Low Wire

	Prof.	Wrap
8pin	10p	25p
14pin	12p	35p
16pin	13p	46p
18pin	16p	52p
20pin	22p	65p
22pin	25p	70p
24pin	30p	78p
28pin	35p	85p
36pin	—	105p
40pin	40p	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	25
AA119	18
AAZ15	15
BY100	24
BY126	12
BY127	12
CR033	157
OA9	50
OA47	12
OA70	12
OA79	15
OA81	15
OA85	15
OA90	8
OA91	8
OA95	8
OA200	9
OA202	9
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

NOISE
Z5J **180**

VARICAPS

BA102	25
BB105B	40
BB106	40
MVAM2	165
MVAM115	140

TRIACS

3A200V	49
3A400V	50
8A100V	54
8A400V	64
8A800V	108
12A100V	60
12A400V	70
12A800V	115
16A100V	110
16A400V	105
16A800V	195
25A500V	235
25A800V	195
T2800D	120

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**

Thyristors

IA/50V	37
IA/100V	42
IA/200V	47
IA/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

DIAC
ST2 **20**

75 SERIES

75108	350
75150	140
75154	150
75450	95
75451	70
75454	225
75491	89
75492	95

LINEAR ICs

702	75
709 14 pin	40
709C 8 pin	35
710	67
733	75
741 8 pin	18
747C 14 pin	78
748C 8 pin	36
753 8 pin	185
810	159
9400CJ	350
AY-1-0212	595
AY-1-1313A	660
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6721/6	210
AY-3-1015	550
AY-3-1270	840
AY-3-8500	390
AY-3-8910	850
AY-3-8912	796
AY-5-1224A	235
AY-5-1230	450
AY-5-1315	595
AY-5-1317A	630
AS-5-3500	350
AY-5-3600	1090
AY-5-4007D	450
AY-5-8100	775
CA3011	110
CA3012	175
CA3014	157
CA3018	68
CA3019	70
CA3020	186
CA3023	191
CA3028A	80
CA3035	235
CA3036	115
CA3043	275
CA3045	365
CA3046	70
CA3048	214
CA3059	195
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
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AJ	1950
ICM7216B	1950
ICM7216C	1950
ICM7217A	790
ICM7224	785
ICM7555	89
LD130	452
LF351	49
LF356	90
LM10	395
LM301AP	26
LM308T	95
LM311	70
LM318S	200
LM324A	50
LM339	68
LM348	90
LM349	115
LM379	415
LM380	80
LM381N	145
LM382	125
LM384	140
LM386	99
LM387	120
LM389	99
LM1458	45
LM2917	195
LM3900	60
LM3909N	70
LM3911	125
LM3914	240
LM3915	240
LM3916	255
LM733	99
LM13600	135
M252AA	625
M253AA	1150
MC663	50
MC1204	250
MC1301	79
MC1303	88
MC1304P	260
MC1310P	150
MC1458	45
MC1488	90
MC1489	90
MC1494	694
MC1495	350
MC1496L	92
MC1596	225
MC3302	150
MC3340P	120
MC3360P	120
MC3401	52
MC3403	135
MC3405	150
MFC6040	97
MK50398	635
MM5303	635
MM5307	1275
MM57160	620
MSM5526	820
NE515	275
NE529	225
NE543K	210
NE544	185
NE555	22
NE556	55
NE560	325
NE561	398
NE562B	410
NE564	435
NE565A	120
NE566	160
NE567V	170
NE570	450
NE571	420
RC4136D	110
S566B	275
SAB3209	425
SAB3210	275
SAS560	150
SAS570	150
SG3402	295
SL414A	275
SN76003N	240
SN76013	170
SN76013ND	130
SN76018	148
SN76023	170
SN76023ND	170
SN76033N	195
SN76115N	115
SN76131	125
SN76227N	95
SN76477	175
SN76660	120
SP8629	299
TAA621AX1	250
TAA661A	155
TAA700	250
TAD100	159
TBA1205	70
TBA540Q	220
TBA550Q	330
TBA641-A12 BX or BX11	250
TBA651	190
TBA800	90
TBA810	95
TBA820	70
TBA920Q	260
TBA990Q	270
TCA270Q	250
TCA965	120
TDA1004	290
TDA1008	310
TDA1022	575
TDA1024	105
TDA1490	290
TDA2020	320
TDA2030	320
TL061CP	46
TL062CP	90
TL064CN	159
TL071CP	45
TL072CP	90
TL074CN	140
TL081CP	42
TL082CP	70
TL083CP	95
TL084CN	120
UAA170	170
UAA180	170
XR2206	350
XR2211	575
XR2266	750
ZN414	95
ZN423	195
ZN424E	130
ZN425E	415
ZN1034E	200
ZN1040E	685

TRANSISTORS

	p
AC125	35
AC126	25
AC127	25
AC128	25
AC141	30
AC142	30
AC176	28
AC187	28
AC188	30
ACY17	70
ACY18	70
ACY19	75
ACY20	75
ACY21	75
ACY22	60
ACY28	75
ACY39	85
ACY41	85
AD142	120
AD149	79
AD161	42
AD162	42
AF118	95
AF124	70
AF126	65
AF139	40
AF178	75
AF186	70
AF239	78
ASZ21	125
BC107	10
BC107B	12
BC108	10
BC108B	12
BC108C	12
BC109	10
BC109B	12
BC109C	12
BC114	22
BC115	22
BC117	24
BC118	23
BC119	38
BC137	40
BC139	40
BC140	30
BC142	30
BC143	30
BC147	9
BC147B	10
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40468A	70
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40595	110
40603	110
40636	175
40673	95

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TTL 74 (TEXAS)

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S475	825

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LS221	120
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LS241	165
LS242	165
LS243	165
LS244	195

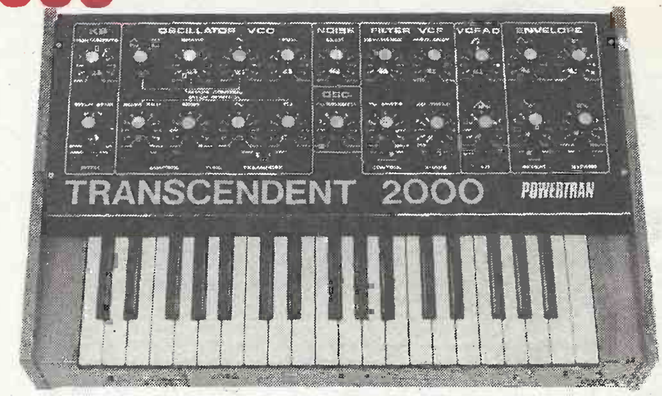
TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

Deigned by consultant Tim Orr (formerly synthesizer designer for EMS Ltd.) and featured as a constructional article in ETI, this live performance synthesizer, is a 3 octave instrument transposable 2 octaves up or down giving 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 team cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal film), 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 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.

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!

COMPLETE KIT ONLY £168.50 + VAT!



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

NEW! TRANSCENDENT POLYSYNTH

EXPANDABLE POLYPHONIC SYNTHESIZER

AS FEATURED IN THIS ISSUE!

COMPLETE KIT from £320 + VAT

By brilliant design work and the use of high technology components the Polysynth brings to the reach of the home constructor a machine whose versatility and range of sounds is matched only by ready-built equipment costing thousands of pounds. This latest addition to the famous Transcendent family is a 4 octave (transposable over 7 octaves) polyphonic synthesizer with internally up to 4 voices making it possible to play simultaneously up to 4 notes. An add-on unit permits expansion up to 8 voices. Each voice is a complete synthesizer in itself with 2 VCOs, 2 ADSRs, 1VCA and 1 VCF. Being voltage controlled all voices can be adjusted simultaneously by master controls yet their own pitch and gate signals mean each voice can be operated independently from the keyboard.

Although using very advanced electronics the kit is mechanically very simple with minimal wiring, most of which is with ribbon cable connectors. All controls are PCB mounted and the voice boards plug into PCB mounted sockets. The kit includes fully finished metalwork, solid teak cabinet, professional quality components (resistors 2% metal oxide or 0.5% and 0.1% metal film), nuts, bolts, etc. Complete kit with 1 voice £320, 2 voices £368, 4 voices £464, expansion unit to extend to 8 voices £295 (all prices subject to V.A.T.). A mere fraction of what you would have to pay for a ready-built comparable instrument!

TRANSCENDENT DPX MULTI-VOICE SYNTHESIZER

Another superb design by synthesizer expert Tim Orr published in Electronics Today International

COMPLETE KIT ONLY £299 + VAT!

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

The Transcendent DPX is a really versatile 5 octave keyboard instrument. These 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 as 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 as 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 vibrator comes in only after waiting a short time after the note is struck for even more realistic string sounds.

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!

POWERTRAN

MANY MORE KITS ON PAGE 115. MORE KITS AND ORDERING INFORMATION ON INSIDE FRONT COVER

All projects on this page can be purchased as separate packs, e.g. PCBs, components sets, hardware sets, etc. See our free catalogue for full details and prices.

DIGEST

Hitachi MAGic

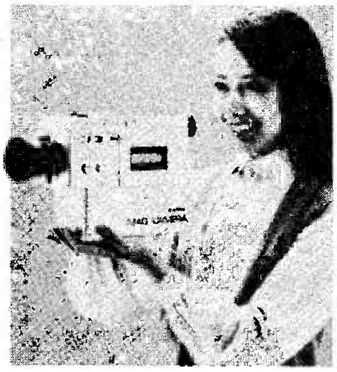
Hitachi have developed an experimental colour video camera combined with a video tape recorder — provisionally christened the 'MAG Camera'. Using high density recording techniques, the combination is little bigger than an 8 mm cine camera. The cassette, using ¼" tape, is almost as small as an audio cassette and allows two hours of recording/playback. The complete unit weighs only 2.6 kg, including a rechargeable battery pack. Watch this space for news on development of the MAG Camera.

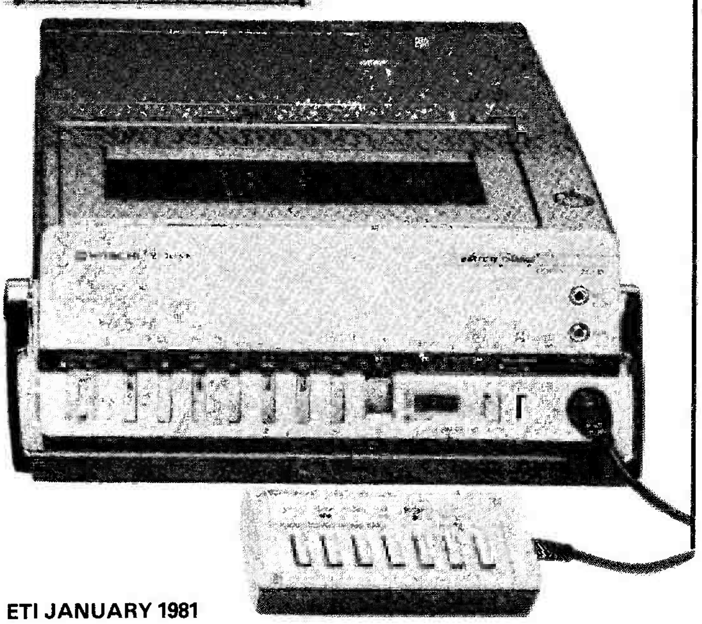
Hitachi have also launched a new portable VHS video recorder. The VT 7000 is one of the lightest in the world — just 5.9 kg. All the controls are of feather touch 'IC logic' operation, with a remote control facility. The recorder can be linked up with the VT TU 70 video tuner, which also doubles as an AC power source/charger for the recorder.

If you don't feel like getting up for a bowlful of breakfast telly, you can amuse yourself in bed with Hitachi's new K 2300 portable monochrome set combined with a quartz clock. The set has a 4½" tube and receives both VHF and UHF. Its four way power source means that the K 2300 can be used virtually anywhere — bedroom (mains/battery), car, caravan, garden or Santa's grotty (sorry) grotto.

The quartz clock can be used to switch the TV on or off, so you can use it as a snooze switch at night and a telly alarm in the morning. Also featured is an audio output socket, so that sound recordings can be made (naughty).

Now what about the pound notes? The VT 7000 is £579, the VT TU 70 £159 and the K 2300 £115. All prices include VAT.





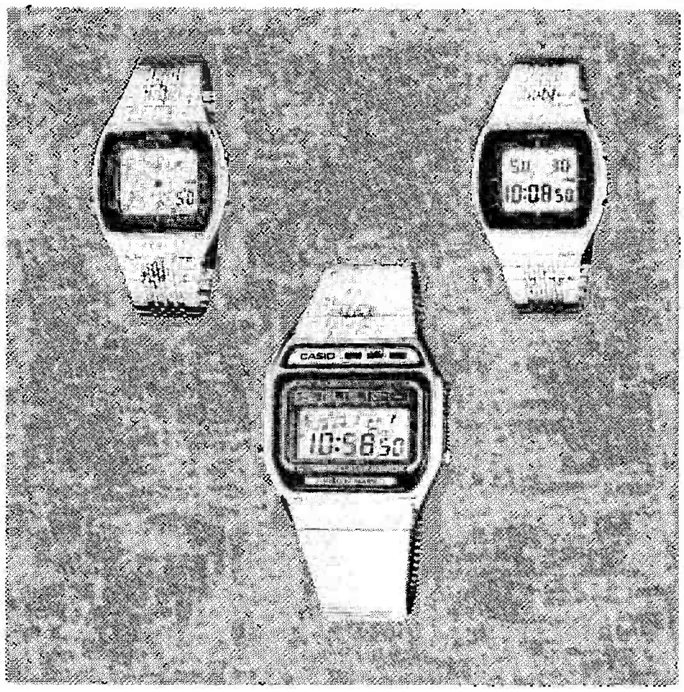
Hitachi's new MAG camera (top) combines video camera and recorder. The K2300 portable telly (left) is also an alarm clock. Their new VHS video recorder (below) is one of the lightest portables available.

Welsh Chip Shop

Within the next year construction work is to begin on the first Inmos large scale production facility in Newport, Gwent. Production of advanced very large scale integrated semiconductor devices for world-wide distribution should begin in 1982. Inmos is a subsidiary of the National Enterprise Board.

Ace Move

Business must be booming in Bately — Ace Mailtronix Ltd has moved into larger premises at 3a Commercial Street, Batley, West Yorks. WF17 5HJ. The Ace component catalogue, listing approximately 1,000 items, is available for 30p (refundable on orders above £5) to mail order customers. If you're passing through Batley (as one does), call into Ace and collect your copy free.



Anne O'Log Watches

Poor old Anne O'Log died a death when digital watches took off, but now she's in demand again. Casio's new AA81 is a digital watch with hands — nothing strange in that, you may say. However, the AA81 has no moving parts. It's all done with LCDs.

The display offers a choice of digital hours, minutes and seconds plus day and date (automatic calendar) OR hours and minutes on 'hands' plus digital seconds. There is also a wristful of extra features — stopwatch (to 1/100th of a second), daily alarm with variable tone pitch and count-down alarm/timer up to 60 minutes.

The Casio M12 doesn't have a hand in sight. Its speciality is playing tunes — a different one for every day of the week, if you feel the need. Its repertoire includes 'Happy Birthday', 'Wedding Bells' and 'Jingle Bells' for those special days in the year. It will also play the Big Ben chimes every hour.

The digitial display shows hours, minutes, seconds, AM/PM (or 24 hour clock), month, date and day (not all at once, of course). When it's sounding off, a musical stave magically appears on the display as the melody is played. AND the M12 features a countdown alarm/stopwatch function.

The Casio AA81 with chrome case, stainless steel bracelet and 18 month lithium battery costs £34.95. The AA83 (same features with stainless steel case and bracelet) costs £49.95 and the AA81G (gold plated) costs £54.95. The M12 costs £26.95 with resin case and strap or you can buy the same watch packaged in a stainles steel case and bracelet for £34.95 (the M1200). Casio's recommended retail prices are the maximum you can expect to pay, so shop around for bargains.

ELECTRONICS TOMORROW

Dave Raven of Metac Electronics reports on the development and applications of Surface Acoustic Wave devices.

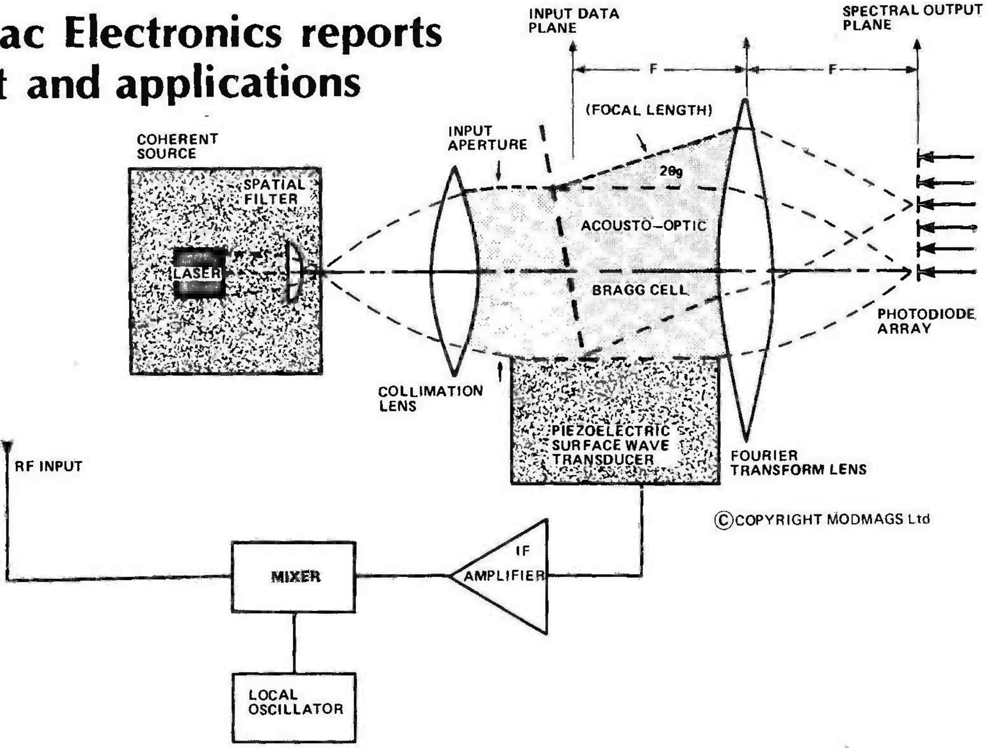


Fig. 1 An integrated optical spectrum analyser incorporating an acousto-optic Bragg cell.

It was at HMS Vernon (the Royal Navy's experimental station at Portsmouth) that wireless staff produced the first "Tuned Shunts" receiving circuit at the beginning of the 1900s. Ever since there has been an increasing demand for higher frequency tuners, filters and delay lines. Surface acoustic wave (SAW) devices have been with us now for over 10 years and are in common use for colour television receivers. They can be incorporated in bandpass filters for radio-frequency receivers, TV intermediate-frequency amplifiers and frequency synthesisers. Others serve as dispersive delay lines in linear frequency-modulated chirp radar, microscan receivers, as tapped delay lines in biphase-coded waveform generators and correlators and as convolvers with memory and programmable matched filters. Most of the applications for SAW devices occur in the high-frequency range. Crystal and LC filters both overlap the bandwidth and frequency range of SAW filters.

However, in the frequency region of 30 to 500 MHz and bandwidth range of 0.1% to 30% only SAW filters simultaneously offer reproducibility, reliability, low cost, selectivity and small size. The techniques used for producing SAW devices are similar to other solid-state devices so that low cost and high repeatability can be achieved. Once the mask has been designed, filters from one production to the next can be easily produced with identical characteristics. On the other hand, LC and discrete crystal filters require laborious tuning procedures.

Under The Surface

Until recently most SAW devices were fabricated on two particular substrate materials, lithium niobate and ST-cut quartz. Lithium niobate can achieve a large coupling coefficient but it has poor temperature stability. Frequency shifts are — 90 parts per million per °C. So it is used mostly for wider fractional bandwidth devices. A reasonable range of bandwidths is from 3% to 50% of centre frequency.

Quartz has a zero temperature coefficient at room temperature, but a low coupling coefficient. Minimum loss filters can be fabricated for bandwidths below 4%. Wide band devices are less desirable in quartz due to the much higher insertion loss. The physical constraints of the size of the substrate rule out filters at low frequency. A filter with a 100 MHz centre frequency, 40 dB side lobes, and a 0.1% bandwidth would require a four inch long substrate.

Thin Films

When comparing the fabrication of SAW devices to other solid-state devices, it should be pointed out that single crystal piezoelectric materials are not as easily produced in the same manner as, say, silicon slices for microchip production. The surface states of these materials are critical and, to enable cheaper volume production of SAW devices, development work is being carried out to produce thin film piezoelectric material. Research at Nottingham University in the Department of Electrical and Electronic Engineering is being carried out on producing thin film piezoelectric materials. One such material, zinc oxide, is of particular interest.

In addition to producing SAW devices it is possible to exploit both the optical and piezoelectric properties of zinc oxide. Work at Nottingham on producing thin film material using silicon with a layer of zinc oxide sputtered onto the surface has further shown that high quality device structures can be produced. Suggested applications are integrated optical spectrum analysers, acoustically scanned image devices, convolvers with surface controlling junctions and storage correlators. One other piezoelectric material which showed promise was gallium arsenide. Work has been carried out to produce a tapped delay line and, incorporated on the same slice, a field effect transistor which could be modulated by the surface acoustic wave.

Integrated Optics

The development of electro-optical components is a major new area for thin film technology and during the next 10 years integrated optics will become as familiar as integrated electronic circuitry. Once again it is at the materials stage that most of this work is taking place and it will be largely determined by the fabrication techniques and suitable film structures. It has been known for some time that techniques normally used in the production of electronic devices can also be used to form optical waveguides and components. The waveguiding is based on the creation of a localised region having a higher refractive index than the surrounding medium, leading to modes of propagation in which the light undergoes total reflection at each interface. Here once again, gallium arsenide is a promising material for the development of integrated optics and, as with attempts to combine an acoustic device with an electrical one, gallium arsenide fulfills the vast majority of requirements for optical circuits, in the emission and detection of light as well as modulation and guiding. Further, it should be possible to integrate the optics and electronic circuitry.

The Generation Game

Integrated optics can best be described as a kind of second-generation optical fibre telecommunications. The first generation employs multimode fibres and electroluminescent diodes. The evolving field of integrated optics combines single-mode fibres with laser diodes to increase information handling capacity, with control also at the optical level. The basic building blocks for an integrated optical circuit have reached an advanced state of development, where complete circuits are being attempted.

As always in high technology, a major role for integrated optics is seen in electronic warfare. An integrated RF spectrum analyser is used to detect RF pulsed signals from a dense signal spectrum. A leading application of integrated optics is in coherent optical signal processing. One approach to an integrated optical spectrum analyser incorporates most of the techniques discussed throughout the article, a piezoelectric zinc oxide transducer and integrated optics. A radio frequency signal is mixed with a coherent optical-signal carrier in a device known as an acousto-optic Bragg cell. The heterodyned RF signal is converted by a transducer into a surface elastic wave that travels through the Bragg cell. The wave alters the refractive index, producing a grating effect that deflects the optical beam. An array of photo detectors provides individual responses for each frequency—resolution cell.

SAW devices and integrated optics promise some very exciting developments in the next decade and once again it demonstrates how important and closely related the whole subject of physics is to electronics. **ETI**

THE REMOTE CONTROL STORY


ONCE UPON A TIME

If you wanted to control any equipment remotely you had to buy a dozen logic ICs, chase around the shops for crystals and expensive ultrasonic transducers and then spend a few days getting the unit to work. Then one day TK began stocking a new system. All you required was one IC, a couple of transistors, resistors and a keyboard for the transmitter and a couple of ICs plus a few capacitors for the receiver, to give you up to 16 on/off (digital) outputs or 10 channels plus three analogue (0-10V) outputs. The SL 490 transmitter/encoder accepts inputs from a keyboard (up to 32 way) and encodes these into a pulse train which may be transmitted using infra red, ultrasonic, radio or even wire links. For the receiver you may use the SL480 pre-amplifier if you want an infra red link or a suitable pre-amplifier for ultrasonic or radio links, and one of the ML920 series decoders depending on the number and type of outputs required. The only adjustment you need to make is to set one preset (by trial or with a 'scope) and that's it.

LD271 IR Emitting Diode	.36	ML926 16-channel receiver 4 momentary binary outputs	1.40
SFH205 Photodiode Detector	.95	ML928 16-channel receiver, 4 latched binary outputs	1.40
SL480 IC Pulse Amp.	1.70	ML929 16-channel receiver, 4 latched binary outputs	1.40
SL490 32 Command Encoder/transmitter	2.40		
ML922 10-channel receiver + 3 analogue outputs	4.20		

NEW ML925. A decoder designed for model/toy control, providing a 2-speed drive motor and three position latched steering system or a vehicle with momentary action steering and a third motor, eg. gun turret, winch, etc. Outputs also available for other facilities such as horn, turn indicators, headlights, etc. **2.10**

To make things EVEN EASIER, we have designed several new kits. —

MK6 — Simple Infra Red TRANSMITTER. A Pulsed infra red source which comes complete with a hand held plastic box. Requires a 9V battery. **4.20**

MK7 — Infra Red RECEIVER. Single channel, range approximately 20 ft. Mains powered with a triac output to switch loads up to 500W at 240Vac, but can be modified for use with 5 to 15V dc supplies and transistor or relay outputs. **9.00**

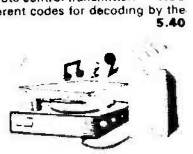
'Special Price' MK6 and MK7 together. Order as RC500K. **12.50**

MK8 — Coded Infra Red TRANSMITTER. Based on the SL490, the kit includes 2 IR LEDs, measures only 8x2x1.3 cms and requires a 9V (PP3) battery. **5.90**

MK9 — 4 Way KEYBOARD. For use with the MK8 kit, to make a 4 channel remote control transmitter. **1.90**

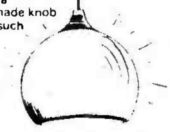
MK10 — 16 Way KEYBOARD. For use with the MK8 kit, to generate 16 different codes for decoding by the ML926 or ML928 receiver (MK12) Kit. **5.40**

MK12 — 16 Channel IR RECEIVER. For use with the MK8 kit with 16 on/off outputs which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Outputs may be latched or momentary, depending on whether the ML926 or ML928 is specified. Includes its own mains supply. **11.95**



Now you can buy all the components you require for your infra red system or complete kits from one supplier, at unbeatable prices, and live happily ever after.

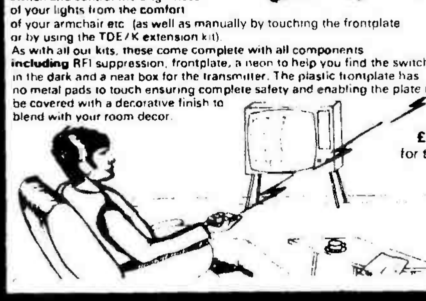
AND NOW A DIMMER THAT MAKES TOUCH DIMMERS OBSOLETE



Two years ago TK Electronics launched a touchdimmer kit, the TD300K, which made knob controlled dimmers obsolete. This was such a great success that many magazines and more retailers soon produced similar designs SO THAT OTHERS MAY FOLLOW. TK have designed a touch dimmer kit with an Infra Red Remote control enabling you to switch and control the brightness of your lights from the comfort of your armchair etc (as well as manually by touching the frontplate or by using the TDE/K extension kit).

As with all our kits, these come complete with all components **including** RFI suppression, frontplate, a neon to help you find the switch in the dark and a neat box for the transmitter. The plastic frontplate has no metal pads to touch ensuring complete safety and enabling the plate to be covered with a decorative finish to blend with your room decor.

We have designed the light dimmer unit to fit a standard wall box, the transmitter to fit your hand and the price to fit your pocket.



In two years time everyone will be selling remote control dimmers but you can have your TDR300K kit NOW for only **£14.30** for the dimmer unit and **£4.20** for the transmitter.

For the more athletic of you the TD300K is still available at **£6.50** and the TDE/K at **£2.00**

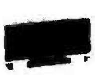
DON'T FORGET to add 40p P&P and 15% VAT to your total purchase

CT4000 CLOCK/APPLIANCE TIMER KIT

The CT4000 has been designed to preset the state (on or off) of four outputs at four times per day for up to 7 days in advance enabling the unit to control tape recorders, appliances, central heating, lights, etc. The times are set on a 0.1" high red LED display by means of a keyboard and the output states are displayed on four LEDs. Each output can switch up to 20mA at 9V. For mains loads use our Solid State Relay Kit (MK2). The kit includes a PCB, keyswitches, IC, 4 digit LED display, transformer, plus all other components and a screen printed and drilled box which can also accommodate up to 4 Solid State Relay Kits. **£25.25**

Size 10 × 12 × 4.5 cms
Colour: Black.

24HR. CLOCK/APP. TIMER KIT



Switches any appliance up to 1KW on and off at preset times once per day. Kit contains AY 5-1230 IC, 0.5" LED display, mains supply, display drivers, switches, LEDs, triac, PCBs & full instructions

CT1000K Basic Kit	£14.90
CT1000KB with white box (56/131 × 71mm)	£17.40
Ready Built	£22.50

LIGHTING CONTROL KITS

Directly replace conventional light switch and control up to 300W of lighting. No mains rewiring. Insulated touchplates. Easy to follow instructions.

TD300K TOUCHDIMMER. Single touchplate with alternate action. Brief touch switches lamp on and off, longer touch dims or brightens lamp. Neon lamp helps find the switch in the dark **£6.50**

TDE/K Extension kit for TD300K for 2-way switching, etc. **£2.00**

TSA300K TIME DELAY TOUCHSWITCH
Turns off after preset delay (2 secs. to 3½ mins) **£4.30**

LD300K Conventional Lightdimmer **£3.20**

DISCO LIGHTING KITS

Each unit has 4 channels (rated at 1KW at 240V per channel) which switch lamps to provide sequencing effects, controlled manually or by an optional opto isolated audio input.

DL 1000K
This kit features a bi-directional sequence, speed of sequence and frequency of direction change being variable by means of potentiometers. Incorporates master dimming control. **£14.60**

DLZ1000K
A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a preset pot. Outputs switched only at mains zero crossing points to reduce radio interference to minimum. **£8.00**

Optional Opto Input DLA1 **60p**

DIGITAL VOLTMETER/THERMOMETER KIT

Based on the ICL 7106. This kit contains a PCB, resistors, presets, capacitors, diodes, IC and 0.5" liquid crystal display. Components are also included to enable the basic DVM kit to be modified to a Digital Thermometer using a single diode as the sensor. Requires a 3mA 9V supply (PP3 battery) **£19.50**

MINI KITS

These kits form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB, short instructions and all components.

MK1 TEMPERATURE CONTROLLER/THERMOSTAT
Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater 1KW **£4.**

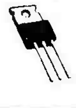
MK2 SOLID STATE RELAY
Ideal for switching motors, lights heaters etc from logic. Opto-isolated with zero voltage switching. Supplied without triac. Select the required triac from our range. **£2.60**

MK3 BAR/DOT DISPLAY
Displays an analogue voltage on a linear 10-element LED display as a bar or single dot. Ideal for thermometers, level indicators etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply **£4.75**

MK4 PROPORTIONAL TEMPERATURE CONTROLLER
Based on the TDA1024 Zero voltage switch this kit may be wired to form a burst fire power controller or a proportional temperature controller enabling the temperature of an enclosure to be maintained to within 0.5 C 3KW **£5.55**

MK5 MAINS TIMER
Based on the ZN1034E Timer IC this kit will switch a mains load on (or off) for a preset time from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component changes. Maximum load 1KW **£4.50**

TRIACS



400V Plastic Case (Texas)

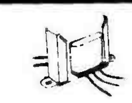
3A	49p	16A	95p
8A	58p		
12A	85p		
6A with trigger	80p		
8A isolated tab	65p		
Diac	18p		

INTEGRATED CIRCUITS

555 Timer	21p
741 Op Amp	19p
AY-5-1224 Clock	£2.60
AY-5-1230/2 Clock/Timer	£4.50
AY-3-1270 Thermometer	£8.20
ICL7106 DVM (LCD drive)	£7.00
LM377 Dual 2 W Amp	£1.45
LM379S Dual 6W Amp	£3.50
LM380 2W Audio Amp	80p
LM382 Dual/low noise Preamp	£1.00
LM386 250mW low voltage Amp	75p
LM1830 Fluid Level Detector	£1.50
LM2907 f-v Converter (8 pin)	£1.40
LM2917 f-v Converter (14 pin)	£1.60
LM3909 LED Flasher/Oscillator	60p
LM3911 Thermometer	£1.20
LM3914 Dot/Bar Driver	£2.10
MM74C911 4 digit display controller	£6.50
MM74C915 7 segment-BCD converter	96p
MM74C926 4 digit counter with 7 seg o/p	£4.50
S566B Touchdimmer	£2.50
S9263 Touchswitch 16-way	£4.85
SN76477 Complex Sound Generator	£2.52
TBA800 5W Audio Amp	68p
TBA810AS 7W Audio Amp	£1.00
TDA1024 Zero Voltage Switch	£1.20
TDA2020 20W Audio Amp	£2.85
ZN1034E Timer	£1.80

All ICs supplied with data sheets
Data Sheets only 10p each device.

MINI TRANSFORMERS



Standard mains primaries 240V a.c.
100mA secondaries

6-0-6V	80p
9-0-9V	85p
12-0-12V	90p

LEDs

LEDS	
0.1" Red	9p
0.1" Green	12p
0.1" Yellow	12p
0.2" Red	9p
0.2" Green	12p
0.2" Yellow	12p
0.2" clips	3p
Rectangular Red	18p
Rectangular Green	20p
Rectangular Yellow	21p

DISPLAYS

DL304 Red 0.3" c.c. pin compatible with DL704	75p
DL307 Red 0.3" c.a. pin compatible with DL707	75p
DL727 Dual 0.5" c.a. Red	£1.50

CMOS

4000	17p	4019	42p	4069	19p
4001	18p	4023	22p	4070	19p
4002	18p	4025	21p	4071	18p
4007	17p	4026	£1.30	4077	26p
4011	19p	4027	40p	4081	20p
4012	17p	4028	50p	4093	54p
4013	38p	4040	80p	4501	24p
4015	75p	4049	38p	4511	90p
4016	35p	4050	40p	4514	£1.80
4017	70p	4060	£1.08	4516	£1.80

BOXES

Moulded in high impact ABS. Supplied with lids and screws. Black.

B2 95 x 71 x 35mm	85p
B3 115 x 95 x 37mm	95p

D.I.L. I.C. SOCKETS

8 pin	8p	18 pin	17p
14 pin	12p	28 pin	24p
16 pin	14p	40 pin	36p

Soldercon Pins **50p/100**

ZENER DIODES

400mW 3.3V-30V	8p
1.3W 7.5-27V	15p

RESISTORS

¼W 10ohm-10M E12 Pack of 10 (one value)	10p
10 Packs (10 values)	80p

CAPACITORS

Polyester 250V

0.01	6p	0.22	12p
0.002	6p	0.33	12p
0.033	7p	0.47	15p
0.047	7p	0.68	18p
0.068	7p	1.0	24p
0.1	7p	1.5	27p
0.15	12p	2.2	31p

Electrolytics A Axial R Radial

63V	1.0	R	5p	16V	10	R	5p
	2.2	R	5p		22	R	5p
	4.7	R	6p		33	R	5p
	10	R	7p		47	R	6p
	47	R	12p		100	R	8p
25V	22	A	8p		220	R	11p
	47	A	10p		470	R	14p
	100	A	14p		1000	R	20p
	110	A	15p	10V	47	A	8p
	470	A	24p		100	A	8p
	1000	A	34p		220	A	12p

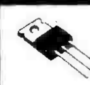
Tantalum (bead)

35V	0.1	9p	10V	22	20p
	0.22	9p	6.3V	33	20p
	0.47	9p		47	27p
	1.0	9p	3V	100	27p
25V	2.2	10p			
	4.7	14p			
	10	20p			

Ceramic 50V

		1,000pF	4p
100pF	4p	2,200pF	4p
220pF	4p	4,700pF	5p
470pF	4p	10,000pF	5p

VOLTAGE REGULATORS



Available in 5V, 12V & 15V versions.

78L series 100mA pos	26p
79L series 100mA neg.	60p
78 series 1A pos.	52p
LM317T adjustable 1.2V-37V 1.5A	£1.80

RECTIFIERS

1N4001 1A/50V	4p
1N4004 1A/400V	6p
1N5401 3A/50V	8p
1N5404 3A/400V	10p
1A 50V Bridge	19p
1A 400V Bridge	22p
3A 50V Bridge	48p
3A 400V Bridge	58p

(Bridge rectifiers are miniature PCB mounting types)

VMOS POWER FETS

VN10KM 0.5A/60V (TO92)	52p
VN66AF 2A/60V (TO220)	88p

TRANSISTORS

BC108	8p	BFY50	20p
BC182	8p	TIP31A	40p
BC182L	8p	TIP32A	40p
BC212	9p	2N3055	45p
BC212L	9p	2N3442	90p
BC337	16p	2N3819	20p

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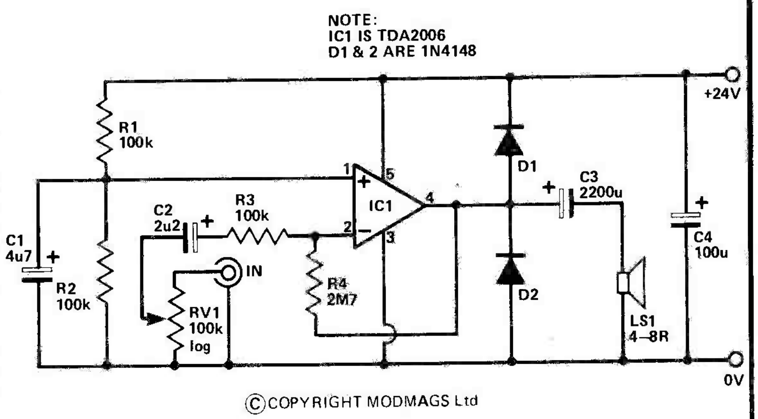
(ETI), 11 BOSTON ROAD
LONDON W7 3SJ. 01-579 9794

8 Watt Audio Amplifier

Using a modern audio power amplifier IC, it is easy to produce an amplifier giving several watts of output with quite good quality. This amplifier is based on the TDA2006 and gives about 8 W RMS into an 8R speaker, or 12 W when using a 4R load. At most output powers the distortion is typically only a fraction of one percent, but it does rise significantly at higher output levels.

The TDA2006 is in many ways like an operational amplifier, but it has a class B power output stage. In this circuit it is used in the inverting amplifier mode with R1 and R2 forming a potential divider that biases the non-inverting input to half the supply voltage. C1 filters out hum and noise which might otherwise be coupled from the supply lines to the non-inverting input via the bias circuit. The inverting input is biased by R4 and together with R3 this resistor forms a negative feedback circuit, which sets the voltage gain and input impedance of the amplifier. As would be the case with an operational amplifier, the voltage gain is equal to R4 divided by R3 and the input impedance is equal to R3. With the values shown this gives a voltage gain of 27 times and an input impedance of 100k. However, within reason these figures can be modified by changing the values of R3 and R4. RV1 is the volume control and does of course shunt the input impedance of the circuit as a whole (down to as little as 50k with the specified values).

As the TDA2006 has a supply ripple rejection ratio of 50 dB, it is not essential to use a very well smoothed supply, but it is important that the device's 30 V maximum supply voltage rating is not exceeded. The maximum average supply current is a little over 500 mA when using an 8R speaker and about 800 mA when using a 4R load. The TDA2006 should be mounted on a substantial heatsink, but has thermal shutdown circuitry, which protects it against overheating. It also incorporates output current limiting circuitry.



THE ZX80 COMPANION

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SOUND EFFECTS MODULE Brand new, designed for 'Spaceman' toy. Gives 5 audio/visual programs. Requires 8 ohm speaker (not supplied). **85p.** Cat. No. 108.
SIMULATED LASER CANNON for spaceman toy. LEO on moulded 6" lead with mini jack plug. Fits socket on Sound Effects Module. Only **20p** each
GIANT LED DISPLAY Common cathode, non-Multiplexed super 4 digit LED clock display. Lots of other uses too. Only **£3.95** each. Cat. No. 204.
DIGITAL MULTIMETER CHIP Builds into high accuracy dvm or panel meter. Requires additional circuitry. With data and circuit. MM5330 only **£3.55.** Cat. No. 404.
POLARISING FILTER MATERIAL 0.006" thick plastic film. Any size cut — even 1 sq. inch. Max. width 19", any length. Only **3p** per sq. inch. Cat. No 701
DIGITAL ALARM CLOCK CHIP MM5316 alarm clock chip. With data **£2.35.** Cat. No. 203.
LED DISPLAYY Red, common anode 0.3" digits with crisp, bright segments, 14 pin DIL package. Super value at **52p.** Cat. No. 313.
MINI 8 DIGIT LED DISPLAY 8 digit, 7 segment calculator style display. Common cathode, multiplexed, with 0.1" high digits. **99p** each Cat. No. 312
20 KEY KEYBOARDS. Calculator keyboards, excellent key action. 20 keys per board. 2 keyboards for **99p.** Cat. No. 101.
0.1" LED WRISTWATCH DISPLAY. High brightness display in 'legless flatpack' style package. Requires fairly fine soldering. With data. **99p** each or 2 for **£1.50.** Cat. No. 209.
MOMENTARY SWITCHES Miniature push button switches (spring loaded) with one normally open contact. Super value at **15p** each. Cat. No. 703.
SLIDER SWITCHES A miniature slide switch with 2 pole change-over contacts. All brand new. **16p** each. Cat No. 702.
2102 MEMORIES (static RAM's). A snip at **99p** each. With data. Cat No. 102.
RESISTORS 1 ohm to 10 megohms E12 series, 2 ohms to 1 megohm E24 series. ¼w, 5% **2½p** each or **8p** for five of same value.
CAPACITORS 25V electrolytics 1.0, 2.2, 4.7, 10uF, **6p** each. 22, 47uF, **8p** each. 100uF, **10p** each. 220uF, **12p** each. 470uF, **18p** each.
100v Mylar 0.001, 0.002, 0.0033, 0.0039, 0.0047uF, **6p** each. 0.01, 0.022, 0.025, 0.033uF, **7p** each. 0.04, 0.05, 0.1uF, **8p** each.
100v ceramic plate 1.8pf to 47pf, **5p** each. 56pf to 4700pf, **6p** each
TRANSISTORS BC207, **15p** each. BC251B, **15p** each. BD135, **28p** each. BD136, **28p** each.
DIODES 1N3470, **4p** each or 25 for **50p.** 1N4003, **5p** each. 1N4148, **3p** each. 1N4151, **5p** each or 10 for **35p.**
CALCULATOR CHIP Nortec 4204, 4 function and constant. Not compatible with our calc. kybds. With data and calculator circuit, **80p.** Cat. No. 408.
BRIGHT ORANGE DISPLAY 9 digit, 7 segment gas discharge display. 0.25" high digits. With data, only **75p** each. Cat. No. 310.

Untested Items

FLUORESCENT CALCULATORS Manufacturers rejects. Most repairable but no guarantees. 10 function with full memory. With 'repairing calculator' info **£2.50.** Cat. No. 107.
LED DISPLAYS (untested — no guarantees) 10 seven segment LED displays. 0.127" digits, common cathode, 10 for **99p.** Cat. No. 311.

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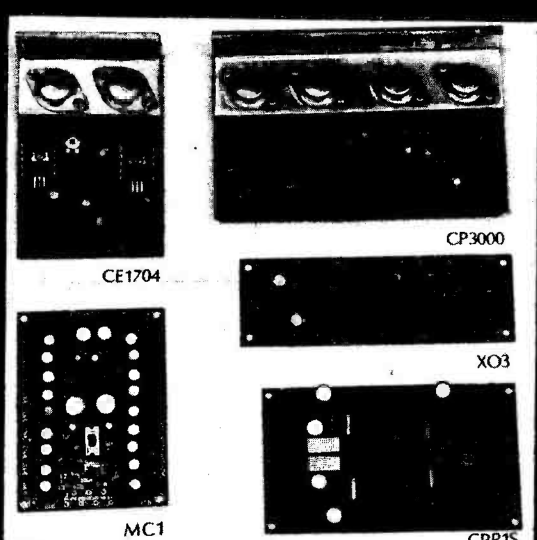
Crimson modular audio amplifiers feature: ✱Low values of transient and steadystate distortions ✱Envelope distortion (below 500 Hz) less than 0.05% ✱on-board electronic protection ✱P.C.B. pin and edge connector termination ✱ Full range of complimentary components, i.e. P.S.U.'s, heatsinks etc. available from Crimson.



The Crimson range of amplifier modules are built to very high standards and have earned an enviable reputation in every field to which they have been applied. The boards come ready built and tested (guaranteed for two years) and can be used to advantage where high quality signal amplification is required. The power amplifier modules range from 60WRMS to 310WRMS with up to twice this amount in bridge mode. All feature substantial heatsink brackets which can be bolted to any available heatsink or the Crimson purpose designed types. Input sensitivity is set at 775mV and power supply requirements are catered for by one of the three Crimson toroidal power supplies. The Pre-amplifier module (CPR1) is basically a phono amplifier with sophisticated circuitry incorporating R.I.A.A. equalisation. Also on-board is auxiliary amplification for tape and tuner inputs. A separate module (MC1) is also available and gives the required boost for low output moving coil type cartridges. External components required are potentiometers for volume and balance, switches for signal routing and a regulated ±15V D.C. power source (REG1). Complimenting this range, are the electronic crossover modules XO2/XO3 which, with a special muting board (MU1) can be incorporated in all types of active speaker systems.

Numerous applications are possible with Crimson modules. For example, a complete Hi-Fi Pre & Power amplifier of 40-125WRMS/channel can be built using our Hardware kits (see Hobby Electronics review, August 1980). Alternatively, Mono or Stereo slave amps of up to 500WRMS can be built into proprietory flight cases, while other uses include active loudspeaker systems such as designed by R.I. Harcourt in Wireless World October/November 1980. Further details of how to use the modules are contained in the Users/Application Manual available at £0.50.

SPECIFICATIONS

Type	O/P8ohms*	O/P4ohms*	PSU	H/Sinks	Slew	S/N	Sensitivity	T.H.D. (typ)	F.R.	Size
CE 608	38		CPS1	50mm	30V/uS	110dB	775mV	0.0035%	1.5Hz 50Khz (3dB)	80 · 120 · 25
CE1004	44	70	CPS3	100mm	30V/uS	110dB	775mV	0.0035%	1.5Hz 50Khz (3dB)	80 · 120 · 25
CE1008	65		CPS3	100mm	30V/uS	110dB	775mV	0.0035%	1.5Hz 50Khz (3db)	80 · 120 · 25
CE1704	85	121	CPS6	150mm/FM1	30V/uS	110dB	775mV	0.0035%	1.5Hz 50Khz (3dB)	80 · 120 · 25
CE1708	125		CPS6	150mm/FM1	30V/uS	110dB	775mV	0.0035%	1.5Hz 50Khz (3dB)	80 · 120 · 25
CP3000		250	CPS6	FM2	30V/uS	110dB	775mV	0.0035%	1.5Hz 50Khz (3dB)	161 · 102 · 35
CPR1(S)	Output	77mV	REG1		3V/uS	70dB	2.8mV/RMS	0.008%	20Hz 20Khz	138 · 80 · 35
MC1(S)	Output	2mV	REG1			65dB	70uV/150	0.008%	20Hz 20Khz	80 · 120 · 35
XO2 XO3	Output	775 2500mV	REG1		9V/uS	90dB	775mV	0.01%	C over points pre set	150 · 50 · 20

*Power output is quoted WRMS and is given for two modules run off the same power supply. Higher powers are obtainable if using one module per P.S.U. or if using a stabilised P.S.U.

PRICES HELD FROM MAY — TO FEB '80

Power Amplifier Modules		Power Supply Modules		Heatsinks	
CE 608	£21.00	CPS1 (80VA)	£19.50	50mm	£1.70
CE1004	£24.50	CPS2 (150VA)	£23.50	100mm	£2.70
CE1008	£27.50	CPS6 (250VA)	£30.00	150mm	£3.50
CE1704	£35.00	REG1	£9.30	FM1	£36.00
CE1708	£35.00	TR6	£2.50	FM2	£42.00
Pre-Amplifier Modules		**Active Crossovers**		**Hardware**	
CPR1	£34.00	XO2	£19.00	Pre Amp	£39.80
CPR1S	£44.50	XO3	£28.35	Power Amp	£38.00
MC1	£26.00	MU1	£7.50	Thermal Cutouts	£1.90
MC1S	£37.00				

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Name ....

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Crimson Elektrik

9 CLAYMILL ROAD, LEICESTER LE4 7JJ, ENGLAND. Tel 0533 761920 Telex 34694 Chanco G CRIMLEK

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ETIPRINTS offer you the easy way to produce high quality printed circuit boards. Each ETIPRINTS sheet contains a set of etch resistant rub down transfers of the printed circuit board designs for several of our projects.

ETIPRINTS are made from our original artwork ensuring a neat and accurate board. We thought ETIPRINTS were such a good idea that we have patented the system (patent numbers 1445171 and 1445172).

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040A	ETI 80 VCO/VCLFO	Feb 80
040B	ETI 80 PSU Tuning Fork Hi-Lo Filter Coin Toss	Feb 80
041A	Audiophile Driver Amp VCA Signal Tracer Heater Controller Main Board Electromyogram	Mar 80
041B	ETI 80 VCM Heater Controller Sensor	Mar 80
046A	ETI 80 Dual VCA 100 W Power Amplifier	Aug 80
046B	Capacitance Meter US Alarm BGM 100 W Amplifier Logic Tester 100 W Power Amp	Aug 80
047A	Digital Test Meter	Sep 80
047B	Vocoder Internal Excitation Speed Control DTM Switching Board RIAA Preamp	Sep 80
047C	ETI 80 Envelope Shaper TV Sound Survival	Sep 80
048A	Sustain/Fuzz Box Flash Trigger FM Radio Control Receiver: (Top side) (Bottom side) FM Radio Control Transmitter	Oct 80
048B	Vocoder Slew Rate Control Vocoder Output Amp Vocoder Input Amp Vocoder PSU Vocoder LED PPM Display	Oct 80
048C	Cassette Interface ETI 80 Monitor Amp	Oct 80
049	AF Generator Multi-Option Board Space Invasion PSU	Nov 80

BUYLINES

Sheets for Sep 79, Dec 79, Jan 80 and April - July 80 are temporarily out of stock. Earlier ETIPRINT sheets are available.

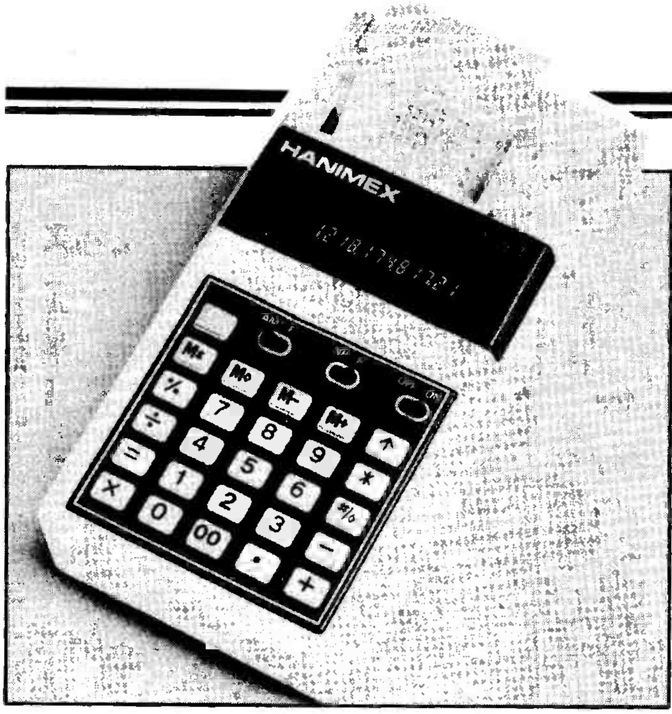
Send a cheque for PO (payable to ETI) for £1.20 per sheet with details of the project for which you require an ETIPRINT, and the month and year of publication to:

ETIPRINTS,
ETI,
145 Charing Cross Road,
London WC2H 0EE.

HOW IT WORKS

Lay down the ETIPRINT and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!

ETIPRINTS



Crystal Clear

Ambit International's four new compact modules combine a data decoder and LCD display for only £19.95. Two versions (DM180/ DM181), based on the ICM 7211, provide simultaneous decoding and display from multiplexed BCD inputs. Hex or Code B displays are also available. Power consumption is 3V5 to 6 V at typically 20 uA in either four or 3½ digit formats.

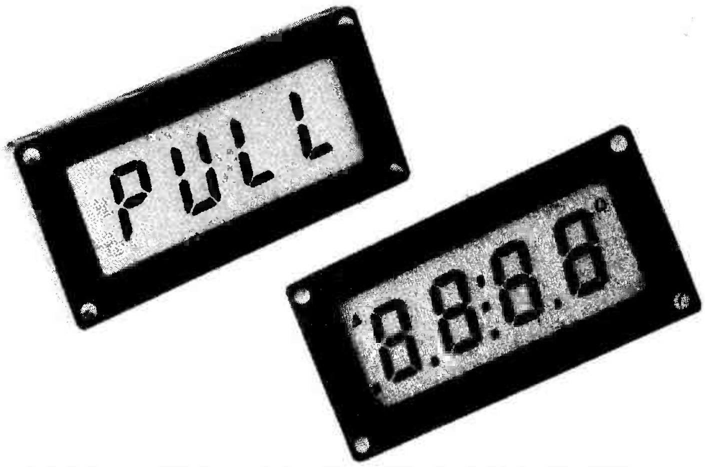
All the modules measure 60 x 30 x 7 mm (12.5 mm LCDs with integral incandescent backlighting) and can be supplied with a panel mounting bezel. For further details contact Ambit International. 200 North Service Road, Brentwood, Essex CM14 4SG.

Beckman Instruments' new model 740 and 742 large area LCDs feature as standard pin connectors bonded to the display. The connectors are also available separately.

The 740 features six digits (½" high) with colons and decimal points in a 2.75" x 1.2" package. The 742 offers eight digits, also ½" high with colons and decimal points, in a 3.7" x 1.2" package.

Power consumption is very low — 50 uW for the 740. Both models offer a wide operating voltage range (3-20 V RMS) and are compatible with available CMOS drive circuits.

For further information contact Beckman Instruments Ltd, Queensway, Glenrothes, Fife, Scotland KY7 5PU.



Ambit International (above) and Beckman (below) displaying themselves.

Pocket Printer

Hanimex have launched what they believe to be the smallest and most versatile print and display calculator in the world. The Micro 1226T features a 12 digit green display plus full print-out capability in a 140 x 72.4 x 23.5 mm package weighing only 260 g.

It uses standard 38 mm thermal paper from its own paper store or from a larger paper holder. The keyboard includes a fully addressable four key memory, percentage key, item count key and single and double zero input key. Print-out speed is 1.8 lines per second.

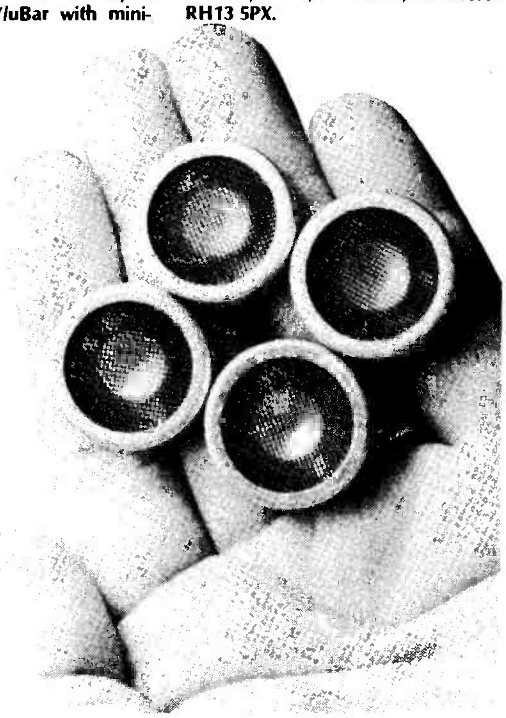
Ultrasound

A new series of matched, low-cost ultrasonic transducers from Impectron are small, light and highly sensitive. They offer excellent performance in applications such as industrial control and intruder detection systems.

The EFR-OCB25K5 and EFR-RCB25K5 are transmitter and receiver respectively, with a nominal centre frequency of 25 kHz. Sensitivity is around −60 dB/V/uBar with minimum bandwidth of 3 kHz. Overall dimensions are 1" long (body length 0.37") by 0.95" diameter for both transducers.

Their internal construction incorporates a compound vibrator (ceramic chip plus conical aluminium resonator) providing sensitivity and bandwidth.

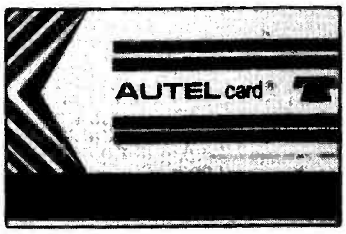
Delivery is ex-stock and application notes for designers are available from Impectron Ltd, Foundry Lane, Horsham, W Sussex RH13 5PX.



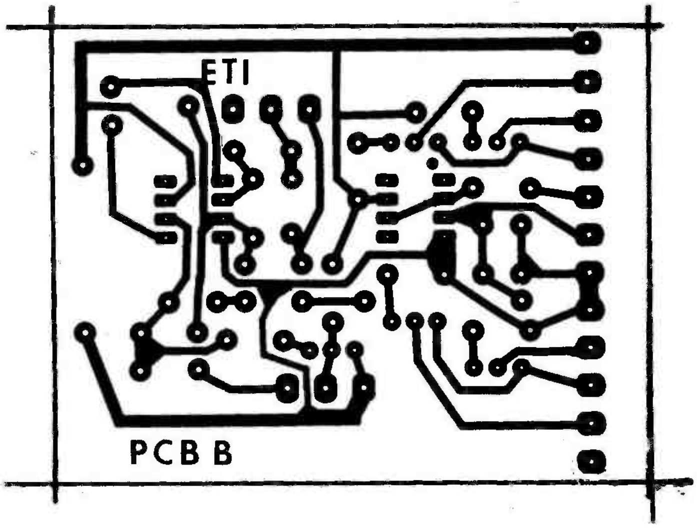
Autel

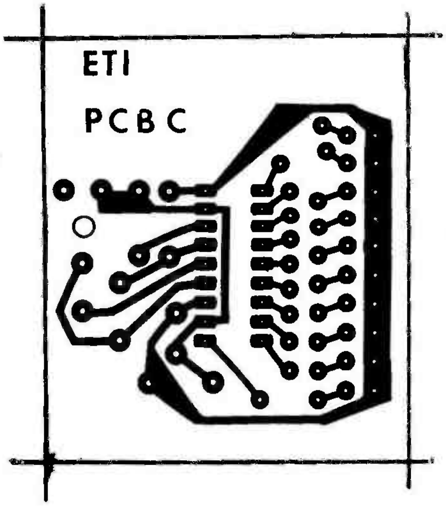
EMIDATA and Autelca Ag, the Swiss pay-phone manufacturer, have got together to produce a new pay-phone credit card system. When the customer buys a card, its magnetic strip is pre-coded with an agreed credit value (a number of time units).

To pay for a call you simply insert the card in a slot in the telephone. Its value is displayed on a digital read-out and reduced unit-by-unit at the appropriate rate during the call. When you hang up, the card is returned coded with its reduced value. If the value should fall to zero during a call, the card is returned and the display flashes for a few seconds before automatic disconnection. The card is then disposed of and a new one purchased.

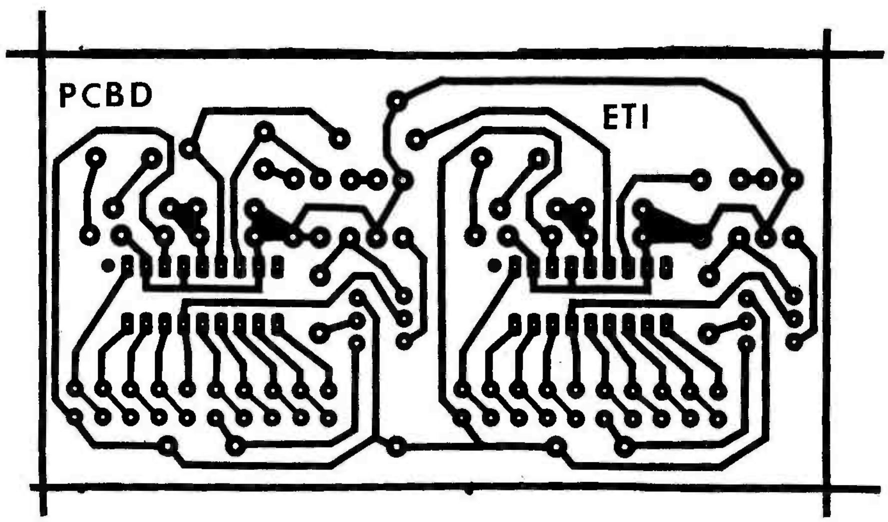


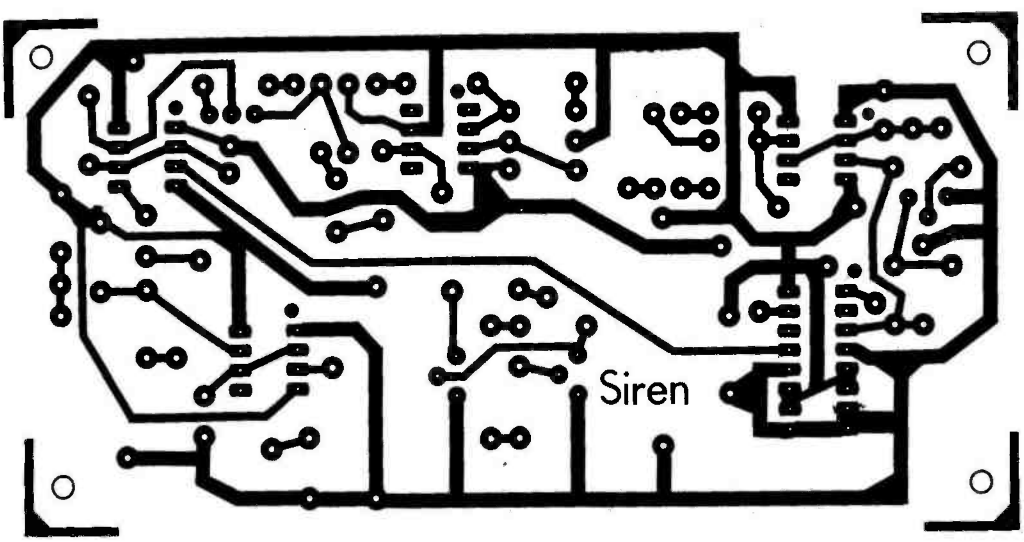
PCB FOIL PATTERNS



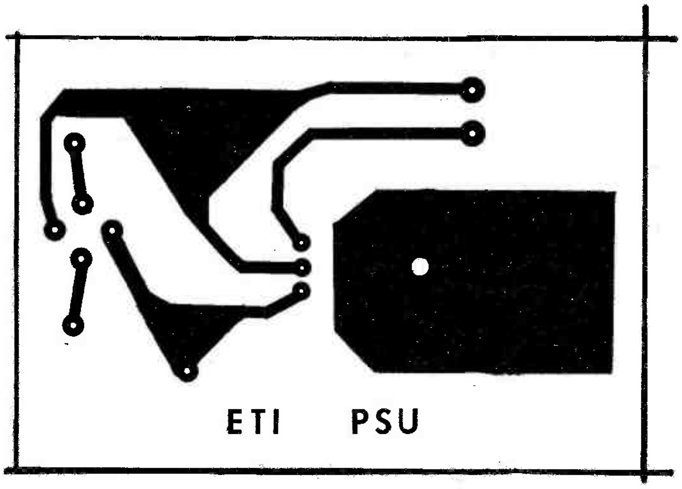


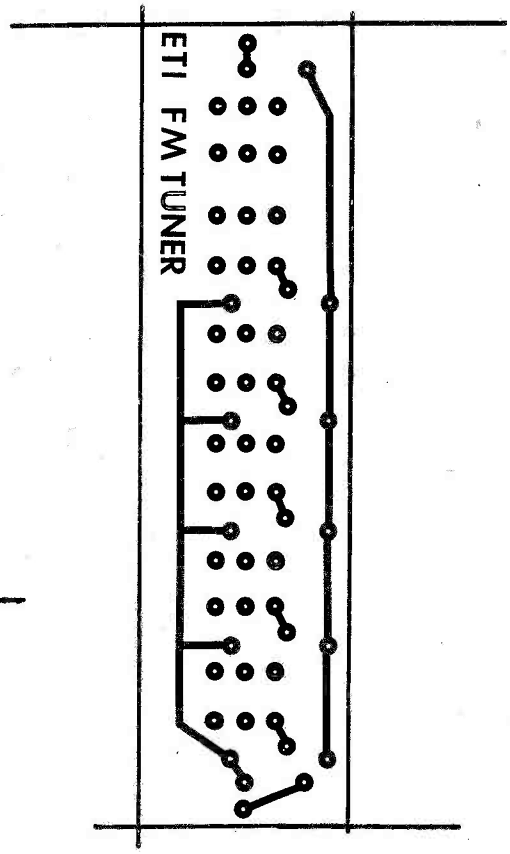
The FM Tuner boards B (above), C (left) and D (below).



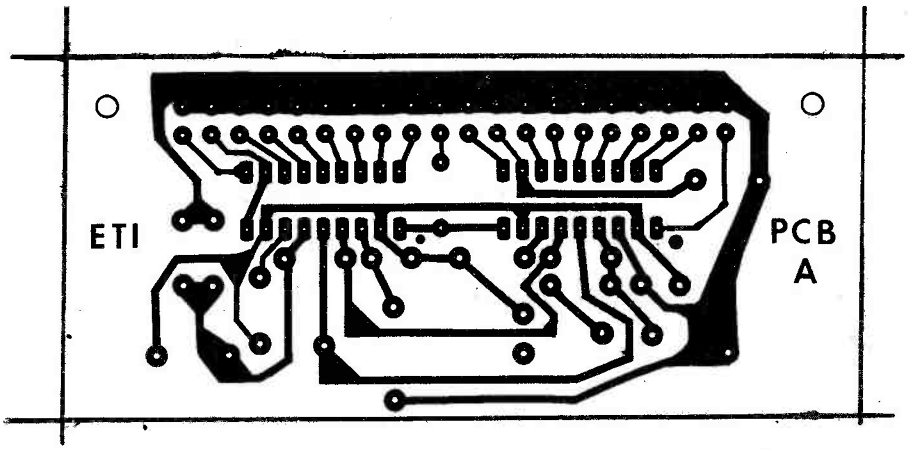


(Above) Multi-Option Siren.

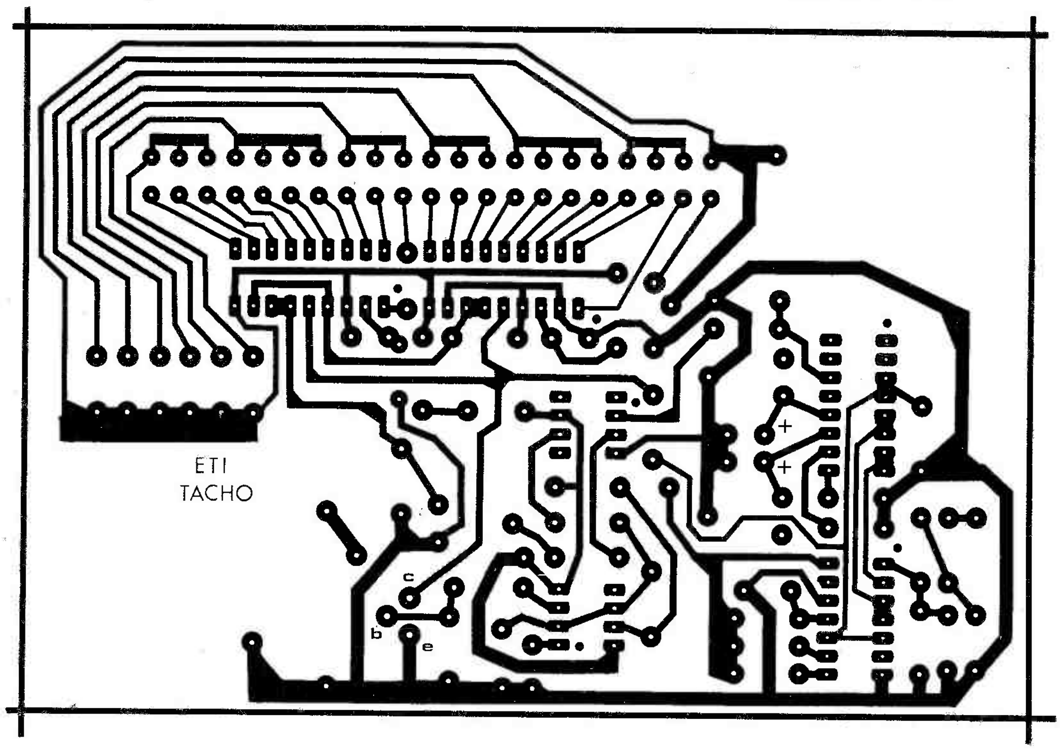


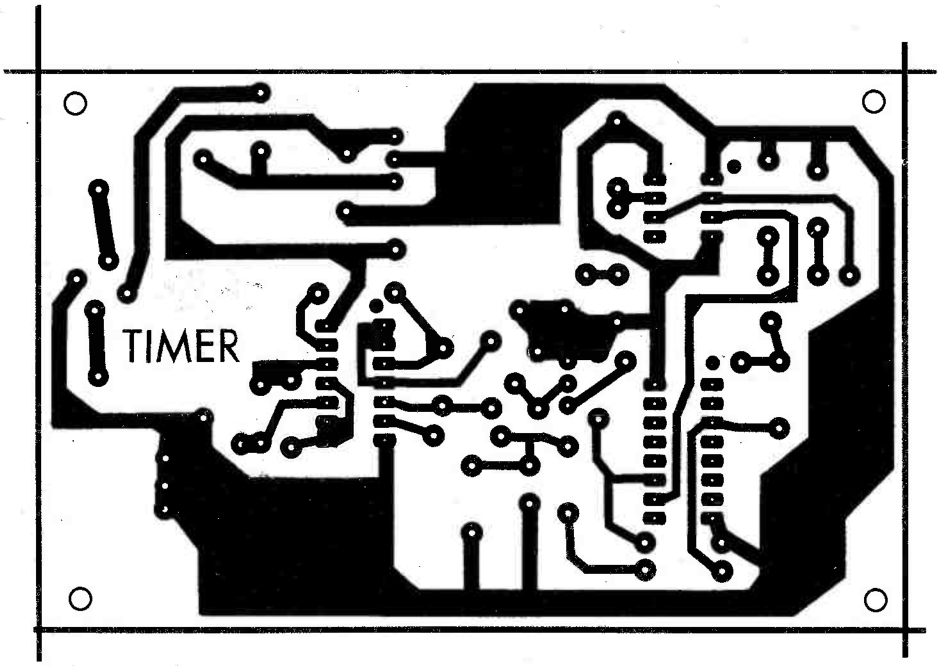


The FM Tuner PSU (above), switch assembly board (right) and PCB A (below).



(Below) LED Tacho.

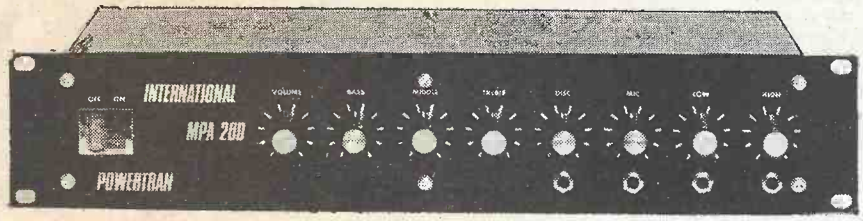




(Above) Universal Timer.

MPA 200 100 WATT (rms into 8Ω) MIXER/AMPLIFIER

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 an adaptable input mixer which accepts a wide range of sources such as a 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"

COMPLETE KIT ONLY £49.90 +VAT!

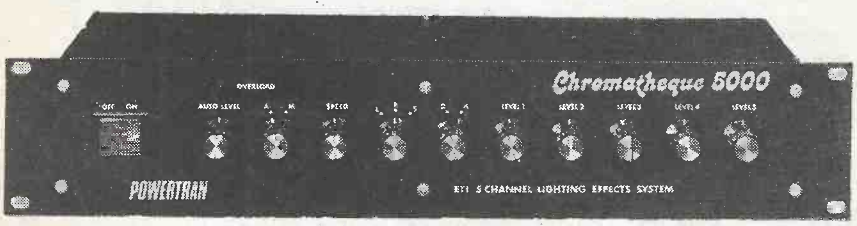
MATCHES THE CHROMATHEQUE 5000 PERFECTLY!

CHROMATHEQUE 5000 5 CHANNEL LIGHTING EFFECTS SYSTEM

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!

COMPLETE KIT ONLY £49.50 + VAT!

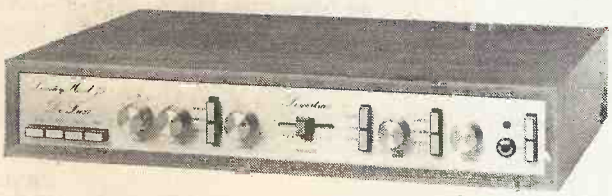


Panel size 19.0"×3.5". Depth 7.3"

POWERTRAN

SYNTHESIZER KITS ON PAGE 8. MORE KITS AND ORDERING INFORMATION ON INSIDE FRONT COVER.

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



DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £85.00 + 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 while 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.
MATCHING TUNERS — See our FREE CATALOGUE!

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

MUSIC EFFECTS DEVICE — AS FEATURED IN ELECTRONICS TODAY INTERNATIONAL!

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 antiphase effects to be added. The device is floor standing with foot switch controls, LED effect selection indicators, has variable sensitivity, 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)

De Luxe version (dual delay line system) also available for **£59.80**+VAT

Cabinet size 10.0" x 8.5" x 2.5" (rear) 1.8" (front)

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K001 50V ceramic plate capacitors. 5%. 10 of each value 22pF to 1,000pF. total 210. **£3.69.**
K002 Extended range 22pF to 0.1µF. 330 values **£5.53.**
K003 Polyester capacitors, 10 each of these values 0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1, 0.15, 0.22, 0.33, 0.47µ. 110 altogether for **£5.07.**
K004 Mylar capacitors, min 100V type 10 each all values from 1,000pF to 10,000pF. Total 130 for **£4.05.**
K007. Electrolytic capacitors 25V working small physical size. 10 each of these popular values 1, 2.2, 4.7, 10, 22, 47, 100µF. Total 70 for **£3.59.**
K008 Extended range, as above, also including 220, 470 and 1000µF. Total of 100 for **£6.05.**
K021 Miniature carbon film 5% resistors CR25 or similar. 10 of each value from 10R to 1M, E12 series. Total 610 resistors **£6.15.**
K022 Extended range. Total 850 resistors from 1R to 10M **£8.50.**
K041 Zener diodes 400mW 5% BZY88, etc. 10 of each value from 2.7V to 36V, E24 series. Total 280 for **£16.37.**
NEW K051 LED's — 10 each red, green & yellow 3mm & 5mm, with clips. Total 60 LED's for **£8.95**

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Z401 Powerful 6V DC buzzer, all metal construction. 50mm dia X 20mm **85p.**
Z402 Miniature type buzzer, 6, 9 or 12V, only 22×15×16mm. Very neat **65p**
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W892 Heavy Duty 12V relay, ideal for car use — single 15A make contact. Coil 25R in sealed metal can with mounting bracket **85p.**
W890 DIL Reed relay SPCO 2.4-10V. 200R coil. Only **£2.20.**
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Exclusive Greenweld design — better spec. than anything on the market being offered at the price. Panel 110×82×33mm high contains all components including bridge rectifier and smoothing capacitor. Ready built and tested — just add a 30V 2A transformer and two pots for a fully variable voltage and current supply

SPEC Output voltage 0-28V
Output current 20mA-2A
Source Impedance OR1
Open circuit ripple 10mV

Send SAE for full details of the many ways this useful module can be used, together with price list of parts for various options. Only **£7.75**

1N4004 & 6 DIODES

Special purchase of 1A rects, Russian made Packed in boxes of 300, **£8.50** per box 4 boxes **£30.00;** 10 boxes **£75.00**

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0.22uF 12V 9mm dia. Ideal for decoupling 100 for **£2.75;** 1000 **£20.00.**
0.05uF 12V 15mm dia. 100 **£1.50;** 1000 **£12.00.** Pack of disc ceramics, assorted values and voltages — 200 for **£1.00**

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Mains primary, 50V 20A sec **£20.00.** Mains pri 110V 15A sec **£30.00;** 20A **£40.00.**

SLIDER POT SCOOP!!!

Made by Piher, types PL40CP & PL60C Silly prices for superb goods!!
PL40CP — 69×16×9mm, 40mm slide length 220R, 2k2 or 10k lin only. Prices (any mix) 1-24 **20p;** 25-99 **17p;** 100+ **14p.**
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CALC CHIPS 60p!!!

New full spec. supplied with data. Type MK50321 — full function inc memory. **Only 60p**

DISPLAYS

8 and 9 digit 7-segment bubble type for above chips — most have minor faults, dud segment, etc. Mixture of 2 or 3 different types with data. **5 for £1.00**

NICADS

Ex-equip size C approx. **£1 each; 10 for £8.00**

COMPONENT PANELS

Z525 Contains 11 800mA 60V 2N5061 SCRs, 11 6V8 zeners, 11 1N4004 diodes plus Rs, Cs, etc. Only **£1.**
Z529 74 Series ICs — Gates and complex logic, 20 asstd. ICs on panels **£1;** 100 ICs **£4.**
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TTL, LINEAR, OPTO

All new full spec — Fairchild/SGS:
TTL: 5400, 5401, 5402, 5403, 5404, 5405, 5410, 5421, 5430, 5450, 5451, 5453, 5460 — **All 12p ea.** 5470, 5472, 5474, 5475, 5476, 5480, 5486, 5490, 54107, 54121, 54122 — **all 20p ea.** 5482, 54126 — **40p ea.** Others (74S, H) on B/L 12 (SAE please).
LINEAR: 9665 or 9666, 7 x 50V Darlingtons in 16 DIL **60p;** 75452 or 4 dual periph driver **70p;** XK1444 7 CMOS P-channel buffers, 15V 16 DIL **24p.**
OPTO: Isolators, FCD831 **60p;** TIL115/118 **60p;** FPE100/106 Infra red LED **£2.50;** FND847 7 seg 0.8" CA **£2.00;** FND850 CC **£2.00.** (Data on request for linear & opto devices).

VEROBLOC BREADBOARD

New from Vero, this versatile aid for building and testing circuits can accommodate any size of IC Blocs can be joined together. Bus strips on X & Y axis — total 360 connexion points for just **£4.15.**

BULK SUPPLIES

All new full spec. devices. Prices are for a minimum of 100 of any one device and exclude VAT, which must be added at 15%. Minimum order value from this section is £10+VAT+post. VAT receipt on request.

RESISTORS

Min. ¼W 5% carbon film 1R-10M (10% over 1M), all **£6.00**/1,000.
The following values only at **£3.50**/1,000; per value 4R7, 8R2, 18R, 39R 56R, 220R, 1k, 4k7, 18k, 33k, 39k, 47k, 220k, 390k, 560k, 680k, 820k.

MIN. PRESETS

0.1W miniature type, open construction. All values from 100R to 1M, vertical or horizontal mounting. All at **.042.**
The following values only at **.03:** 470RV, 470RH, 500RH, 1kH, 1k5H, 2kV, 2k2H, 2k5H, 4k7H.
Also some Piher enclosed type at **.042:** 150RV, 200RH, 2kV.

POTS

5k lin, 100k lin; 220k lin; 500k log; 1M lin. All with std. bush and spindle. **.14.**

ELECTROLYTICS—PC RADIAL LEAD

All 5mm pitch. Value/Voltage

0.47/50	.022	47/40	.026
1/50	.024	100/16	.022
2.2/50	.024	100/40	.027
4.7/25	.022	220/63*	.048
10/16	.021	330/25	.048
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.068/250/10	.024	.22/100/15	.036
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.01/630/7.5	.022	.47/100/15	.052
.01/100/7.5	.022		

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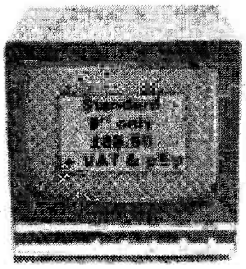

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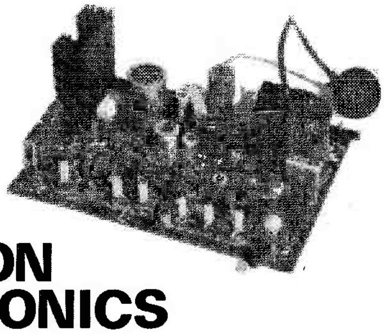

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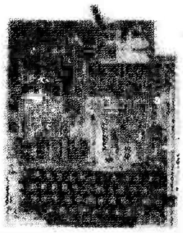

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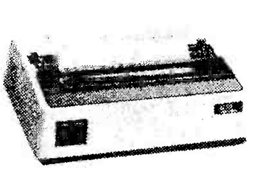

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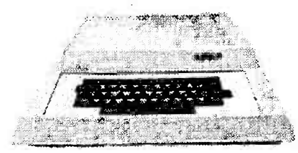

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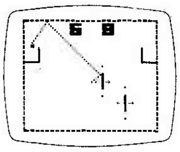

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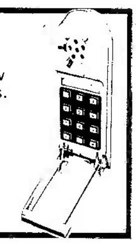

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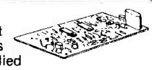

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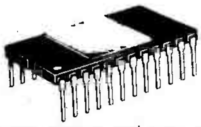

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LS78	45	4019	48
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LS155	98	4055	135
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LS160	120	4071	25
LS161	98	4072	25
LS162	110	4073	25
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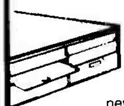

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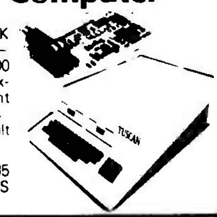

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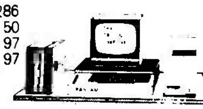

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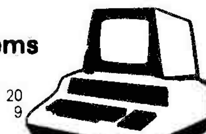

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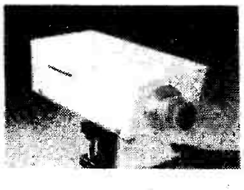

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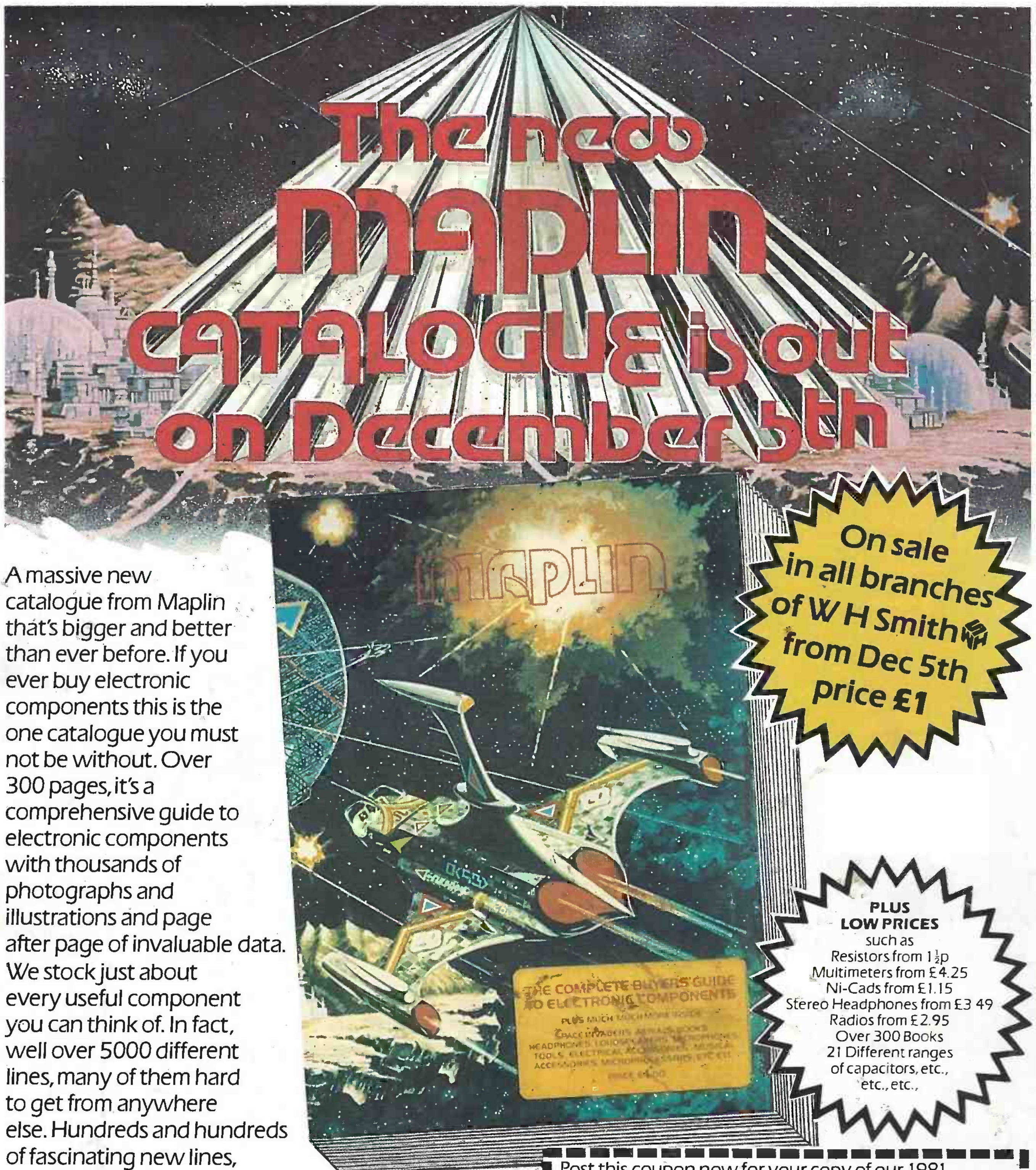

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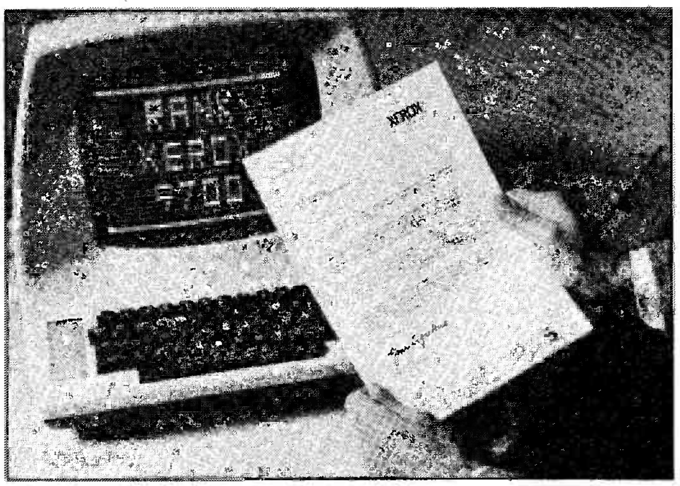


Compu-copy

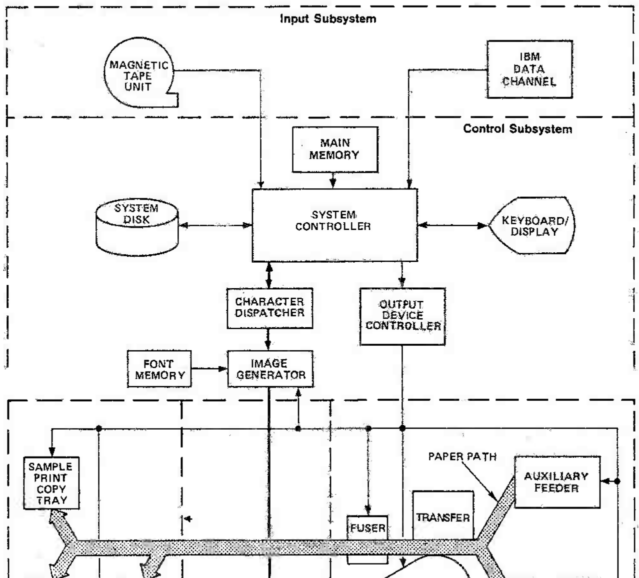
Rank Xerox's new baby, the Xerox 9700, offers the first direct link between computers and the xerographic process. From a digital input, the 9700 can simultaneously produce a business form and the computer-generated text to go on the form.

The input data can be received on-line from an IBM mainframe or off-line via nine-track magnetic tape. Laser technology converts this data into the selected typeface. At the same time, the standard letter or form is called from memory and the two combined, using the same process, printing on both sides of the paper at the rate of two copies per second. Output on A4 paper can be vertical or horizontal, as necessary.

A variety of standard type sizes and faces are available, but the 9700 can also print company logos, signatures and any other shape that can be converted into a digital code using the 90,000 dots per square inch printing format.

Graham Clark, Managing Director of Rank Xerox (UK), said that he hoped to see 100 of the 9700s installed in the UK within three years. Xerox believe a 9700 installation to be feasible in applications where computer technology is linked to a demand for more than 700,000 high quality prints per month.

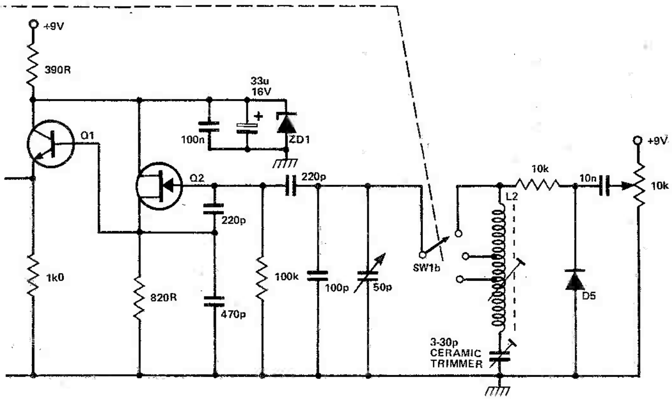
The system will be available with a range of software for sale, lease or rental, a 24 hour service support and free operator training from January 1st 1981. The minimum sale price will be £184,650 and rental options from £5,900 per month (including 700,000 impressions).

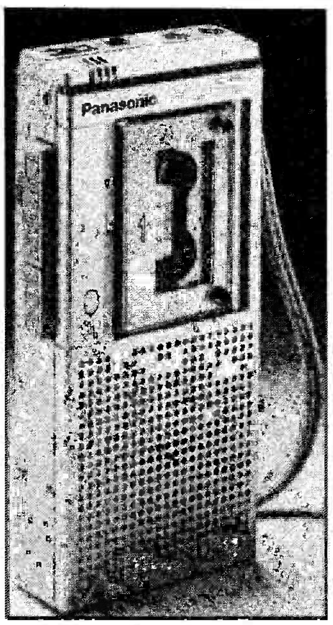


Functional Diagram of Xerox 9700 Electronic Printing System

OOPS Tech-Tips

Last month you may have noticed that the circuit diagram for the Direct-Conversion Receiver made a brave attempt to escape off the edge of the page. We've reprinted the offending end of the diagram, which also shows the values of the capacitors in parallel with ZD1 and a recommended change to the capacitor in series with coil L2.





Micro-Taping

Panasonic Business Equipment has announced the introduction of the Panasonic RN-Z01, a new low-priced, mains/battery, two-speed micro-cassette recorder. Features include one-touch recording with cue and review controls, which allow the tape to be rewound or played on to locate a particular piece of recording. There is also a 'follow-up' feature, which lets you start recording during playback without having to stop the recorder first.

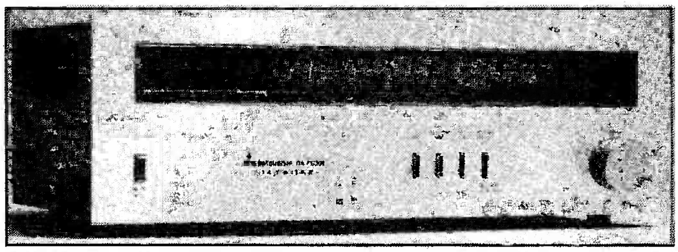
The RN-Z01 measures only 14.25 x 64 x 2.58 cm, weighs only 270 g, is fully compatible with the Panasonic RN-195 transcription machine and comes complete with a cassette and carrying case for only £49.42 plus VAT. It is only available through distributors of Panasonic Business Equipment. For details of local stockists contact Panasonic Business Equipment Ltd, 9 Connaught Street, London W2.

Colour Tuning

Mitsubishi Electric have introduced a new FM/LW/MW tuner, the DA-F630, with an unusual method of tuning indication. When you tune into a mono station, the scale illumination changes from white to orange. When you tune into a stereo station it changes from white to green. As soon as you let go of the tuning control, a locking circuit automatically engages to prevent drift.

The front panel features soft-touch switching for MW, LW, FM, muting/mode and power, a five-LED signal strength indicator and a single tuning LED.

Sensitivity (FM stereo, 40 kHz dev) is 16 uV, S/N (stereo, 40 kHz unweighted) is 70 dB, THD (stereo, 1 kHz, 40 kHz dev) is 0.4% and frequency response is 40 Hz to 15 kHz (± 3 dB). The DA-F630 measures 42.4 x 14 x 25 cm.



NEXT MONTH

electronics today INTERNATIONAL

Look out for the February issue on sale January 2nd

IR Beam Alarm

Our IR Beam Alarm features a dual beam IR link. The two beams, a few inches apart, must be broken simultaneously to activate the alarm. So, you won't have any false-triggering problems when a fly lands on the transmitter or receiver. Mind you, if you are visited by the East Lothian formation fly ensemble, you've got problems. The link will operate over 10m range and could form the basis of a comprehensive house alarm system.

Digital Designers' Circuit Supplement

Only 10 years ago, relatively simple digital circuits occupied acres of boards bristling with components. Now, very often, there's a single, special-purpose chip to do it all. Even if there isn't, a microprocessor can handle most contingencies. So, digital designers face increasingly complex problems as more and more functions are condensed into chip-size logic. Tim Orr's Digital Designers' Circuit Supplement starts you off on the road to making sense of it all.

Drum Sequencer

If you need a lot of banging in your life (perhaps you're a musician), try your hand at the ETI Drum Sequencer. It's designed in two distinct sections. The drum effects unit will simulate high/low tom-tom and bass and snare drum voices, manually triggered by, say, a loudspeaker sensor. The clever bit is the sequential programmer, which will reproduce the drum rhythm of your choice from the effects unit.

Crystal Calibrator

If you need a frequency standard for calibration purposes anywhere in the 100 Hz to 1 MHz range, then you need the February issue of ETI. Our Crystal Calibrator lets you determine the frequency of an unknown crystal or produce an accurate calibration signal for setting up and test applications — a useful piece of test gear.

SPL Meter

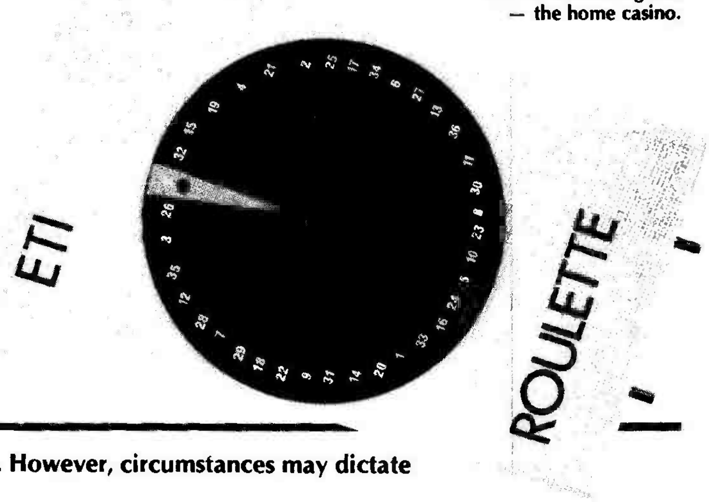
For the first time in a UK electronics magazine, ETI features an accurate, calibrated Sound Pressure Level Meter design based on a special-purpose, but modestly priced, precision microphone insert.

Use it to check absolute values of sound level or loudness at home or work — Crossroads at 96dB can damage your health! Use it to set up the graphic equaliser in your hi-fi system — check that sound levels at all frequencies are equal in your deep-pile, luxuriously upholstered, sound absorbing penthouse. Build the ETI SPL Meter at a fraction of the cost of commercial units.

Stethoscope

ETI February also features our engineers' stethoscope design. This useful instrument can be used in a variety of engineering applications to check for faults in moving parts — pistons in cylinders, for example.

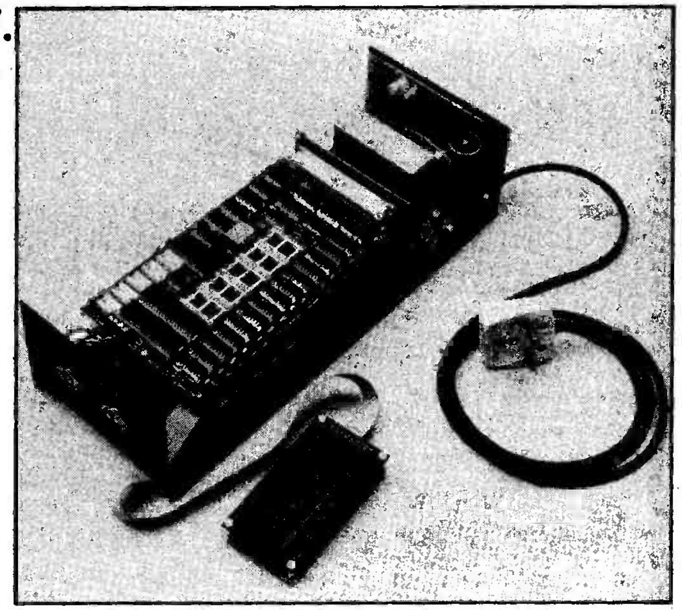
The ETI Roulette game — the home casino.



Articles described here are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

MICROBASICS

'Speak to me only with thine software'. Henry Budgett discusses the monitor program that ties together the hardware from previous Microbasics.



Microtan 65 with TANBUG and XBUG.

If, at this point in the series, you feel that you have got yourself a real microcomputer, then think again. What you have is a collection of hardware that will process, store and transmit data but it has not yet been told how it should do it. Whilst the average person will usually be working in a high level language such as BASIC the actual CPU can only undertand binary numbers. Quite apart from the Interpreter that translates the high level language instructions into the appropriate binary codes there has to be a piece of software called the monitor.

The name 'monitor' is synonymous with the operating system in bigger machines and performs the same tasks as the front panel used to in the days when computers had pretty lights and knobs all over them. The term 'software front panel' is still used in some literature to imply something special.

Monitoring The Situation

Before we take a detailed look at one particular monitor and what it does it is necessary to understand the tasks that should be done first. The monitor must be aware of the size and location of the memory, the location of the I/O devices and, most important of all, how to start everything up in the right way.

If we have informed the computer of these facts by writing a short machine code routine and a look-up table that details the various devices and their functions, we can now proceed.

We will assume that our microprocessor is being driven by an ASCII keyboard and that it will display the information on a TV screen. How does the monitor know when a key has been hit on the keyboard? The usual procedure is to operate under interrupts. This is done by causing a special bit in the CPU's status word to be set whenever a key is pressed. The monitor is continually looking at this bit, even if it's doing something else, and when it detects it, whatever is currently happening is suspended and the I/O port that caused the interrupt to occur is examined. It knows which one this is by means of a wonderful device known as the interrupt vector. It can now read the value of the key that was pressed.

What the monitor does with this piece of information depends on the type of monitor that you have. Some are very complex and allow all manner of special things to be done in the way of machine code programming. The one I am going to take a close look at is a good example of the kind of complexity that you can achieve within a very small space.

Bugging Your Micro

For historical reasons monitors are generally given BUG as part of their name. TANBUG is the standard monitor supplied with the Microtan 65 computer and, along with its enhancement XBUG, is the basis of the rest of this article.

TANBUG is rather special in that you can plug in either a simple Hex keypad or a full ASCII keyboard and it will detect which one is being used. For the sake of simplicity, assume that the ASCII keyboard is used. As soon as the machine is reset by means of the hardware switch, the internal hardware reset vector jumps straight into the start of the monitor. Being polite, 'user friendly' to use the jargon, the monitor announces its existence and gives you a character on the screen known as a prompt. Within the context of a monitor, the prompt and the cursor can be regarded as the same unless an error has occured and then a '?' is displayed.

Before we can run any programs we first have to write them and thus we need a means of getting information into the memory and changing it if necessary. This is achieved by the M <addr> command which opens the specified address and displays its contents on the screen followed by a prompt. We can now type in the code that we require to replace that currently stored, step back to the previous location, step forward to the next location or go back to the monitor by pressing respectively ESC, LF or CR. These apparently meaningless mnemonics are ESCape, Line Feed and Carriage Return respectively and are interrupted in various ways by the monitor. Let us assume that you have written a program into the memory of your micro using the monitor and that you now wish to run it. In the case of TANBUG simply type 'G <addr> CR'. This tells the CPU to load the CPU's program counter with the specified address, to load the stack pointer with the beginning of the stack area in RAM and to start obeying the instructions. Clever stuff.

Doing It Slowly

The trouble with programs written in machine code is that they tend to run extremely quickly. We can slow them down by writing delay loops but we can also use a monitor command which gives us single steps. Keying S sets the process into one-step-at-a-time mode. After each step has been processed the program stops and goes back to the monitor with a full display of the CPU's registers. You can execute the next step by keying P for proceed. It must be noted that a program step is not just the contents of one address but the complete instruction such as 'jump to address A000'.

Because the main cause of programs crashing is the wrong interpretation of information in the registers, the monitor allows you to adjust their values in much the same way as you can alter the contents of the memory. Even more common than that is the occasional 'bug' that lurks within the code and only jumps out at obscure times. We can catch this by setting a trap for it called a breakpoint. We generally know where the bug comes from but we don't know what causes it to appear so we set the breakpoint to the relevant position in the program and leave it running. When the bug appears and takes the trapped route it trips the breakpoint and this causes a complete printout of all the registers allowing you to find the reasons for its sudden emergence. With the TANBUG monitor you can set up to eight different traps, allowing bug catching on a lavish scale.

Display Your Contents

Keeping track of the program in the depths of the memory is made easy by having a list command. This allows you to display memory contents on the screen in a regular format, making the checking and copying on to paper easy. As the final option in the TANBUG repertoire, we can calculate offsets. Because it is quicker to tell a program to jump back ten steps rather than to tell it the absolute address, there is a relative jump command which allows you to move up to 127 steps in either direction. To use this, merely key in the address of the jump command, the address you wish to get back to and CR. The monitor then gives you the HEX value for the relative jump.

Saving The Day

The basic Microtan 65 is equipped with only 1K of RAM and out of this must be taken the stack requirements for the CPU and the monitor, the 512 bytes of video RAM and some working space. The user is left with about 430 bytes for his programs although it is possible to use the video RAM area to some extent. Because of this limited area it was not thought necessary to include any cassette storage capability on the CPU card; there isn't any space left anyway! Once one enters the realms of expansion with the TANEX card, cassette I/O is essential and the enhanced monitor package, XBUG, supplies this and more.

XBUG is packaged in a 2K EPROM and gives the user three extra functions. These are cassette handling, a line-by-line assembler and a line-by-line translator. The latter two are almost unique and, at this price level, give the system a distinct edge.

The cassette-handling software allows the saving and loading of named files as well as the verification of saved files against the memory at two speeds. The slow CUTS (Computer Users Tape Standard) 300 baud speed is generally used for important system files, and for any back-up copies because the recordings made are inherently less prone to corruptions. That

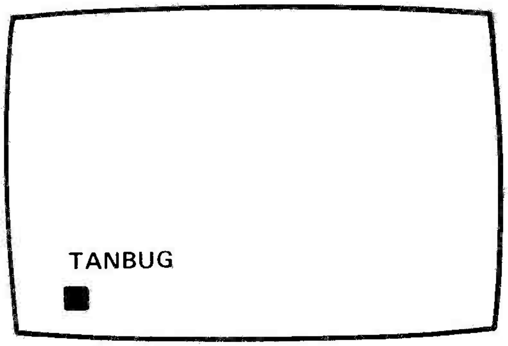


Fig 1. The monitor announces itself to the world and 'prompts' the user to do something. The ■ is replaced by a '?' in the event of an error.

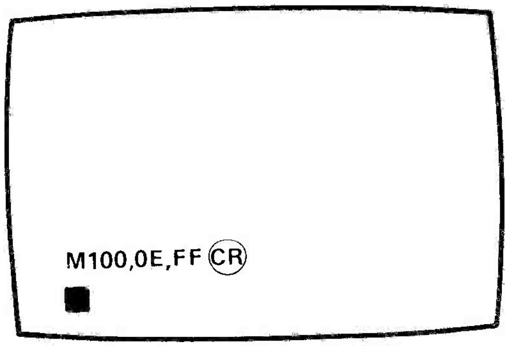


Fig 2. Typing M100 CR opens the specified location and reveals the current value 0E. We have replaced this with FF and closed the location but we could have stepped forward or back through memory by using other commands.

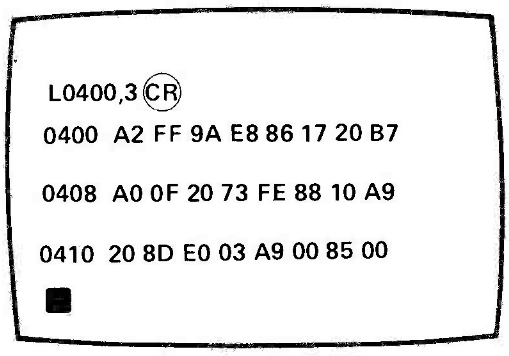


Fig 3. The monitor will list the program from any given address in blocks of eight bytes per line for up to 256 lines. Here we have selected three.

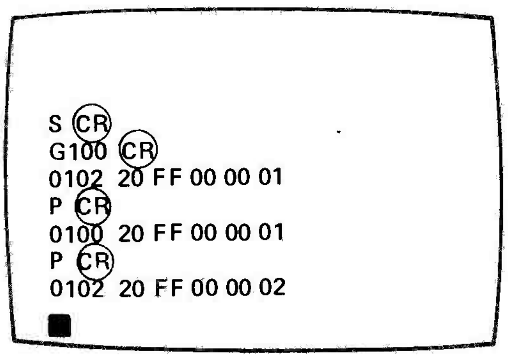


Fig 4. By setting the monitor to operate in single steps, we can inspect the contents of each register in the CPU after each step before proceeding with the P command. The registers are; next address to be executed, CPU status value, low byte of the stack pointer, index X register value, index Y register value and the accumulator value.

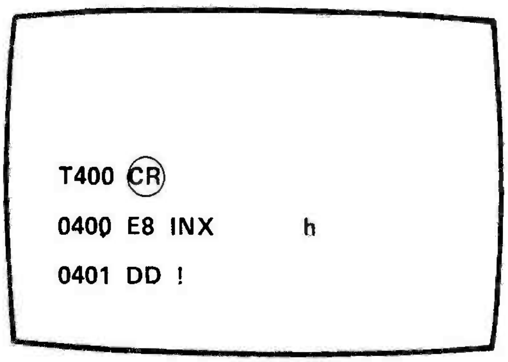


Fig 5. Using the assembler, we define the starting address and the current memory value is displayed. We have overwritten this by keying INX which has been translated into its correct Hex code and the assembler has stepped to the next location in memory. The prompt symbol '!' is used to identify the fact that you are in the assembler mode and the 'h' to the extreme right is the ASCII character that corresponds to the Hex code. This acts as a check.

is not to say that the fast speed, of approximately 2400 baud, is unreliable — one generally uses this for the convenience of loading programs quickly; a program takes eight times longer to load using the CUTS format. The manual gives the setting up information in two programs which should be tried at each tape speed. I use a manual level control tape recorder which also allows the tape speed to be varied slightly, but the system works perfectly on virtually any cassette recorder. The reason that I chose a rather more expensive machine is not because I've got money to burn, but because I receive programs for a wide variety of machines and sometimes the speeds or recording settings vary, hence the need to be able to adjust my system to that of the person who is supplying the tape.

Interpretations Supplied

As mentioned earlier the XBUG monitor is equipped with a simple assembler and dis-assembler. This allows the budding machine code programmer to use assembly language mnemonics rather than the actual Hex codes. The mnemonics are effectively one step towards high level language programming. They allow the programmer to think in logically sounding 'words' rather than in specific Hex codes.

Given a starting address and the appropriate commands, the assembler will convert the op-code and its associated operands into the proper Hex codes. It is quite intelligent too; most common errors are trapped before they can be entered.

As a direct complement to the assembler there is a line-by-line translator, which converts the stored Hex into the more meaningful assembly language mnemonics. It is called a 'line-by-line' system because it needs to know the correct start or else it will try to convert Hex data into assembly language mnemonics. In some cases you can have enormous fun dis-assembling a program to reveal another program which, according to the translator, is complete nonsense! Don't get me wrong, I'm not criticising the limited capability of the translator but rather pointing out that, for a 2K package, it packs one heck of a punch. The nearest equivalent system that I can recall is one supplied with the Rockwell AIM 65 and that takes about 2K on its own just to give an equivalent assembler.

The Next Step

Nowadays the almost universal introduction to high level language programming is through BASIC. With a language like this, a new piece of software is required — the Interpreter. This is, if you like, equivalent to the mnemonic assembler in that it converts the 'English' of the BASIC commands into the Hex code that the CPU needs. To avoid wasteful repetitions of the code, the BASIC will use routines that are already written in the monitor, the cassette-handling routines for example.

This use of standard routines allows the BASIC programmer to call machine code programs from this BASIC program. This is often done to speed execution of a program or to perform a repetitive chore. On my system there is no 'Clear Screen' command in BASIC, so I have a standard machine code routine for this stored in memory, which I call as required.

A Close Encounter

I hope to be taking a very close look at one specific computer in the next two episodes. As yet the computer hasn't arrived, but with luck next month will see the first part. The reason for taking a look at a complete computer is to try to explain the systems aspect, ie how all the bits and pieces fit together, rather than continue to inspect the individual elements.

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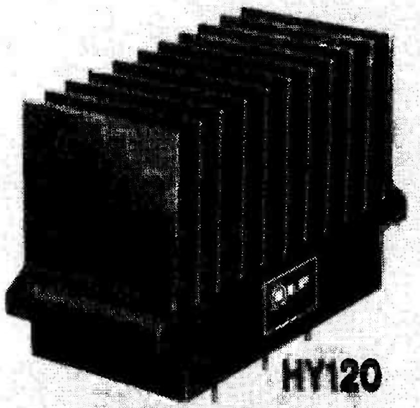

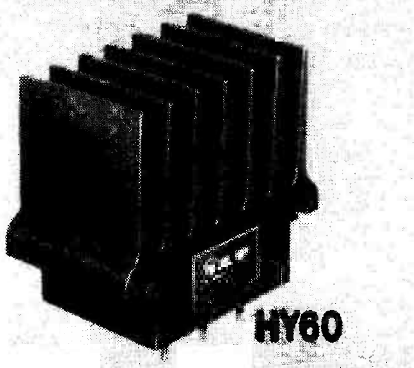

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MOS200	120W into 4-8Ω	0.005%	20V/μs	3μs	100dB	£33.46 + £5.02

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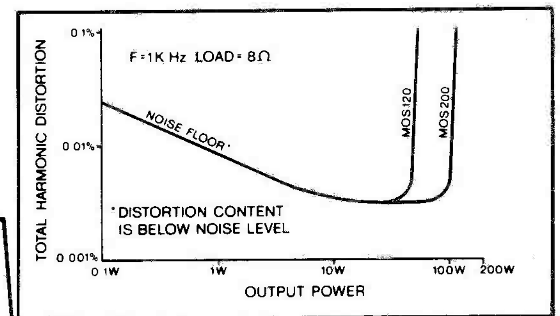
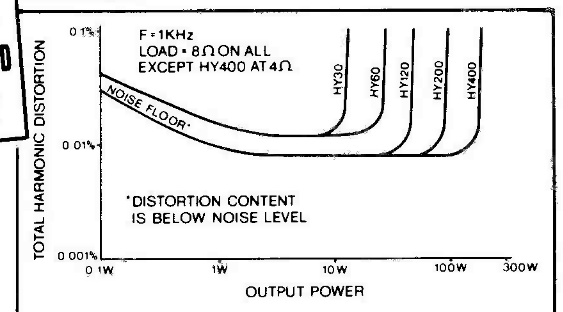
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
HY30	15W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£6.34 + 95p
HY60	30W into 4-8Ω	0.015%	15V/μs	5μs	100dB	£7.24 + £1.09
HY120	60W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£15.20 + £2.28
HY200	120W into 4-8Ω	0.01%	15V/μs	5μs	100dB	£18.44 + £2.77
HY400	240W into 4Ω	0.01%	15V/μs	5μs	100dB	£27.68 + £4.15

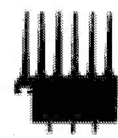
ILP POWER AMPS ARE ENCAPSULATED FOR THERMAL STABILITY AND LONGER LIFE



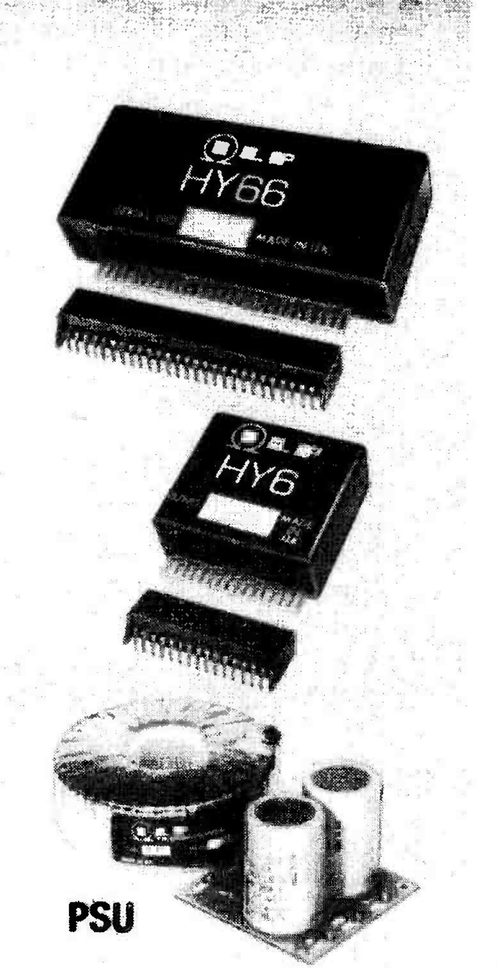
Load impedance both models 4Ω - ∞ Input sensitivity both models 500mV
Input impedance both models 100KΩ Frequency response both models 15Hz-100KHz – 3dB



Load impedance all models 4Ω - ∞ Input sensitivity all models 500mV
Input impedance all models 100KΩ Frequency response all models 15Hz-50KHz – 3dB



THE NEW PROFILE EXTRUSIONS
The introduction of standard heatsink extrusion for all I.L.P power amplifiers achieves many advantages: – Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for lower thermal conductivity. Extrusions vary in size according to module number.

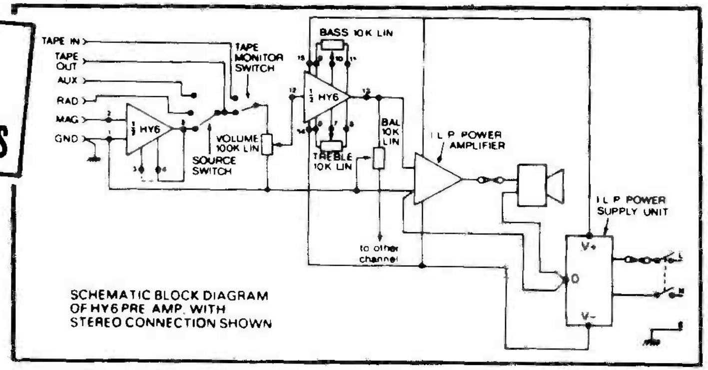


NEW PRE-AMPS

HY6 (mono) and **HY66** (stereo) are new to I.L.P's range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below.
Sizes – **HY6** – 45 x 20 x 40 mm. **HY66** – 90 x 20 x 40 mm.
Active Tone Control circuits provide ±12dB cut and boost.
Inputs Sensitivity – Mag. PU. -3mV: Mic – selectable 1-12mV: All others 100mV. **Tape O/P** – 100mV: **Main O/P** – 500mV: **Frequency response** – D.C. to 100KHz – 3dB.

HY6 mono £5.60 + 84p VAT Connectors included
HY66 stereo £10.60 + £1.59 VAT Connectors included
B6 Mounting Board for one HY6 78p + 12p VAT
B66 Mounting Board for one HY66 99p + 15p VAT

COMPATIBLE WITH ALL ILP MODULES



SCHEMATIC BLOCK DIAGRAM OF HY6 PRE AMP. WITH STEREO CONNECTION SHOWN

- **DISTORTION TYPICALLY 0.005%**
- **S/N RATIO – 90dB (Mag. P.U. – 68 dB)**
- **38 dB overload margin on Mag. P.U.**
- **LATEST DESIGN HIGH QUALITY CONNECTORS**
- **ONLY POTS, SWITCHES AND PLUGS/SOCKETS NEED ADDING**
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- *THE FOLLOWING WILL ALSO DRIVE I.L.P PRE-AMPS*

PSU36 for use with 1 or 2 HY30's — **£8.10** + £1.22 VAT
- *ALL THE FOLLOWING USE TOROIDAL TRANSFORMERS*

PSU50 for use with 1 or 2 HY60's	**£9.75** + £1.46 VAT
PSU60 for use with 1 HY120	**£9.75** + £1.46 VAT
PSU65 for use with 1 MOS120	**£9.75** + £1.46 VAT
PSU70 for use with 1 or 2 HY120's	**£13.61** + £2.04 VAT
PSU75 for use with 1 or 2 **MOS120**	**£13.61** + £2.04 VAT
PSU90 for use with 1 HY200	**£13.61** + £2.04 VAT
PSU95 for use with 1 **MOS200**	**£14.75** + £2.21 VAT
PSU180 for use with 1 HY400 or 2 HY200	**£23.02** + £3.45 VAT
PSU185 for use with 1 or 2 **MOS200**	**£24.20** + £3.63 VAT

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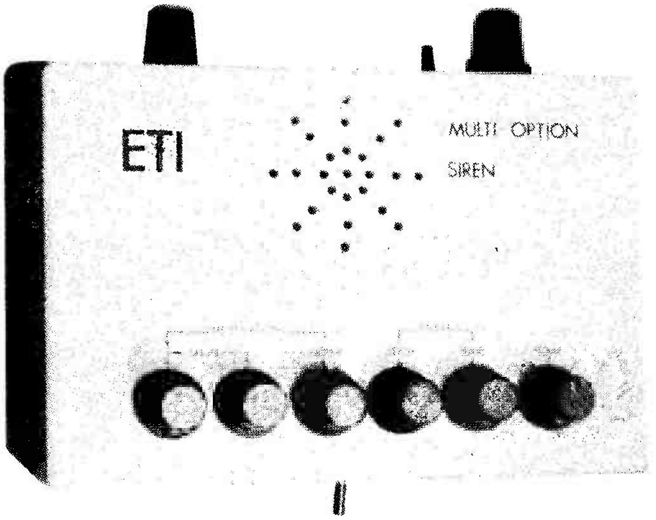
MULTI~OPTION SIREN



Warbles, bleeps, rising tones, falling tones and key-shifted tones, with or without vibrato — just a few of the near-infinite variety of sounds generated by our Multi-option Siren. Design by Ray Marston. Project development by Steve Ramsahadeo.

This design has a total of seven variable controls plus six switch-selectable operating modes and can generate such a vast range of different sounds that it is quite difficult to adequately give a written impression of the full capabilities of the project.

The heart of the unit is a tone generator that can have its operating frequency varied over virtually the full audio range by a single tone control. The frequency of this tone generator can also be modulated by either or both of two more generators, the first of these being a vibrato square wave oscillator. Both the vibrato rate and vibrato depth can be varied by individual controls. Thus, a little bit of fast vibrato imposes a 'buzz' sound on the tone, while lots of slow vibrato produces a sound like that of a tinkling piano key.

The second frequency-modulation generator is a very-low-frequency (VLF) oscillator that can produce either a pulse or a ramp waveform. Two mod shape controls allow the rise and fall times of the ramp or the on and off times of the pulse to be independently varied over a wide range to produce a wide variety of frequency-modulation waveforms. The depth of modulation is fully variable by a mod depth control.

Thus, with lots of symmetrical VLF ramp modulation applied, the circuit produces a 'wailing' American police-car sound without vibrato, or the sound of a repeatedly scaled (up and down) piano when lots of slow vibrato is applied. With a little bit of symmetrical VLF pulse modulation applied, the circuit produces the familiar 'dee-dah' British police-car sound without vibrato, or the alternate sounds of the repeated hammering of one piano key followed by the similar hammering of a different key when lots of slow vibrato is applied. The circuit can, of course, generate a virtually infinite variety of sounds between these extremes.

Gating Facilities

In addition to all the above sound generating facilities we've provided the ETI Siren with a number of gating functions. The gate is driven by the VLF oscillator and can be used to disable the audio output signal during either the leading or the trailing part of the VLF waveform or on alternate VLF-generator cycles. To gain an insight into the functional effect of this gating facility, imagine that the siren controls are set to produce a symmetrical VLF ramp waveform with lots of mod depth and no vibrato.

With the gating circuit turned off, the siren produces the familiar wailing sound. With leading gating applied the siren repeatedly produces a 'peeow' or falling tone sound followed by a blank period. With trailing gating the siren repeatedly produces a 'wheep' or rising tone sound followed by a blank period. With alternate gating the siren repeatedly produces a wail sound followed by a blank period of equal length.

Thus, the gating facility effectively trebles the variety of sounds that our siren can produce — and three times a 'near-infinite variety of sounds' should be enough to satisfy anyone!

The Multi-option Siren circuit needs a 12 V supply, which can be derived either from batteries or from the mains via a suitable supply circuit.

All components are mounted on a single PCB to ease construction. Begin by inserting all low profile components, ie wire links and sockets, followed by resistors, diodes, capacitors and transistors, observing the orientation of all polarised components. Fit the ICs last, taking care when handling the CMOS 555.

If you decide to use the recommended Vero case, drill all the holes to accommodate the potentiometers, switches and loudspeaker vent. Fix the loudspeaker in the upper half of the case and hold it in place with a few drops of the ever faithful Super-glue. The PCB must be centralised, so that the two battery holders can be placed either side. To enable the holders to fit in this way the battery connectors are not used. The power connections are soldered directly onto the studs, so take care not to apply excessive heat. A piece of insulating tape can then be stuck across the connections to stop interference with the front panel.

After a visual check, you will now be able to produce a variety of sound effects that will span the galaxy; yes, you too can have the best battery-powered bird caller in the land.

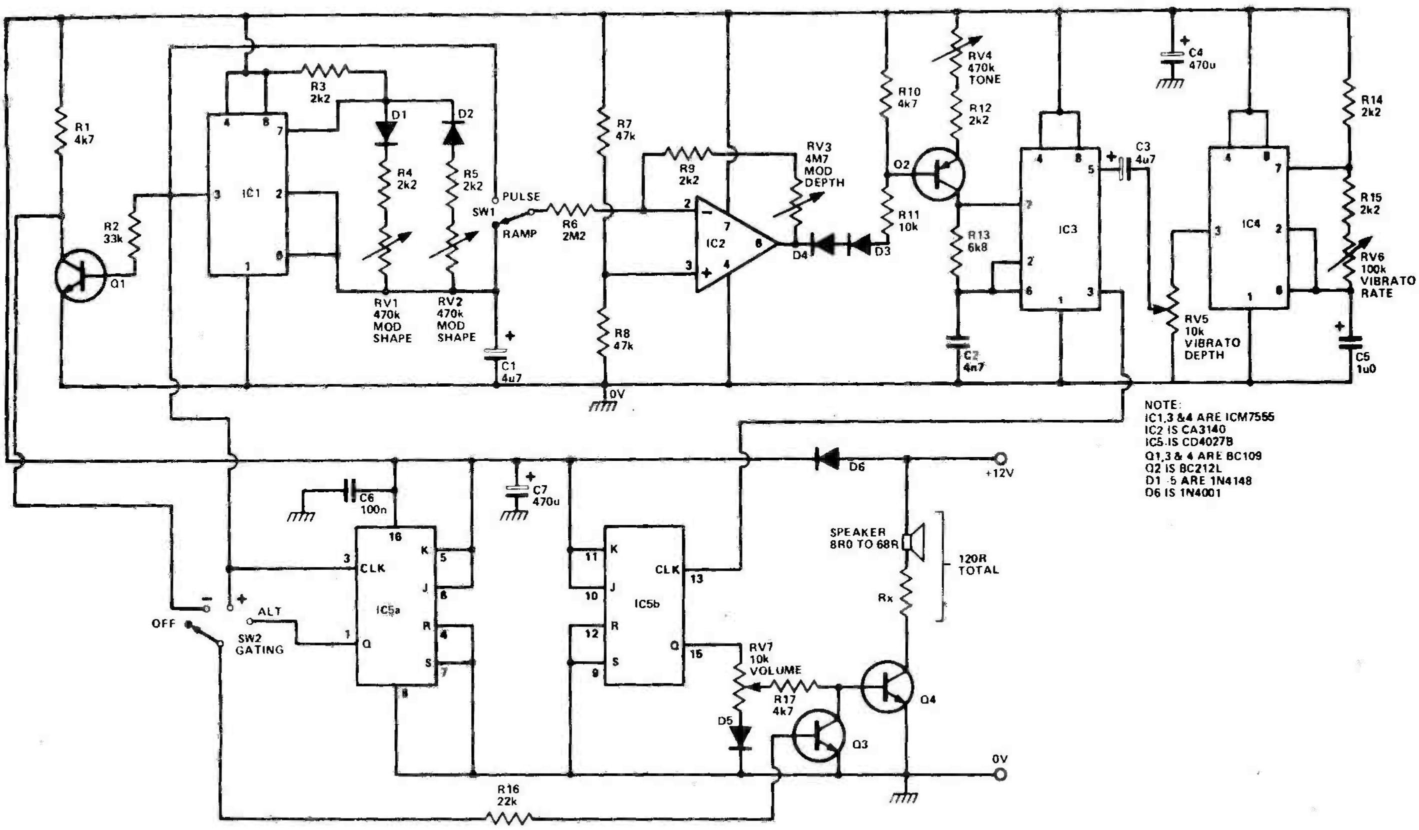


Fig.1 Circuit diagram.

HOW IT WORKS

The heart of the project is the tone generator designed around IC3. This is a fairly conventional 555-type astable, except that C2 charges via R13 and the constant current generator formed by Q2 and its associated resistor and diode networks. Normally, the output of IC2 (feeding D4) is at half-supply volts, so Q2 base is at a couple of volts below the positive supply value. The operating frequency of IC3 is variable via tone control RV4. The output (pin 3) of the IC3 tone generator is divided-by-two to provide a symmetrical waveform (via IC5b) and the resulting audio signal is fed to the speaker via Q4-R17 and volume control RV7.

IC4 is wired as a perfectly conventional 555 type astable and is used as a vibrato generator, with its square wave output being used to frequency modulate the IC3 tone generator via pin 5. The vibrato rate is variable via RV6 and the vibrato depth is variable via RV5.

IC1 is also wired as a 555-type astable, but in this case the charge and discharge times of C1 are independently varied by RV1 and RV2 respectively and the circuit operates at a very low frequency (VLF). The output of the VLF oscillator can be used to frequency-modulate tone-generator IC3 via IC2 and constant-current generator Q2, the pin 3 output being used to provide pulse modulation and the C1 output to provide ramp modulation. The depth of modulation can be varied by mod depth control RV3, which enables the gain of IC2 to be varied from near-zero (RV3 = zero) to approximately x2 (RV3 = 4M7).

The square wave (pin 3) output of the VLF oscillator can also be used to synchronously gate the audio output signal of the siren on and off via Q3. When this transistor is driven to saturation (by a high bias to R16) it kills the input signal to amplifier Q4. If R16 is driven directly from pin 3 of IC1, the audio signal is killed (gated off) when the VLF output is high. If R16 is driven from the collector of inverter Q1, the audio signal is killed when the VLF output is low. If R16 is driven from the output of divide-by-two flip-flop IC5a, the audio signal is killed on alternate VLF cycles.

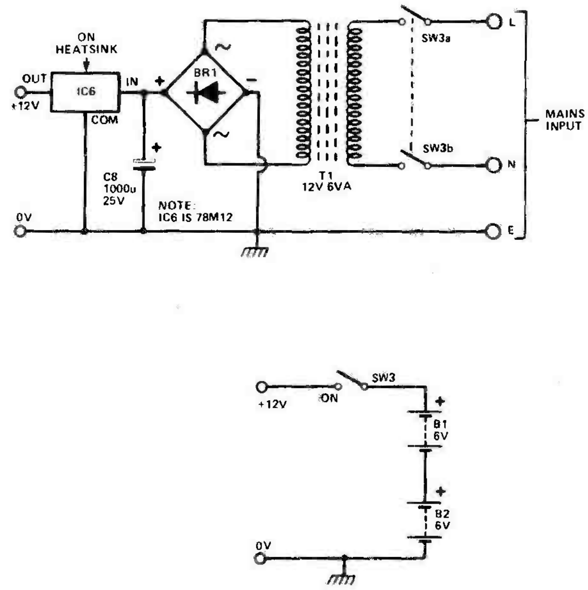
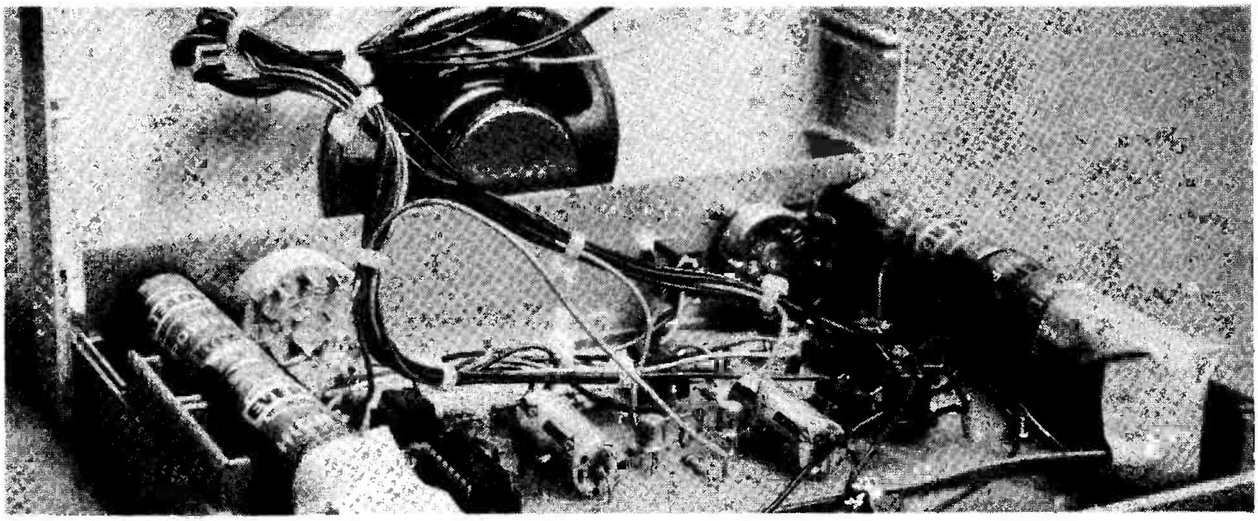


Fig.2 Alternative battery and mains power supply options.

BUYLINES

There should be no problem in obtaining any of the components used in the ETI Siren. All should be available from mail order suppliers advertising in this issue. If you have trouble obtaining a 68R loudspeaker, Technomatic should be able to help.



PARTS LIST

Resistors all ¼W 5%

R1,10,17	4k7
R2	33k
R3,4,5,9,12, 14,15	2k2
R6	2M2
R7,8	47k
R11	10k
R13	6k8
R16	22k

Potentiometers

RV1,2,4	470k linear
RV3	4M7 linear
RV5	10k linear
RV6	100k linear
RV7	10k logarithmic

Capacitors

C1	4u7 35 V tantalum
C2	4n7 ceramic
C3	4u7 63 V electrolytic PCB type
C4,7	470u 25 V axial electrolytic
C5	1u0 63 V electrolytic PCB type
C6	100n polyester Mullard C280

Semiconductors

IC1,3,4	ICM7555
IC2	CA3140
IC5	4027B
Q1,3,4	BC109
Q2	BC212L
D1-5	1N4148
D6	1N4001

Miscellaneous

SW1,3	DPST miniature toggle
SW2	1 pole 4 way rotary switch
LS1	68R

4 Section battery holders (HP7 type) (2 off)
Vero Case (order code 202-21037L)
Knobs to suit (8 off)

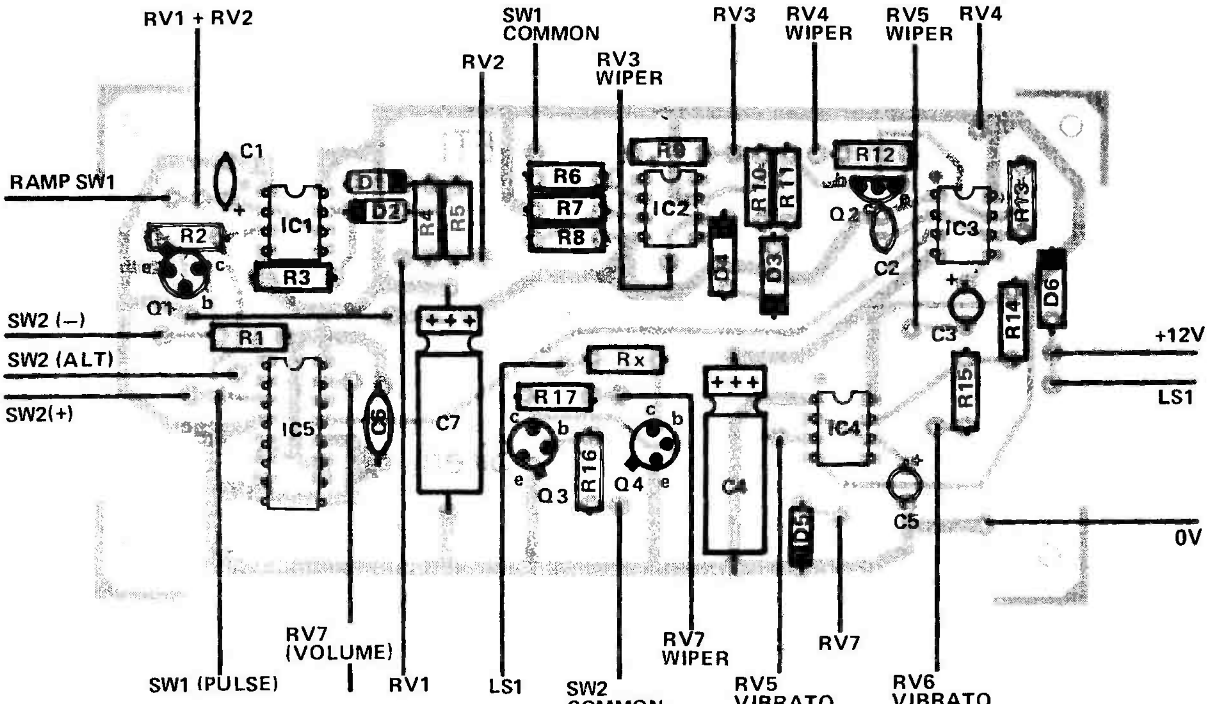


Fig.3 Component overlay.

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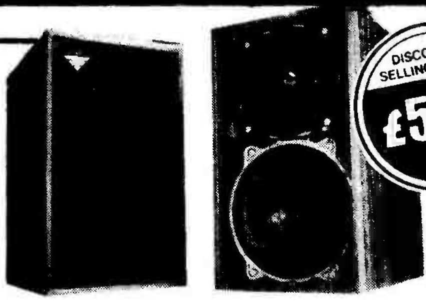

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Cliff. Hardcastle

Managing Director

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7413	30p
7414	40p
74C14	90p
7416	27p
7417	27p
7420	17p
7421	40p
7422	22p
7423	34p
7425	30p
7426	40p
7427	34p
7428	36p
7430	17p
7432	30p
7433	40p
7437	35p
7438	35p
7440	17p
7441	70p
7442A	60p
7443	112p
7444	112p
7445	100p
7446A	93p
7447A	75p
7448	80p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	34p
7474	30p
7475	38p
7476	32p
7480	50p
7481	100p
7482	84p
7483a	90p
7484	100p
7485	110p
7486	34p
7489	210p
7490A	30p
7491	80p
7492A	46p
7493A	36p
7494	84p
7495A	70p
7496	65p
7497	180p
74100	130p
74107	34p
74109	55p
74116	200p
74118	130p
74119	210p
74120	110p
74121	34p
74122	48p
74123	60p
74125	75p
74126	60p
74128	75p
74132	78p
74136	75p
74137	50p
74141	50p
74142	200p
74145	90p
74147	190p
74148	150p
74150	130p
74151A	70p
74153	70p
74154	120p
74155	90p
74156	90p
74157	70p
74159	190p
74160	100p
74161	100p
74162	100p
74163	100p
74164	120p
74165	130p
74166	120p
74167	200p
74170	240p
74172	450p
74173	120p
74174	90p
74175	85p
74176	90p
74177	90p
74178	160p
74180	93p
74181	160p
74182	90p
74184A	150p
74185	150p
74186	500p
74188	325p
74190	120p
74191	120p
74192	100p
74193	100p
74194	120p
74195	95p
74196	95p
74197	80p
74198	150p
74199	150p
74221	160p
74251	140p
74259	250p
74278	290p
74279	110p
74283	140p
74284	360p
74285	360p
74290	150p
74293	150p
74298	200p
74365	100p
74366	100p
74367	100p
74368	100p
74390	200p
74393	200p
74490	225p

74LS SERIES

74LS00	14p
74LS02	16p
74LS03	18p
74LS04	18p
74LS05	25p
74LS08	22p
74LS09	21p
74LS10	20p
74LS11	40p
74LS13	40p
74LS14	50p
74LS20	20p
74LS21	40p
74LS27	38p
74LS30	20p
74LS32	27p
74LS37	30p
74LS38	38p
74LS42	70p
74LS47	75p
74LS51	24p
74LS55	30p
74LS73	50p
74LS74	27p
74LS75	36p
74LS76	45p
74LS83	70p
74LS85	80p
74LS86	40p
74LS90	40p
74LS92	70p
74LS93	60p
74LS96	110p
74LS107	45p
74LS109	80p
74LS112	40p
74LS113	90p
74LS114	45p
74LS122	80p
74LS123	60p
74LS124	180p
74LS125	60p
74LS126	60p
74LS132	60p
74LS133	30p
74LS136	55p
74LS138	65p
74LS139	75p
74LS145	120p
74LS147	220p
74LS148	175p
74LS151	80p
74LS153	60p
74LS154	200p
74LS155	80p
74LS156	90p
74LS157	60p
74LS158	60p
74LS160	90p
74LS161	75p
74LS162	140p
74LS163	100p
74LS164	90p
74LS165	140p
74LS166	180p
74LS173	110p
74LS174	100p
74LS175	100p
74LS181	320p
74LS190	100p
74LS191	100p
74LS192	100p
74LS193	100p
74LS195	140p
74LS196	120p
74LS197	90p
74LS221	120p
74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	150p
74LS245	250p
74LS247	140p
74LS251	140p
74LS253	90p
74LS257	90p
74LS258	160p
74LS259	160p
74LS266	100p
74LS273	170p
74LS279	90p
74LS283	90p
74LS298	160p
74LS323	400p
74LS324	200p
74LS348	200p
74LS365	48p
74LS367	70p
74LS368	100p
74LS373	150p
74LS374	150p
74LS375	120p
74LS377	160p
74LS378	140p
74LS390	120p
74LS393	120p
74LS399	200p
74LS445	140p
74LS670	400p

4000 SERIES

4000	15p
4001	22p
4002	20p
4006	95p
4007	20p
4008	80p
4009	40p
4010	50p
4011	20p
4012	25p
4013	50p
4014	84p
4015	84p
4016	45p
4017	70p
4018	89p
4019	45p
4020	100p
4021	110p
4022	100p
4023	27p
4024	50p
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4034	200p
4035	110p
4036	295p
4039	295p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	45p
4050	45p
4051	80p
4052	80p
4053	80p
4054	150p
4055	125p
4056	135p
4059	600p
4060	115p
4063	120p
4066	50p
4067	450p
4068	27p
4069	20p
4070	30p
4071	25p
4072	25p
4073	25p
4075	25p
4076	107p
4081	27p
4082	27p
4086	72p
4089	150p
4093	70p
4094	250p
4095	95p
4096	95p
4097	340p
4098	120p
4099	200p
40100	220p
40101	132p
40102	180p
40103	180p
40104	99p
40105	120p
40106	90p
40107	60p
40108	470p
40109	100p
40110	300p
40114	250p
4502	120p
4503	70p
4507	55p
4508	290p
4510	99p
4511	120p
4512	80p
4514	250p
4515	300p
4516	110p
4518	100p
4520	100p
4521	250p
4526	108p
4527	150p
4528	100p
4532	140p
4534	550p
4536	375p
4538	120p
4543	180p
4553	320p
4556	72p
4560	200p
4569	250p
4572	40p
4583	110p
4584	90p
4585	150p
4724	250p
40097	90p
14411	1100p
14412	1100p
14433	1100p
14500	700p
14599	290p

INTERFACE ICs

AD536A	£13
AD561J	1400p
AD7524	600p
DM8123	175p
DM8131	375p
DP8304	450p
DS8835	250p
DS8836	150p
DS8838	225p
MC1488	75p
MC1489	75p
MM58174	£13
25S10	350p
75107	160p
75110	325p
75150	175p
75154	175p
75182	230p
75322	300p
75324	375p
75325	375p
75361	300p
75365	300p
75451/2	72p
75491/2	70p
8T26	160p
8T28	250p
8T95	180p
8T97	160p
81LS95	120p
81LS96	140p
81LS97	120p
81LS98	140p
9602	220p

93 SERIES

9301	160p
9302	175p
9308	316p
9310	275p
9311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	360p
9368	250p
9370	300p
9374	200p

74S SERIES

74S00	60p
74S04	60p
74S05	75p
74S08	75p
74S10	60p
74S20	60p
74S30	60p
74S32	90p
74S37	90p
74S64	60p
74S74	90p
74S85	300p
74S86	180p
74S112	120p
74S114	120p
74S124	300p
74S132	160p
74S133	75p
74S138	225p
74S139	225p
74S157	250p
74S174	250p
74S175	320p
74S194	350p
74S241	450p
74S260	70p
74S373	500p
74S374	500p

LINEAR I.Cs

AY1-0212	600p
AY1-1313	668p
AY1-1320	320p
AY1-5050	140p
AY3-1270	840p
AY3-8912	650p
AY5-1224A	240p
AY5-1315	600p
AY5-1317A	775p
AY5-4007D	520p
CA3019	80p
CA3046	70p
CA3048	225p
CA3080E	72p
CA3086	48p
CA3089E	225p
CA3090AQ	375p
CA3130E	90p
CA3140E	50p
CA3160E	100p
CA3161E	140p
CA3162E	450p
CA3189E	300p
CA3280	160p
DAC1408-8	200p
FX209	750p
HA1388	280p
ICL7106	850p
ICL8038	300p
ICM7555	80p
LF13331	310p
LF351	48p
LF356P	95p
LM10C	425p
LM301A	27p
LM311	70p
LM318	200p
LM319	225p
LM324	45p
LM339	75p
LM348	95p
LM358P	50p
LM377	175p
LM380	75p
LM381AN	180p
LM386	95p
LM393	100p
LM709	36p
LM710	50p
LM725	350p
LM733	100p
LM741	18p
LM747	70p
LM748	35p
LM2917	250p
LM3302	140p
LM3900	70p
LM3909	70p
LM3911	130p
LM3914	225p
LM3915	225p
LM13600	125p
MB3712	150p
MC1310P	150p
MC1458	48p
MC1495L	350p
MC1496	70p
MC3340P	120p
MK50398	750p
ML920	775p
MM57160	620p
NE531	150p
NE555	20p
NE556	70p
NE562B	425p
NE564	420p
NE565	130p
NE566	155p
NE567	140p
NE571	425p
NE5534A	250p
RC4136	120p
S566B	270p
SAD1024A	1250p
SFF96364	1100p
SL490	400p
SN76477	175p
SP8515	750p
TA7205	140p
TAA621	275p
TBA641B11	300p
TBA651	200p
TBA800	90p
TBA810	100p
TBA820	90p
TBA950	300p
TCA220	350p
TCA940	175p
TDA1004	300p
TDA1008	320p
TDA1010	225p
TDA1022	570p
TDA1024	120p
TDA1034B	250p
TDA1170	300p
TDA2002V	325p
TDA2020	320p
TL071/81	45p
TL072/82	75p
TL074	130p
TL084	110p
TL170	50p
UAA170	175p
UDN6118	320p
UDN6184	320p
ULN2003	100p
XR2206	300p
ZN414	90p
ZN419C	225p
ZN424E	135p
ZN425E	400p
ZN427E	750p

VOLTAGE REGULATORS
Fixed Plastic TO-220

1A	+ve		–ve	
5V	7805	60p	7905	65p
12V	7812	60p	7912	65p
15V	7815	60p	7915	70p
18V	7818	60p	7918	70p
24V	7824	60p	7924	70p
100mA	TO-92			
5V	78L05	30p	79L05	70p
12V	78L12	30p	79L12	70p
15V	78L15	30p	79L15	70p

OTHER REGULATORS

LM309K	135p
LM317T	200p
LM323K	500p
LM723	37p
78HGKC	600p
78HO5KC	550p
78MGT2C	135p
79HGKC	600p
TL497	300p

OPTO-ELECTRONICS

2N5777	45p
OCP71	90p
ORP12	120p
ORP60	120p
ORP61	120p
TIL78	55p

OPTO-ISOLATORS

ILD74	130p
MCT26	100p
MCS2400	190p
TIL111	90p
TIL112	90p
TIL116	90p

LEDS

0.125"		0.2"	
TIL32	55p	TIL220 Red	16p
TIL209 Red	13p	TIL222 Gr	18p
TIL211 Gr	20p	TIL228 Red	22p
TIL212 Ye	25p	Rectangular LEDs (R, G, Y)	30p
TIL216 Red	18p		

NSB5881	570p
TIL311	600p
TIL312/3	110p
TIL321/2	130p
TIL330	140p
7750/60	200p

DISPLAYS

3015F	200p
DL704	140p
DL707 Red	140p
FND357	120p
FND500	110p
FND507	110p
MAN3640	175p
MAN4640	200p

DRIVERS

9368	250p
9370	300p
UDN6118	320p
UDN6184	320p

TRANSISTORS

AC126	25p
AC127/8	20p
AC176	25p
AC187/8	25p
AF116	50p
AD149	70p
AD161/2	45p
AU107	200p
BC107/8	11p
BC109	11p
BC117	20p
BC147/8	9p
BC149	10p
BC157/8	10p
BC159	11p
BC169C	12p
BC172	12p
BC177/8	17p
BC179	18p
BC182/3	10p
BC184	11p
BC187	30p
BC212/3	11p
BC214	12p
BC237	15p
BC327	16p
BC337	16p
BC338	16p
BC461	36p
BC477/8	30p
BC516/7	40p
BC547B	16p
BC548C	9p
BC549C	18p
BC557B	16p
BC559C	18p
BCY70	18p
BCY71/2	22p
BD131/2	50p
BD135/6	54p
BD139	56p
BD140	60p
BD189	60p
BD232	95p
BD233	75p
BD235	85p
BD241	70p
BD242	70p
BDY56	200p
BF200	32p
BF244B	35p
BF256B	70p
BF257/8	32p
BF259	36p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFX29	40p
BFX30	34p
BFX84/5	40p
BFX86/7	30p
BFX88	30p
BFW10	90p
BFY50	30p
BFY51/2	30p
BFY56	33p
BFY90	90p
BRY39	45p
BSX19/20	20p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU126	150p
BU180A	120p
BU205	200p
BU208	200p
BU406	145p
E300	50p
E308	50p
E310	50p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJE340	50p
MJE2955	100p
MJE3055	70p
MPF102	45p
MPF103/4	40p
MPF105/6	40p
MPS6531	50p
MPS6534	50p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	32p
MPSA70	50p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU65	78p
OC28	130p
OC35	130p
TIP29A	40p
TIP29C	55p
TIP30A	48p
TIP30C	60p
TIP31A	58p
TIP31C	62p
TIP32A	68p
TIP32C	82p
TIP33A	90p
TIP33C	114p
TIP34A	115p
TIP34C	160p
TIP35A	225p
TIP35C	290p
TIP36A	270p
TIP36C	340p
TIP41A	65p
TIP41C	78p
TIP42A	70p
TIP42C	82p
TIP54	160p
TIP120	120p
TIP122	130p
TIP142	130p
TIP147	130p
TIP2955	78p
TIP4055	70p
TIS43	45p
TIS93	30p
ZTX108	12p
ZTX300	13p
ZTX500	15p
ZTX502	18p
ZTX504	30p
2N457A	250p
2N696	35p
2N697	25p
2N698	45p
2N706A	30p
2N708	30p
2N918	45p
2N930	18p
2N1131/2	36p
2N1613	25p
2N1711	25p
2N2102	70p
2N2160	350p
2N2219A	30p
2N2222A	30p
2N2369A	25p
2N2484	30p
2N2646	45p
2N2904/5	30p
2N2906A	30p
2N2907A	30p
2N2926	9p
2N3053	30p
2N3054	65p
2N3055	48p
2N3442	140p
2N3553	240p
2N3565	30p
2N3584	250p
2N3643/4	48p
2N3702/3	12p
2N3704/5	12p
2N3706/7	12p
2N3708/9	12p
2N3773	300p
2N3819	25p
2N3820	50p
2N3823	70p
2N3866	90p
2N3902	700p
2N3903/4	18p
2N3905/6	20p
2N4037	65p
2N4058/9	12p
2N4060	12p
2N4061/2	18p
2N4123/4	27p
2N4125/6	27p
2N4401/3	27p
2N4427	90p
2N4871	60p
2N5087	27p
2N5089	27p
2N5172	27p
2N5179	90p
2N5191	90p
2N5194	90p
2N5245	40p
2N5296	55p
2N5401	50p
2N5457/8	40p
2N5459	40p
2N5460	60p
2N5485	44p
2N5875	250p
2N6027	48p
2N6041	160p
2N6044	160p
2N6052	300p
2N6059	325p
2N6107	65p
2N6247	190p
2N6254	130p
2N6290	65p
2N6292	65p
2SC1172	150p
3N128	120p
3N140	120p
3N141	110p
3N201	110p
3N204	120p
40290	250p
40360	40p
40361/2	75p
40364	120p
40408	90p
40409	100p
40410	100p
40411	300p
40594	120p
40595	120p
40673	75p
40841	90p
40871/2	100p

6A	50V	80p
6A	100V	100p
6A	400V	120p
10A	400V	200p
25A	400V	400p

ZENERS

2.7V-33V	
400mW	9p
1W	15p

TRIACS PLASTIC

3A 400V	60p
6A 400V	70p
6A 500V	88p
8A 400V	75p
8A 500V	95p
12A 400V	85p
16A 400V	110p
16A 500V	130p
T2800D	130p

DIODES

BY127	12p
BYX36-300	20p
OA47	9p
OA81	15p
OA85	15p
OA90	9p
OA91	9p
OA95	9p
OA200	9p
OA202	10p
1N914	4p
1N916	7p
1N4148	4p
1N4001/2	5p
1N4003/4	6p
1N4005	6p
1N4006/7	7p
1N5401/3	14p
1N5404/7	19p
IS920	9p

THYRISTORS

1A 50V	70p
1A 400V	90p
3A 400V	100p
8A 600V	140p
12A 400V	160p
16A 100V	160p
16A 400V	180p
BT106	110p
C106D	45p
MCR101	36p
TIC44	27p
2N3525	130p
2N4444	140p
2N5060	34p
2N5064	40p

HEAT SINKS

For TO220 Voltage Regs and Transistors	22p
For TO5	12p

BRIDGE RECTIFIERS

1A	50V	19p
1A	100V	20p
1A	400V	25p
1A	600V	30p
2A	50V	30p
2A	100V	35p
2A	400V	45p
3A	200V	60p
3A	600V	72p
4A	100V	95p
4A	400V	100p

LOUDSPEAKERS

Size		
2½"	64R	80p
2½"	8R	80p
2"	8R	90p
1½"	8R	100p

MODULATORS

6MHz UHF	375p
8MHz UHF	450p

MEMORIES

2101-4L	400p
2102-2L	120p
2107B	500p
2111-4	400p
2112-4	300p
2114	225p
2114-2L	450p
4027-3	375p
4044	900p
4116	350p
4118-4	£1200
5101	400p
6810	325p
74S201	400p
82S16	325p

ROM/PROMs

71301	700p
74S188	225p
74S387	350p
74S470	650p
74S471	650p
74S571	650p

CPUs

1600	1200p
1802CE	750p
2650A	2000p
6502	650p
6800	650p
6802	950p
6809	£20
8080A	450p
8085A	1100p
INS8060	1000p
TMS9980A	£20
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Z80A	880p

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1702A	500p
2708	450p
2716 (+5V)	£7
2532	£25
2732	£25

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3242	800p
3245	450p
6522	650p
6532	825p
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6821	340p
6845	£20
6850	300p
6852	370p
8155	1100p
8205	320p
8212	225p
8216	200p
8224	275p
8226	250p
8228	525p
8251	475p
8253	1000p
8255	480p
8257	900p
8259	960p

TMS9918	POA
Z80P10	600p
Z80AP10	700p
Z80CTC	600p
Z80ACTC	700p
Z80ADART	£15
Z80S10-1	£24
MC1441L	1100p

UART

AY-3-1015P	450p
AY-5-1013A	400p
IM6402	450p

CHARACTER GENERATORS

3257ADC	990p
RO-3-2513 U.C.	600p
RO-3-2513 L.C.	700p
SN74S262AN	£10

KEYBOARD ENCODER

AY-5-2376	700p

CRYSTALS

32.768KHz	250p
100KHz	300p
200KHz	370p
1.0MHz	320p
1.008MHz	350p
1.8432MHz	325p
2.00MHz	325p
2.45760MHz	325p
3.276MHz	300p
3.579MHz	175p
4.00MHz	290p
4.194MHz	POA
4.43MHz	125p
5.0MHz	325p
6.0MHz	300p
6.144MHz	300p
7.0MHz	300p
7.168MHz	300p
8.00MHz	300p
8.867MHz	300p
10.00MHz	310p
10.7MHz	300p
12.0MHz	350p
16.00MHz	350p
18.00MHz	300p
18.432	350p
19.968MHz	390p
26.690MHz	350p
27.145MHz	325p
38.6667MHz	350p
48.0MHz	300p
55.5MHz	400p
116.0MHz	350p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	20p	28 pin	30p
16 pin	11p	22 pin	22p	40 pin	40p

ZERO INSERTION FORCE SKT
24 pin £7

WIRE WRAP SOCKETS BY TEXAS

8 pin	25p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

SUBMINIATURE SWITCHES

Toggle	
SPST	60p
SPDT	65p
DPDT	70p
DPDT (centre off)	85p
Push to make	15p
Break	25p
Push latching SPCO	60p
SLIDE DPDT	18p
ROCKER SPST	28p
WAFER	
1P/12W	45p
3P/4W	45p
4P/3W	45p
2P/6W	45p

ANTEX SOLDERING IRONS

C-15W	415p
CX-17W	425p
CCN-15W	425p
X25	440p

SPARE BITS

C/CX/CCN	50p
X25	50p

SPARE ELEMENTS

C/CX/X25	180p
CCN	200p

VEROBOARDS

	0.1 (copper clad)
2.5×3.75"	68p
2.5×5"	75p
3.75×3.75"	78p
3.75×5"	90p
3.75×17"	290p
4.75×17.9"	380p
Pkt of 100 pins	50p
Spot face cutter	80p
Pin insertion tool	118p
Vero Wiring Pen + 2 wire spools + combs	370p
Combs	7p

DIL SWITCHES

4 way SPST	90p
8 way SPST	120p

TRANSFORMERS
(prim 220/240V)

6-0-6 100mA	90p
9-0-9 75mA	95p
9-0-9 1Amp	330p
0-12V 2A	410p
15-0-15 1A	325p

EDGEBOARD CONNECTORS 0.156" PITCH

2 × 10 way	85p	2 × 22 way	135p
2 × 15 way	100p	2 × 25 way	160p
2 × 18 way	120p		

COUNTERS

74C925	550p
74C928	600p
ICM7216B	2000p
ICM7217A	850p
ZN1040E	700p

TTL & ECL

MC4024	325p
MC4044	325p
10116	70p
10231	350p

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2114L (150ns)	£2.00	7805/7812	£5/10
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PB102	2295p
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DM235 Digital Multimeter	£50
DM350 Digital Multimeter	£69
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TG105 Pulse Generator	£81

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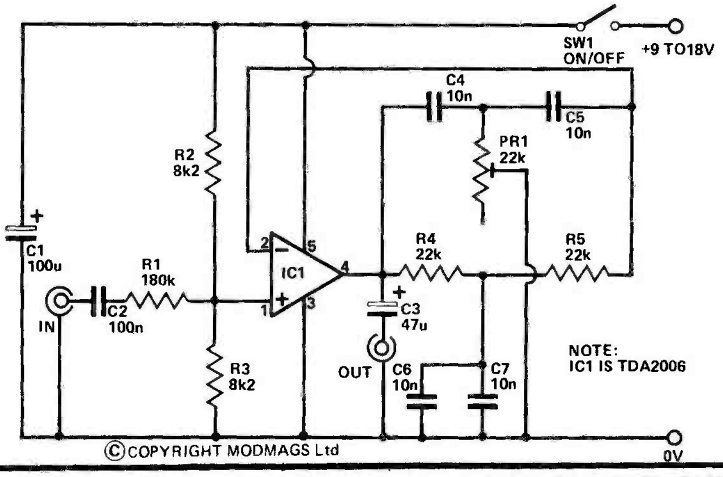
CW Filter

One of the most desirable features of a communications receiver is a set of really good IF filters for the various modes of modulation. Presumably due to the expense and complexity of such circuitry, this is lacking in many sets. In such cases it is often possible to obtain a worthwhile improvement in performance by using an audio filter with a response tailored to suit the required mode of reception. A filter of this type is of most help for CW (Morse) reception, where only a very narrow bandwidth is needed. In fact, an infinitely narrow bandwidth is the theoretical ideal, since the CW signal is just a single frequency! In practice, a bandwidth of a few hundred Hertz is necessary, since it is very difficult to tune to a signal and stay accurately tuned to it with a narrower bandwidth.

The circuit uses an integrated circuit audio amplifier (TDA2006) in the non-inverting mode, with R2 and R3 being used to bias the non-inverting input. C4 to C7, R4,5 and PR1 form a T-notch filter, which provides frequency selective negative feedback over IC1. R4 and R5 also bias the inverting input of the device. A T-notch filter allows most frequencies to pass readily, but at and close to its operating frequency it gives a high level of attenuation. Thus, in this case it gives virtually 100% negative feedback and only about unity voltage gain at most frequencies. However, at its operating frequency there is little feedback and high voltage gain. This gives the required narrow passband.

PR1 controls the bandwidth of the filter and a fairly flat response will be obtained at maximum resistance. Decreasing its resistance gives a sharper and narrower response, but too low a resistance will give an unusably sharp response. The circuit might even start to oscillate. R1 attenuates the input signal to a level that gives roughly unity gain at the centre of the passband, but the exact voltage gain depends on the setting of PR1. The output can be fed to low, medium, or high impedance headphones, or a loudspeaker. Current consumption is about 15 mA.



AUDIOPHILE

It's almost time for Rudolph the red-nosed guinea pig (everyone's had to economise) to drag his sleigh across your roof. If you haven't sent your letter to Santa yet, Ron Harris offers a few sound suggestions.

It's that time of the year again, is it not? Out with the plastic holly, stale booze and cast-iron fruit cake. At work everyone goes around smiling and saying "cheers" too often, all the time checking people over with hungry eyes to see who is gonna grab who at this year's booze-up. Goodwill to all men and all that.

Another quaint little custom widely practised in some social circles is that of spending money that doesn't exist upon things which are totally unnecessary and giving them away to people who don't want them anyway, in return for which you are guaranteed to receive several pieces of ultra-modern junk yourself. Sheer unadulterated lunacy really.

Why not change things this year? As you are most unlikely to get Felicity Kendal, regardless of who you ask (*I've* written to Santa seven years running with no luck, so far — why should you be any different, eh?), something remotely hi-fi might make the pain and heartache of disappointment a little less hard to bear. Now, unless you're friends with a few dozen Arab Sheiks it is *also* unlikely that, on the morning of the 25th, you will awaken to find a neatly packaged Meridan, SME or Linn sat sitting beneath the Woolies tree . . .

Audiophile this month is dedicated to providing a few dozen or so ideas for additions and improvements to hi-fi systems of all denominations that are financially feasible, be it your intention to give or to receive. It is *especially* more blessed to give when you can afford it.

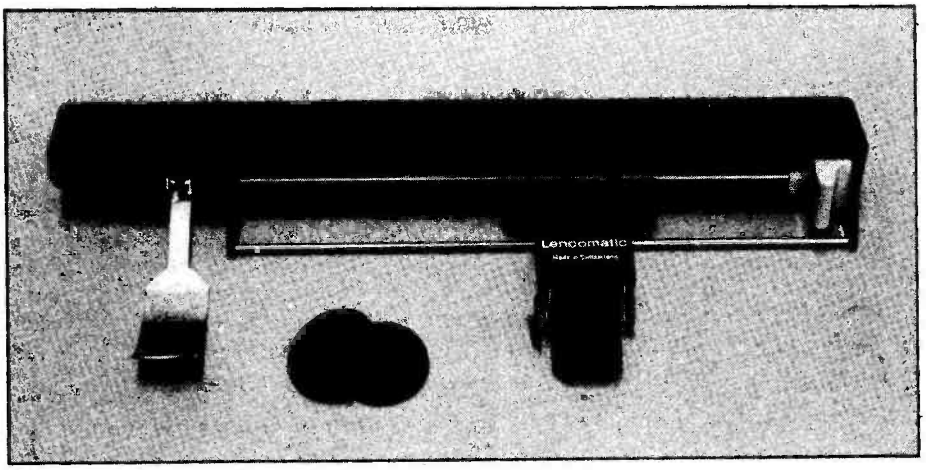
Format For Mats And Things

A glance at any audio emporium will show you that there are more than just a few accessories and gadgets to choose from these days and it would have been totally impossible to cover them all; by the time we published this, someone would have released a hundred more. Beside which, not all the vended items can even remotely meet their manufacturer's claims. I've been very selective, therefore, about which items to include. If you don't find a particular item here, that in itself is no condemnation. However, everything which is included, *is* recommended!

There is in addition a 'special' section for what I think are 'special' items and these are written up in more detail than the rest. Prices appended to each are typical prices you can expect to pay in the shops, inclusive of VAT. It might be an idea to leave this article lying around with certain items heavily ringed in flourescent yellow, or something. Alternatively be direct and hit a few friends over the head with it — you never know, as well as broken bones you *might* just get a stylus cleaner or two.

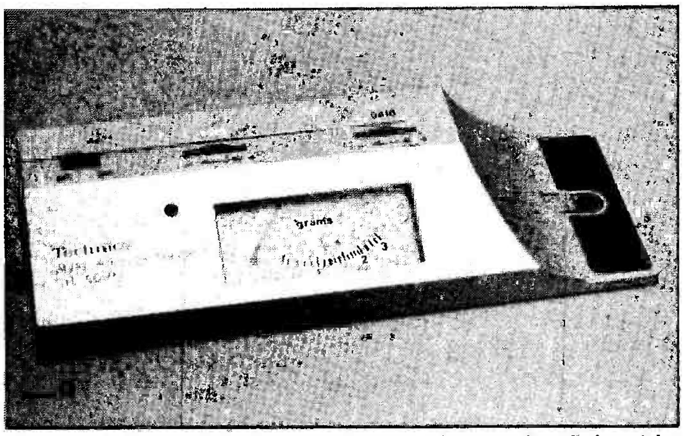
Items appear in no particular order of merit or anything else.

(Oh yes, Merry Thingy and all that.)

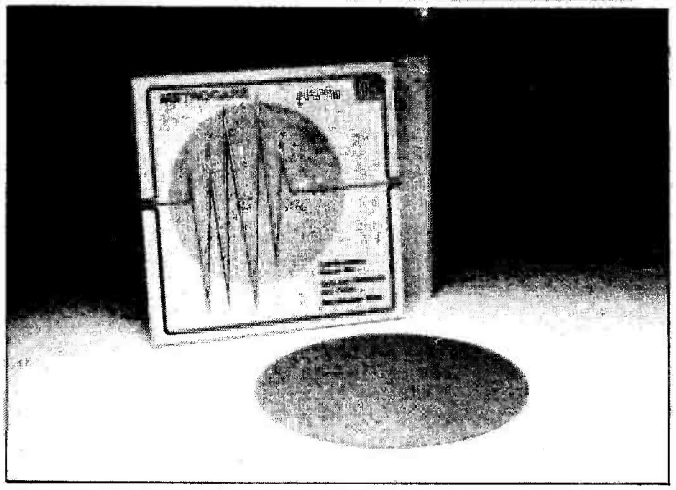


Above the Lencomatic record cleaner. This is the most unusual of the hordes of tracking cleaners arund the shops these days. Rather than fit it to the deck on a nice plain, ordinary, boring pillar it *attaches to the perspex lid* and that evil looking tongue rests on the spindle to locate the device! There is a little carbon-fibre brush and a large pad on the business end. Perfect for lazy people or those who wish to aspire to such heights of inaction. The only drawback is the somewhat odd appearance. Price:- £8.93.

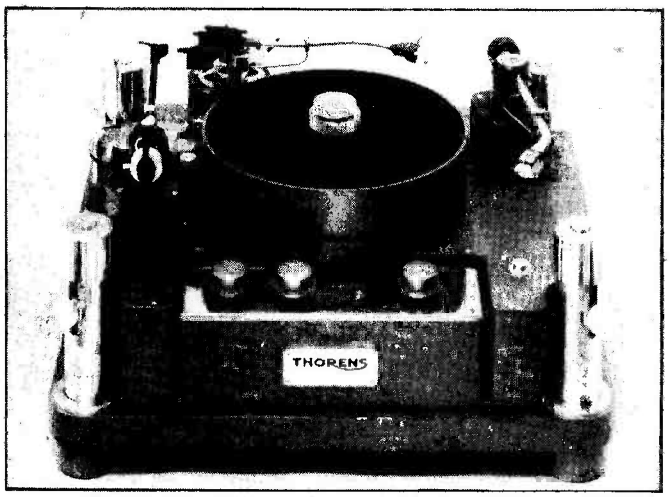
Above: Discguard. I'm always suspicious of things to spray onto records, but this seems harmless enough — if I can overcome the hidebound conservative attitude that the less stuff I put under the stylus, the less will end up stuck all over it! Discguard is a permanent anti-static treatment which is undetectable audibly (we tried it!) and greatly reduces the LP's ability to attract dust. Price:- £4.50.



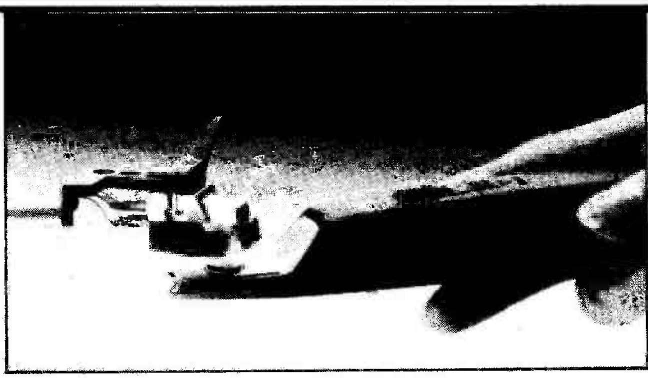
Above: Technics SH-50P1 stylus pressure gauge. A long way from little weights this. A strain gauge measures the downforce present and reads out the tracking weight on a meter. It is accurate to about 0.1g if set-up properly — a reference weight is provided — and looks very very flashy in use. Just the thing to impress the neighbours — and yourself! I like this idea — how about a digital version eh, Technics? **Price:- £17.95.**



Above: Turntable mats are a favourite tune-up these days and these are consequently a large number of them around. This is one of the newest. The Metrocare has a very high surface tension — VERY high. It grips an LP like a Scotsman grips his drink and thus provide an excellent bond. **Price:- £16.75.**



The ultimate accessory? The Thorens Reference deck, built with no compromise whatsoever to price. It weighs 90 kgs, claims to possess unmeasurable rumble and w/f at 0.02%, is a subtle 620 x 360 x 510 mm in size. The chassis is aluminium cast, filled with iron grain. In other words it is very big, very heavy, and very expensive (circa £4,000). Supposed to sound pretty good too.

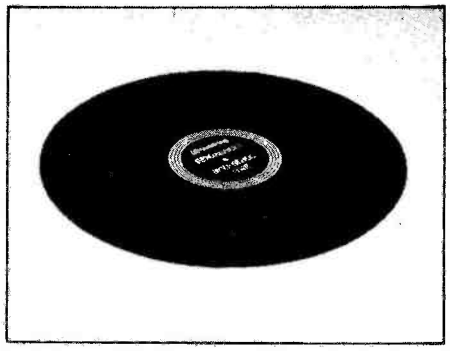


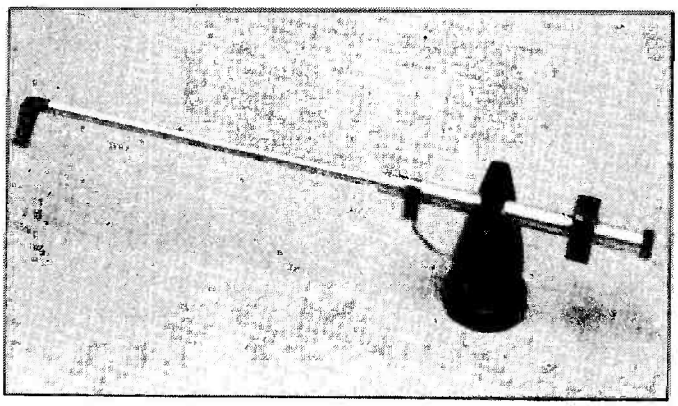
Above (and below!): Now this has got to be the Idea Of The Year! Without passing any comments — and you mucky minded lot out there can keep quiet too — this is a vibrating stylus cleaner from Audio Technica. There is a pad at the end, attached to a vibrator within the body of the device. You lower the stylus onto the pad and leave it alone for a few seconds. The clever little widget meanwhile proceeds to shake all the muck off the stylus!

Ingenious in the extreme and it works superbly. Sheer magic. Never in the field of human grooves has so much been cleaned so well by so little. There is a bottle of cleaner supplied to deal with really bad cases of encrustation. Thoroughly and totally recommended. Every home should have two. **Price:- £9.95.**

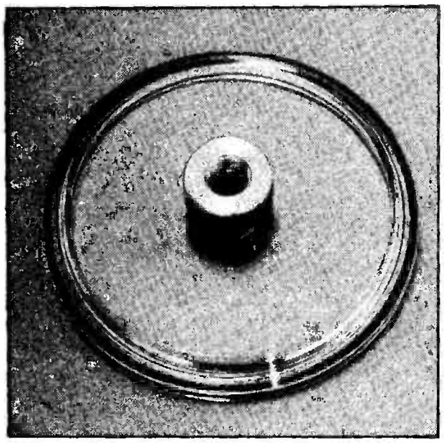
Not all turntable mats are designed to be anti-resonance à là the Metrocare. This Goldring is primarily anti-static and is composed of carbon fibres to provide a leak-path to earth for the charge present on the LP.

Price:- £3.90.





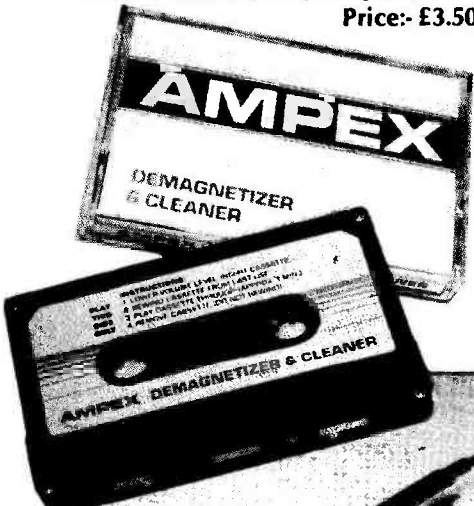
Above: the Exstatic carbon fibre sweep arm. Of all the millions of Dust-Bug descendents available this is my favourite. It looks very classy indeed and does the job better than most. An earthing lead is provided to form a conductive path to ground static encountered in mid-sweep and the counterweight provides playing weight adjustment to optimise tracking. **Price:- £8.40.**



Above: the Metrocare anti-resonance clamp. This is formed of clear perspex with a brass center. The idea being that it is fitted over the spindle atop your records, to clamp them firmly onto the mat, thus de-warping warps and supressing resonance. Used together with a good turntable mat the clamp can offer a worthwhile improvement in sound quality, especially in the bass. **Price:- £4.54**

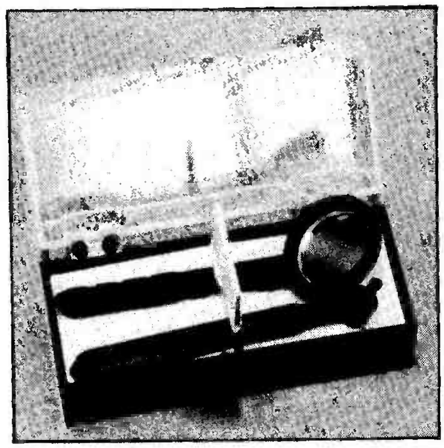
Below: a neat little notion this. As the cleaning tape passes the heads, it rotates a cunningly placed rotary magnet which simultaneously de-magnetises them. The magnet is moved away automatically within the cassette by the spooling action.

Price:- £3.50.



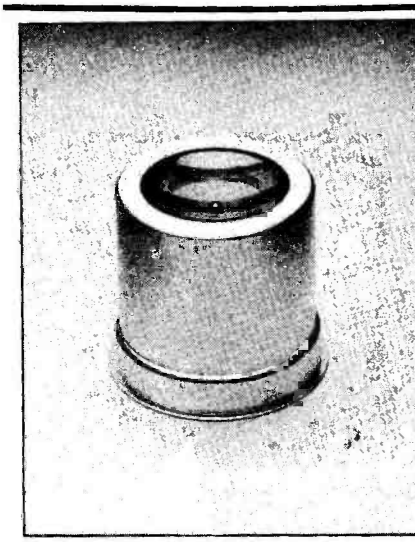
Above: one for those always in the dark. A light from Goldring, which fits onto the dust-cover (or cupboard door) wherein lurks the record deck and switches on as you open the door! A little mercury switch does the work, leaving you free to return to whatever it is you were doing in the dark . . . .

Price:- £12.00.



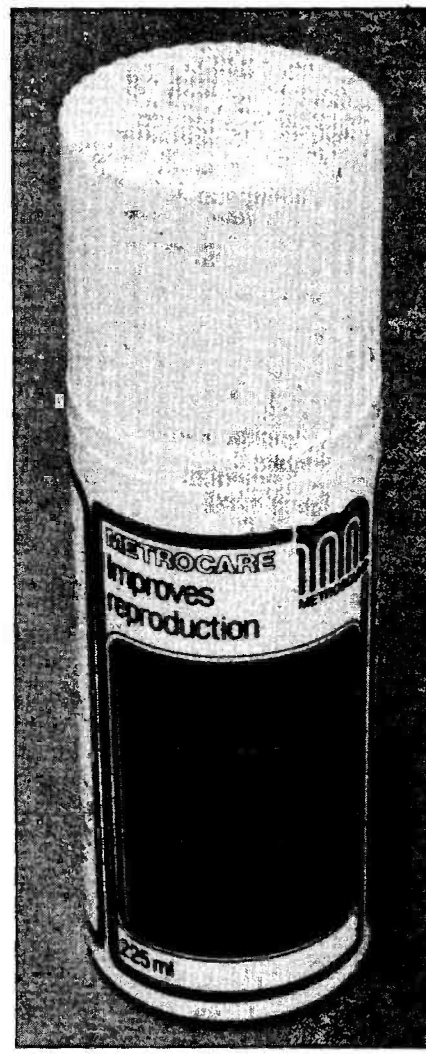
Above: a smallie-but-goodie. Just the thing to buy with the change from an LP! The Exstatic stylus care kit only costs 90p and will earn that back with the first wipe of the brush! Go on — you know it makes sense. Make a good present for the person that bought your Des O'Connor Greatest Hits last year. If he plays that sort of stuff, SOMEONE better take care of his stylus and quick!

Price:- £0.90.



Above: Triple Checker! Well, it is. A record weight, spirit level and 45 RPM adaptor all in one. That little ball bearing you can see lurking under the glass rolls around in a shallow dish to indicate how level the deck is (inaudibly I might add) and the thing is so heavy no warp will dare defy it! The Triple Checker comes from Goldring and costs;

Price:- £6.00



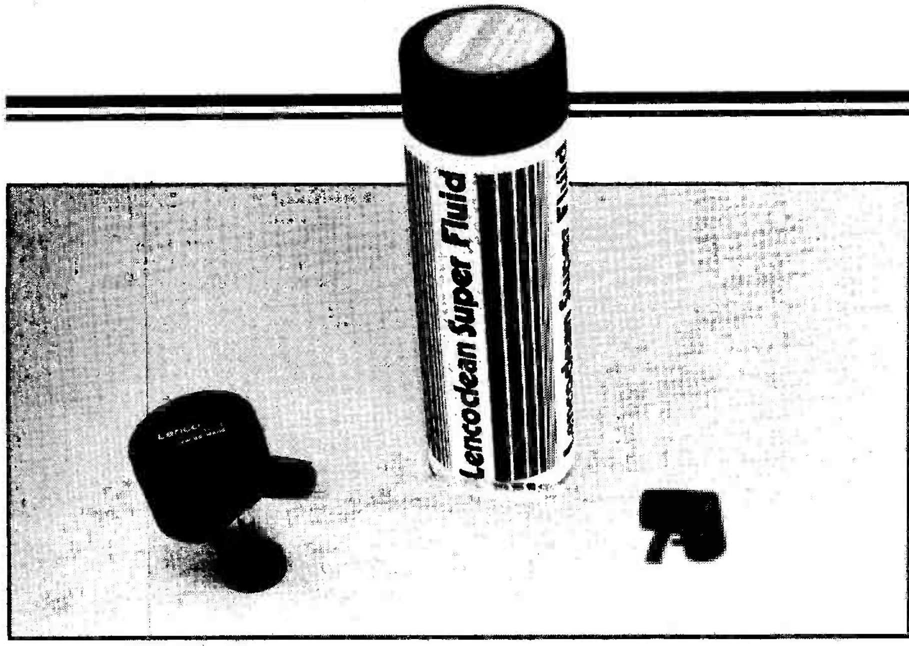
Above: do you suffer from dirty, ingrained, groove dust? Do your records lack that new-look sparkle? Are your highs too low and your lows distorted? Give your LPs a face-lift with the Metrocare Rejuvenating Fluid!

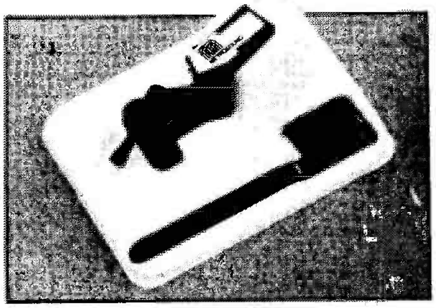
This is literally applied like a face-pack from the bottle, being smeared across the surface and allowed to dry into a thin plastic film. This is then peeled away, taking most of the gunge with it!

Price:- £4.24.

Below and left: the Exstatic record brushes. Both consist of carbon fibre bristles, with the wiper possessing a pad down the centre for better dust collection. Both come with a stand.

Prices:- £6.00 and £7.50 (super).



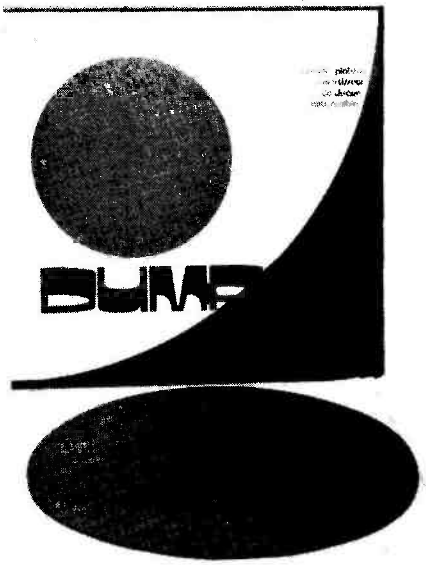


Above: the tracking cleaner for automatic record players. It attaches to the headshell. From Metrocare at **Price:- £1.68.**

Above: how about playing your record under water? Or under liquid anyway. The Lencoclean has been around a long time and continues to have its followers. It is a wet-playing system, which means that the arm (filled with fluid) tracks ahead of the stylus, dispensing a band of liquid into the groove. Any matter present is held in suspension when the stylus arrives and has minimal effect. No more snap, crackle and pop. No more static. Quiet backgrounds guaranteed.

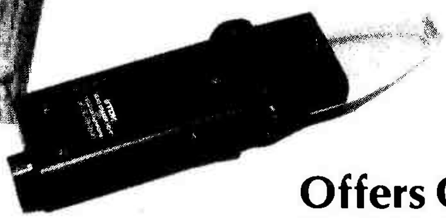
The penalty to be paid is that once used, always used. Dry playing becomes impossible because the mud in the grooves has to be suspended else it gathers around the stylus somewhat rapidly. As I said, the system has a lot of followers and works superbly. It is up to you whether you take the plunge!

Price:- £5.93.



Left and below: TDK make two head demagnetisers, one very pretty cassette unit (left) which is fully automatic and absolutely beautiful! The conventional unit below (not to scale!) is designed for reel-to-reel mainly and is superbly constructed.

Price:- £11.25 (cassette)
£21 (reel-to-reel).



Above: the renamed Spectra mat. Dumpa it is called now apparently, but it is *still* one of the very best of the turntable mats to be purchased working well on a wide range of decks.

Price:- £19.80.

Below: the Metrocare 'cling' cleaner. A permanent 'sticky' roller which never needs replacing. Just wash it when dirty and start again!

Price:- £5.87.

Offers On Offer

The ETI switchboard has glowed red in the night since we ran our hi-fi system offer a couple of issues back. The most oft asked questions were whether the equipment was purchasable separately and where it could be heard.

The answers are yes — prices below — and at Videotone's showroom in Crofton Park Road (see advert in this issue). We chose the system for its sound vs price performance and if you make the trip to Videotone you'll see what we mean. Take a copy of ETI along and you can buy at the prices quoted below. But be quick about it as time, tide and stock levels wait for no man!

ST 4120 tuner	£55 + £3 p&p
ST 4130 amplifier	£50 + £3 p&p
SC 3200 cassette deck	£75 + £3 p&p (reduced again from £88. Too good to our readers we are!)
GB2 loudspeakers (pair)	£45 + £7 p&p

Incidentally, since Audiophile uses a Coral MC81 quite extensively as a reference, Videotone are prepared to let ETI readers buy one at a good discount on normal prices. An MC81 and H300 head-amp will cost you £44.50 and £45.00 respectively instead of £48.87 (+ p&p) and £51.75 (+ p&p). Add a quid to each for postage as usual and tell them ETI sent you!

ETI

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Volts	Milli-amps	Ref. No.	Price £	P&P
3-0-3	200	238	**2.60**	.70
0.6, 0.6	1A 1A	212	**3.00**	.75
9-0-9	100	13	**2.30**	.70
0.9, 0.9	330 330	235	**2.15**	.70
0-8-9, 0-8-9	500 500	207	**2.75**	.75
0-8-9, 0-8-9	1A 1A	208	**3.85**	.75
0-15, 0-15	200 200	236	**2.15**	.70
0-20, 0-20	300 300	214	**2.75**	.90
20-12-0-12-20	700(DC)	221	**3.50**	.90
0-15-20, 0-15-20	1A 1A	206	**4.60**	1.05
0-15-27, 0-15-27	500 500	203	**4.05**	.85
0-15-27, 0-15-27	1A,1A	204	**6.10**	1.05

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

Amps 12v	24V	Ref.	Price £	P&P
0.5	0.25	111	**2.30**	.75
1.0	0.5	213	**2.75**	.90
2	1	71	**3.25**	.90
4	2	18	**4.05**	.85
6	3	70	**5.60**	.95
8	4	108	**7.40**	1.20
10	5	72	**8.25**	1.20
12	6	116	**8.85**	1.20
16	8	17	**10.85**	1.30
20	10	115	**13.85**	1.50
30	15	187	**16.85**	1.50
60	30	226	**33.35**	1.80

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

Amps	Ref. No.	Price £	P&P
0.5	112	**2.85**	.90
1.0	79	**3.60**	.90
2.0	3	**5.60**	1.05
3.0	20	**6.30**	1.20
4.0	21	**6.60**	1.20
5.0	51	**9.60**	1.20
6.0	117	**11.10**	1.20
8.0	88	**14.35**	1.50
10.0	89	**16.60**	1.50

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

Amps	Ref. No.	Price £	P&P
0.5	102	**3.60**	.90
1.0	103	**4.60**	1.05
2.0	104	**7.30**	1.20
3.0	105	**8.60**	1.20
4.0	106	**10.85**	1.30
6.0	107	**15.10**	1.50
8.0	118	**20.20**	1.70
10.0	119	**24.10**	2.20

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

Amps	Ref. No.	Price £	P&P
0.5	124	**3.85**	.90
1.0	126	**5.60**	1.05
2.0	127	**7.55**	1.20
3.0	125	**11.10**	1.30
4.0	123	**12.35**	1.50
5.0	40	**14.15**	1.60
6.0	120	**17.60**	1.60

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75	64	**4.10**	.90
150	4	**5.60**	1.05
Input/Output Tapped 0-115-210-220-240V			
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500	67	**10.85**	1.50
1000	84	**18.60**	1.60

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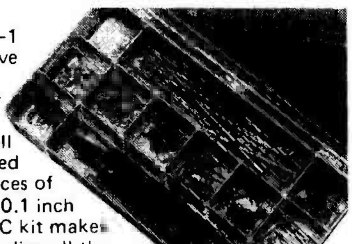

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ETI 1/81

MD609 Gentleman's **super slim** flag date alarm. Only 4mm case thickness. Continuous display of hours, minutes, seconds and day; optional display of date, month, year. 24 hour alarm, alarm mode indication. Back light. Infinitely adjustable stainless steel strap. Very latest technology.
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MD610 Gentleman's dual time melody alarm chrono. Only 5mm case thickness. Continuous display of hours, minutes, seconds plus date and mode indications. 'Running horse' chrono to 1/10 sec, 12 hour alarm plays 30 seconds of 'Yellow Rose of Texas'. Infinitely adjustable stainless steel strap.
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MD606 Ladies five function fashion LCD watch with 3 year battery. Continuous display of hours and minutes, with month/date and date/seconds available. Auto calendar. Only 6mm case thickness. Back light. Infinitely adjustable stainless steel strap.
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MD607 Ladies slim 'sugar coated' dress watch. Continuous display of hours and minutes; optional display of month and date. Auto calendar. Back light. Integral watch and strap. In gold or silver finish.
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MD608 Gentleman's musical alarm chrono. Continuous display of hours, minutes, seconds, plus day indication. Also month and date. Chronograph with lap timing facilities, to 1/10 sec. 24 hour alarm plays 30 seconds of Beethoven's 'Fur Elise' or can be set to awaken to a single note. Back light. Infinitely adjustable stainless steel strap.
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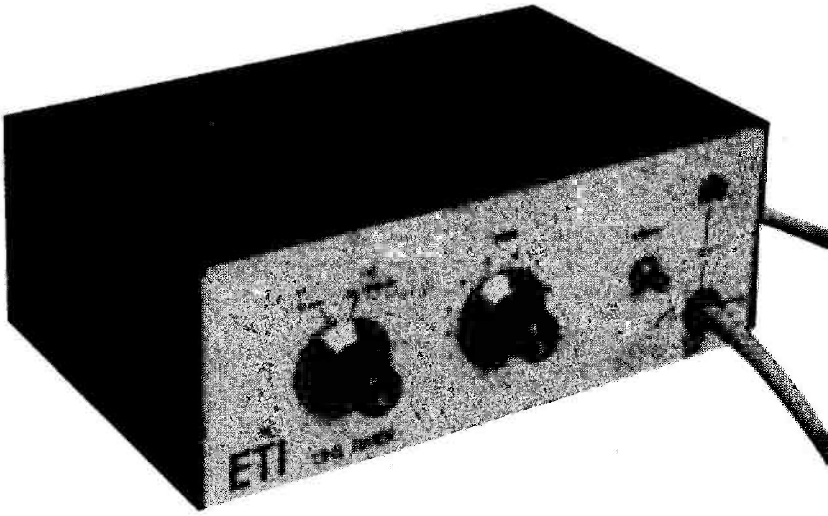
UNIVERSAL TIMER

Our two-range (1-10 and 10-100 min) timer has excellent stability and produces a 30 S pulsed alarm sound at the end of each timing period. The unit is mains powered, can switch 15 A mains loads and can give either make or break timing operation.

Design by Ray Marston. Project development by Steve Ramsahadeo.



Most analogue (pot controlled) long-period timers published in hobby magazines use a 555 one-shot IC and a large electrolytic capacitor as their main timing elements. Unfortunately, conventional electrolytic capacitors have very wide tolerances (typically −50% to +100%) and suffer from relatively large and unpredictable leakage currents. Consequently, these simple circuits cannot be relied upon to give accurate or repeatable timing periods or to give periods significantly exceeding 15 minutes or so.

Our ETI Universal Timer gets away from the conventional design approach, with its inherent disadvantages, by using an astable clock generator and a divide-by-8192 CMOS counter as its main timing elements, the astable period being controlled by a pot and a highly stable polyester capacitor. Consequently, our timer has excellent accuracy and stability and can fully span the 1 min to 100 mins timing range in two switch-selected decade ranges.

Our timer has a few other unusual features. It is mains powered and has a relay-switched mains output lead that can be used to feed power to external loads (heaters, lamps, etc); the relay can switch mains currents of up to 15 A and a mode switch enables the timer to give either make or break timing operations of the external loads.

Timing operations are initiated by a push-button start switch and a pulsed-tone alarm sounds for 30 S to give an audible warning on the completion of each timing cycle. The unit has a variety of practical uses in the home, workshop, darkroom, etc.

Construction

Most of the circuitry (with the exception of T1, the relay, the switches and pot) is mounted on a single PCB, the construction of which should present few problems. Note that IC1-3 (CMOS types) should be mounted in suitable sockets and voltage regulator IC4 needs to be fitted with a small heat-sink.

When construction is complete, fit the PCB in a suitable case, together with the mains transformer and the heavy-duty relay (which MUST be fitted in the specified socket) and proceed with the interwiring. Take special care over the interwiring of the relay contacts and SW2 and the mains connections. Finally, drill a small hole (roughly 4 mm) in the top of the case, bond the PB-2720 acoustic transducer below it and connect it to the rest of the circuitry.

Testing

When the unit is complete, give it a functional test as follows. First, connect the unit to the mains and check that its neon indicator illuminates when SW2 is set to TIMED BREAK position and turns off when SW2 is set to TIMED MAKE. Now set RV1 to its minimum position, set SW1 to the '1-10 min' range and firmly operate PB1. Check that the neon immediately changes state, indicating that the relay has turned on and

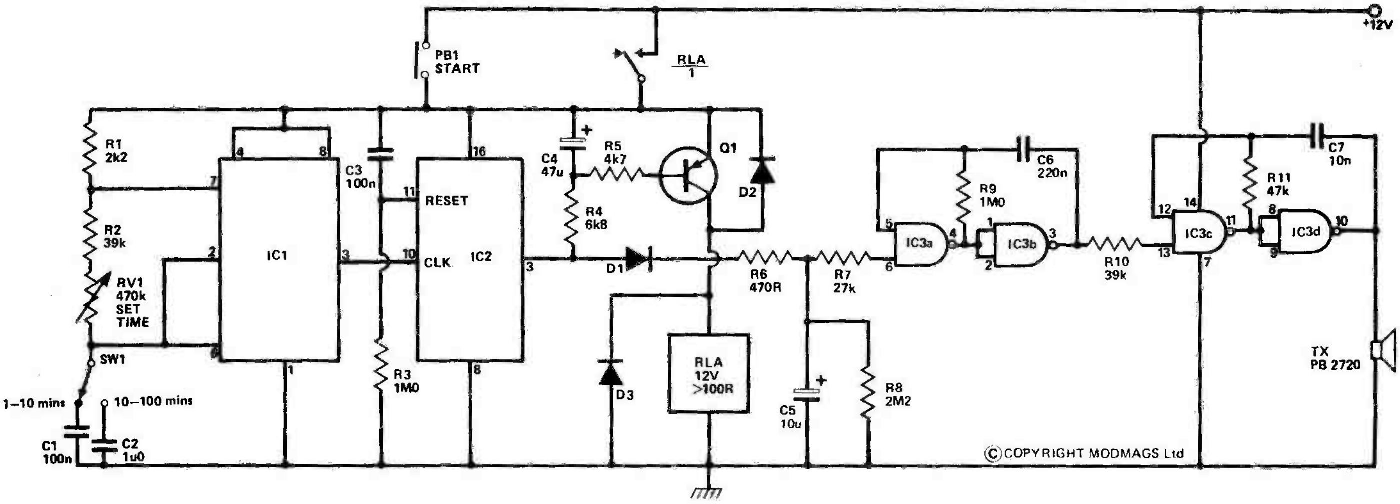


Fig.1 Circuit diagram.

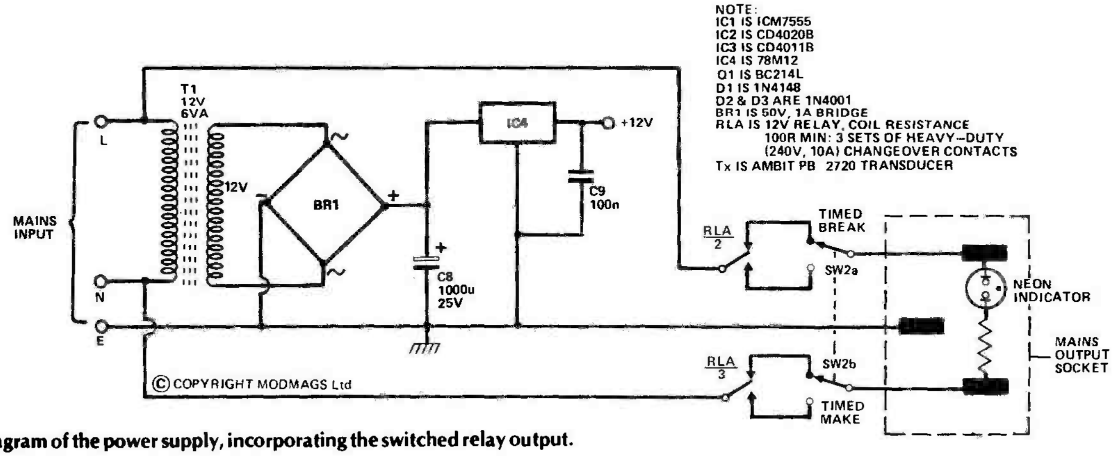


Fig.2 Circuit diagram of the power supply, incorporating the switched relay output.

the timing period has begun; also check that the relay turns off again at the end of the timing period (roughly one minute) and that the acoustic alarm operates and generates a pulsed-tone signal for roughly 30 S when the timing period is complete.

BUYLINES

Most of the components used are readily available from suppliers advertising in this issue. In case of difficulty, Watford Electronics can supply the relay specified.

HOW IT WORKS

The circuit comprises four main blocks, these being an astable clock generator (IC1), a multi-stage binary divider (IC2), a relay driver (Q1) and a gated alarm-call generator (IC3), all powered from a 12 V regulated line provided by IC4.

The clock generator is designed around IC1, a CMOS version of the 555 timer. The chip is wired in the astable mode and generates clock signals with periods variable over the 7.3 mS to 732 mS range via RV1 and SW1. The output of IC1 is used to clock the multi-stage CMOS binary counter designed around IC2, which is effectively wired in the 'divide-by-8192' mode; the output (pin 3) of this counter is normally low but goes high on the arrival of the 8192nd clock pulse.

The output of IC2 is used to drive relay RLA on via Q1 and to gate on the alarm-call generator (IC3) via the D1-R6-C5-R8-R7 network. This generator comprises a fast astable (IC3c-IC3d) and a slow astable (IC3a-IC3b). The slow astable is gated on by a momentary high output from IC2 and then gates the fast astable on and off at a rate of about 2 Hz.

The alarm-call generator part of the circuit is permanently connected to the 12 V supply lines, but the IC1-IC2-Q1 parts of the circuit are only connected to the supply rails when PB1 or relay contacts RLA/1 are closed. The complete circuit functions as follows.

Timing operations are initiated by momentarily closing PB1, thereby connecting the supply to the IC1-IC2-Q1 circuitry. As PB1 is closed, a reset pulse is fed to pin 11 of IC2 via C3 and causes the counter's registers to set to zero, driving the output of IC2 low. As IC2's output goes low it drives Q1 and the relay on via R4-R5, thereby causing contacts RLA/1 to close and maintain the supply to the circuitry once PB1 is released.

As soon as PB1 is closed, IC1 starts to oscillate and generate clock pulses, which are then counted by IC2. On the arrival of the 8192nd clock pulse the output of IC2 switches high, turning Q1 and the relay off and causing contacts RLA/1 to open and break the supply connections to IC1-IC2-Q1. The timing sequence is then complete.

C4 imposes a slight turn-off delay on Q1, so that the output of IC2 remains high for 100 mS or so before the relay turns off. This brief high period is sufficient for the IC2 output to fully charge C5 via D1 and R6, thereby activating the IC3 alarm-call generator, which produces an audible pulsed-tone signal in the PB-2720 transducer. Once the relay has turned off, the charge on C5 slowly leaks away via R8 until, after about 30 S, insufficient charge remains to gate IC3a on, at which point the alarm-call generator turns off. The entire operating sequence is then complete.

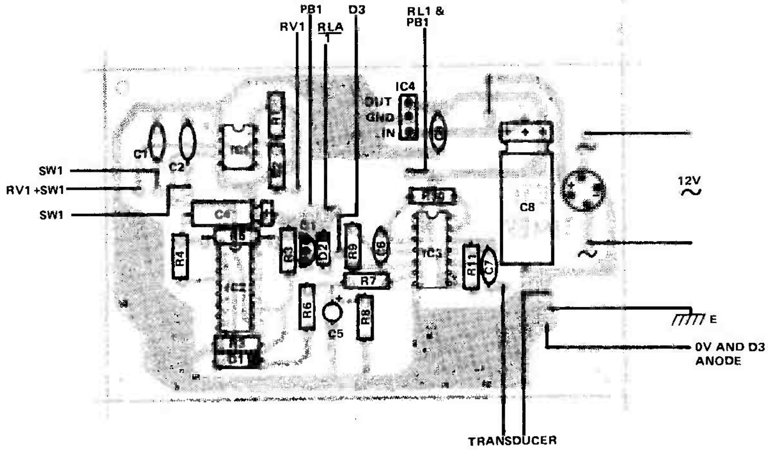
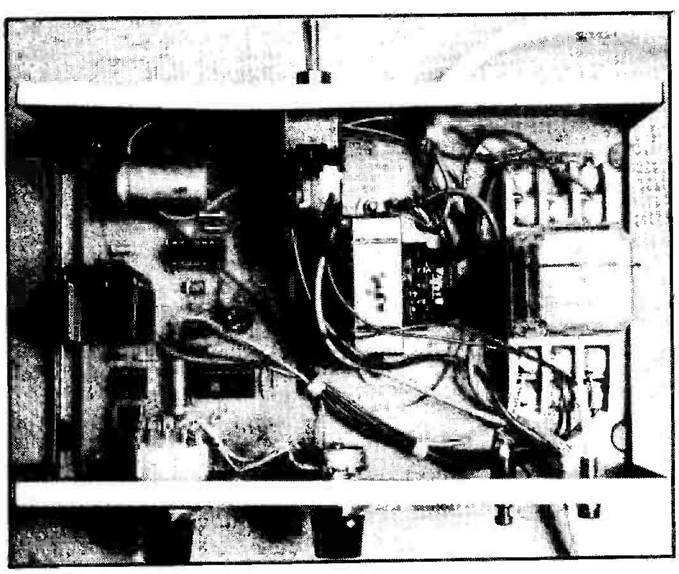


Fig.3 Component overlay.

PARTS LIST

Resistors all ¼ W 5%		**Semiconductors**	
R1	2k2	IC1	ICM7555
R2,10	39k	IC2	CD4020B
R3,9	1M0	IC3	CD4011B
R4	6k8	IC4	78M12 or 7812
R5	4k7	Q1	BC214L
R6	470R	BR1	50 V, 1 A bridge rectifier
R7	27k	D1	1N4148
R8	2M2	D2,3	1N4001
R11	47k		
Potentiometer			
RV1	470k Linear	**Miscellaneous**	
Capacitors		SW1	1 pole rotary switch
C1,3,9	100n polycarbonate	SW2	DPDT toggle 15 A 240 V
C2	1u0 polycarbonate	PB1	momentary push button
C4	47u 25 V axial electrolytic	Tx1	transducer PB 2720
C5	10u 63 V electrolytic PCB type	RLA	12 V coil resistance > 100R. 3 pole changeover, contacts rated at 240 V, 10 A and 11 pin relay base 15 A rated (see Buylines).
C6	220n polycarbonate		
C7	10n polycarbonate		
C8	1000u 25 V axial electrolytic	T1	12 V, 6 VA



Construction is fairly straightforward. IC4 needs a small heatsink and CMOS ICs 1-3 should be mounted in sockets.

Calibration

Once the unit is functioning correctly, you can proceed with the scale calibration. The obvious (and very time consuming) way to do this is to check the timing periods obtained by varying RV1 against a stop watch, by trial and error, until suitable RV1 calibration points are found.

Alternatively

If you have access to a reasonably accurate 'scope, a far easier way to calibrate the timing scale is to directly measure the period of the IC1 clock waveform, noting that a period of 7.32 mS corresponds to a timing period of precisely one minute. Thus, 1 min = 7.32 mS, 5 mins = 36.6 mS, 10 mins = 73.2 mS, etc.

The upper timing range of SW1 is approximately a decade up on the lower range, so a single calibration scale can serve for both ranges. The tracking accuracy of the two ranges depends on the relative accuracies of C1 and C2 and will typically be within 10% if good polyester components are used. If you want precise tracking, you can achieve it by replacing C2 with a 820nF polyester capacitor and then padding its value up by trial and error, until precise coincidence of the '5 min' and '50 min' points is obtained on the two range scales. **ETI**

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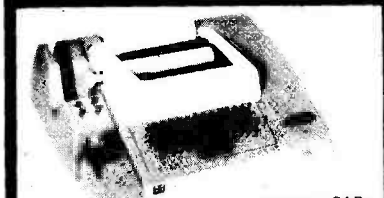

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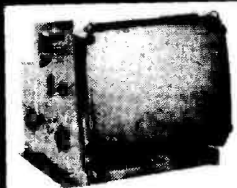

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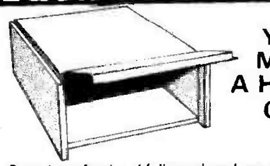

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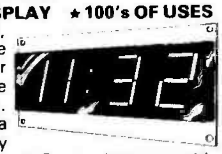

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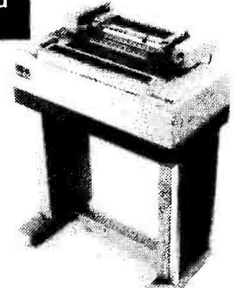

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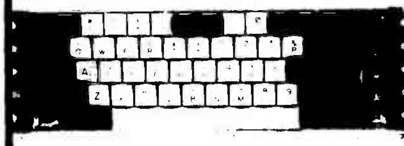

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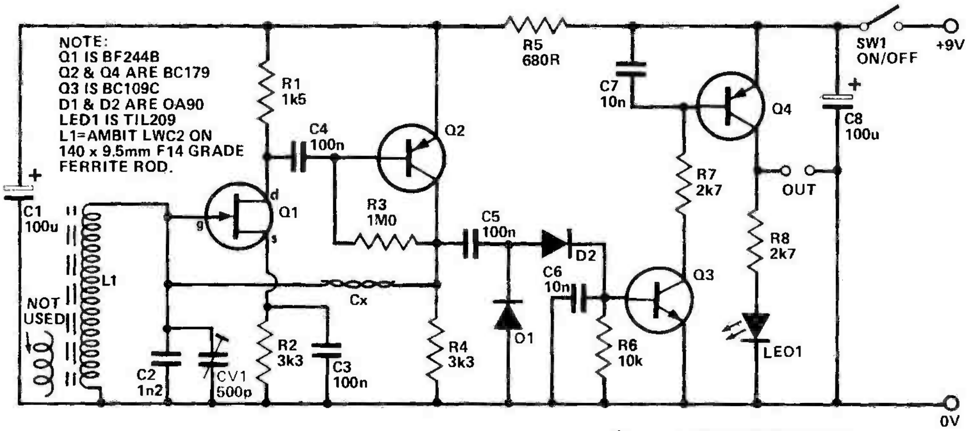


60 kHz Time Receiver

This receiver gives reception of the atomic clock time signals transmitted by the Rugby MSF transmitter on 60 kHz. At this very low radio frequency it is not necessary to use a superhet. A ferrite aerial is used with L1, an ordinary LW broadcast band aerial coil, and the relatively high tuning capacitance of C2 and C3 is used to reduce the resonant frequency to the appropriate figure. The receiver is tuned by CV1 and by adjusting the position of L1 on the ferrite rod.

The output of L1 is direct-coupled to a straightforward common source JFET stage and this in turn feeds a simple common emitter stage. Due to the relatively low frequency involved these can both provide good voltage gain without using tuned circuit loads. The collector of Q2 is in-phase with the gate of Q1 and if necessary, "twisted pair" Cx can be used to provide regeneration between these two points to boost the sensitivity of the set.

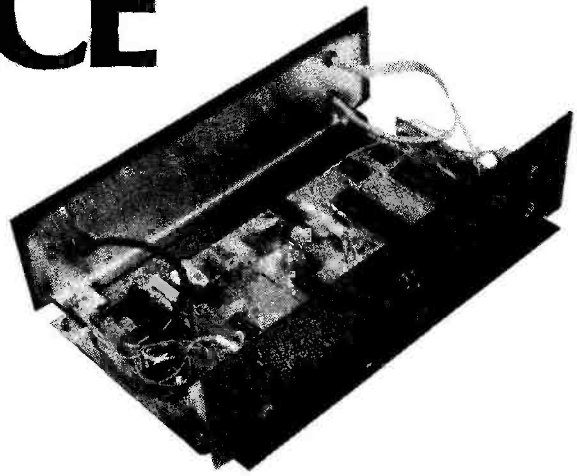
The output from Q2's collector is coupled by C5 to a simple diode modulator circuit which consists of D1, D2, C6 and R6. When the 60 kHz carrier is present a strong DC bias is produced across R6, but this potential quickly decays during the gaps in the carrier (the 1 S markers and other signals are modulated onto the carrier wave in the form of brief pauses in the signal).

Thus Q3 is switched on when the carrier is present, so that Q4 is in turn switched on, giving a high output and causing LED 1 to light up. In the absence of the carrier wave Q3, Q4 and LED 1 all switch off and the output of the receiver goes low.

When initially adjusting the set it is helpful to monitor the output of the detector using a crystal earpiece connected across R6.

I/O INTERFACE

Computers share a common failing with man (and woman) — they use a variety of different languages and dialects. This design by Clive Cartlidge lets the Compucolor II talk to a whole new family of computers.



The interface described here was originally built to allow a Compucolor II microcomputer to be connected to any one of four "mainframes" at North Staffordshire Polytechnic. The mainframes in question were a GEC 4082, an HP 2000E, an ICL 2960 and an ICL 2904; both of the latter machines being front ended by 7502 processors. After construction, however, it became obvious that the device had a much wider appeal and could be used in a variety of applications where bit length and parity changes were necessary.

This device was required to overcome the problem that the Compucolor II transmits and receives eight bit characters from its RS232 port, whereas the mainframes mentioned above all transmit and receive seven bits with an even parity bit added.

The UART is an LSI sub-system which accepts binary characters from either a terminal or a computer and transmits/receives this character with appended control and error detecting bits. All characters contain a start bit, five to eight data bits, one or two stop bits and either an even/odd or a no parity bit. This is all hard wire selectable on the UART together with an operating speed of up to 30 kbaud.

The UART Receiver

The UART requires a clock signal 16 times the designed baud rate. Initialisation is performed by applying a reset pulse to pin 21. This sets the Data Available flag, pin 19, to a logic 0. Reception of data starts when the serial input signal changes from a marking state (logic 1) to a spacing stage (logic 0). This condition constitutes a start bit and it is valid if the serial input line continues to be at logic 0, when centre sampled, eight clock pulses later. If this is not the case, however, and the serial line has returned to logic 1 when sampled, the start bit verification process will be reset. After a genuine start bit has been received and verified by the process above, data bits, parity bit if used and stop bits are received.

On receiving parity and stop bits, the receiver will compare the transmitted parity and stop bits with the 'expected' pattern and indicate any errors by changing the parity error flip-flop and/or the framing error flip-flop to a logic 1.

When a full character has been received, internal logic examines the 'Data Available' line to see if data has been read out. If the line is at a logic 1, the receiver will assume that data has not been read out and the over-run flip-flop will be set to logic 1, indicating an over-run error. If 'Data Available' is set to logic 0, the receiver will assume that data has been read out.

After the Data Available line goes to logic 1, indicating a character has been received, the receiver shift register is ready to accept the next character and has one full character time to remove the first character received.

The Transmitter

The same clock signal may be used for the transmitter as for the receiver. The external reset pulse is also common. When this is applied the 'Transmitter Buffer Empty', End of Character and the Serial Output lines of the device are driven to logic 1. Data occurring on the Data Input lines, pins 26-33, is strobed into the device by a pulse on pin 23, the Data Strobe. Once this has occurred, the Transmitter Buffer Empty (TBMT) flag goes to a logic 0, indicating that a character is being transmitted and the device is unable to accept further characters until this flag returns again to logic 1. The device is double buffered and so when the TBMT flag returns to logic 1, one full character time is available for loading the next character without any loss in transmission speed.

Data transmission is initiated with the transmission of a start bit, data bits, parity bit if required and stop bits. When the last stop bit has been on the line for one bit time, the End of Character flag will go to a logic 1 indicating that a new character is ready for transmission.

Control bits

The number of bits per character (five through eight) together with a parity bit (odd, even or none) and one or two stop bits can be selected by strapping appropriate pins on the UART to logic 1 or logic 0. These selections apply to both the receiver section and transmitter of the chip.

Code Converter

One particular problem encountered when using this interface was that most of the logging-in data received from the mainframes was in lower case ASCII code. While most terminal devices would simply display this as upper case, the Compucolor II treats lower case code as graphics display information. This difficulty is overcome by the NAND gate code converter (IC10). The circuit's logical function simply drops bit six when bit seven is set to a logic 1, effectively converting lower case code to upper case before it emerges from the interface.

A second problem was encountered when using the device with the HP 2000 Basic system. This was the need for a break key. Break not being a valid ASCII character, it cannot be implemented through the UART. This is easily cured by fitting a push button switch on to the computer side of the interface as shown.

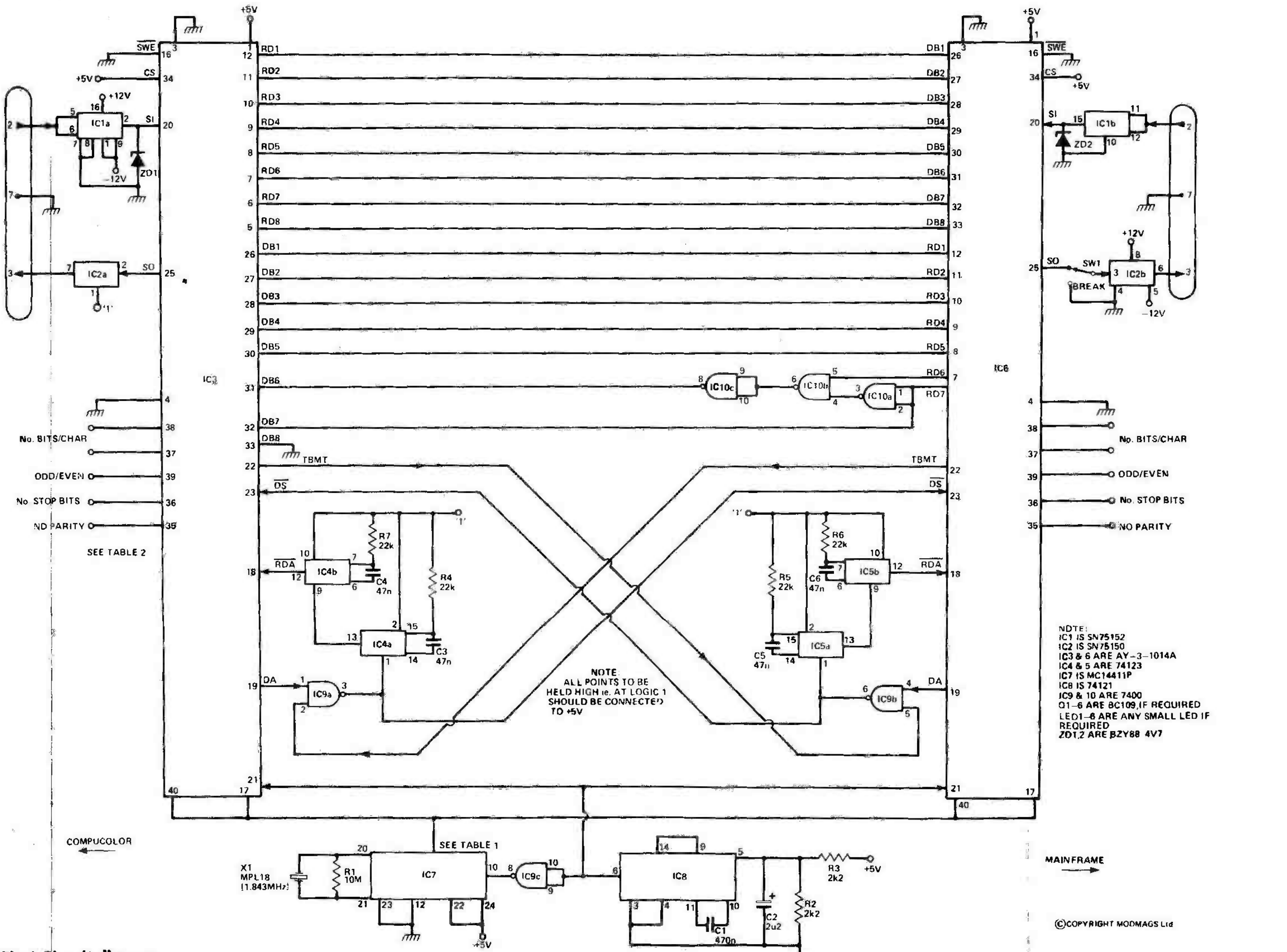


Fig.1 Circuit diagram.

HOW IT WORKS

On switching on the power, the monostable multivibrator IC8 gives a 100 uS positive-going pulse at its 'Q' output, pin 6. This is applied to both UARTS at their reset inputs, pins 21. This pulse is also inverted by the NAND gate IC9b and used to reset the baud rate generator chip IC7 at pin 10. The clock signal is applied to both UARTs at pins 40 and 17 at 16 times the baud rate required. Referring now to Fig. 2, the pulse timing diagram, it will be seen that at T_0 pin 2 of IC9a is at logic 1 (derived from the Transmitter Buffer Empty flag of IC6). Assuming reception of a character by UART IC3, pin 1 of IC9a will go to logic 1 when data becomes available on the reception of a complete character. This is shown on Fig. 2 at T_1. The output of the NAND gate, pin 3 of IC9a will, therefore, go to logic 0.

This negative-going pulse is used to strobe the received character into the transmit buffer of the second UART at pin 23 (Data Strobe) and to trigger monostable multivibrator IC4a whose output, pin 9, will go to a logic 1. NAND gate IC9 pin 2 is now returned to logic 0 as the Transmit Buffer Empty flag of UART IC6 will be driven to logic 0, having been 'filled' with a character. The time delay shown on the diagram is due to chip propagation which proves ample in the design shown. After a timing delay in the first monostable set by timing components C3 and R4, pin 9 on IC4b goes to logic 0 (T_2 on the timing diagram). Pin 12 on IC4 follows it and this signal is used to reset the Data Available flag on UART IC3. At this stage, once the Transmitter Buffer Empty line of UART IC6 has returned to logic 1, the circuits are back in their original states and ready to accept the next character.

This description also applies to characters flowing through the interface in the opposite direction. IC1 and IC2 are both dual level converter chips which convert RS232 levels (usually ±12 V) to TTL levels of 0 V and 5 V.

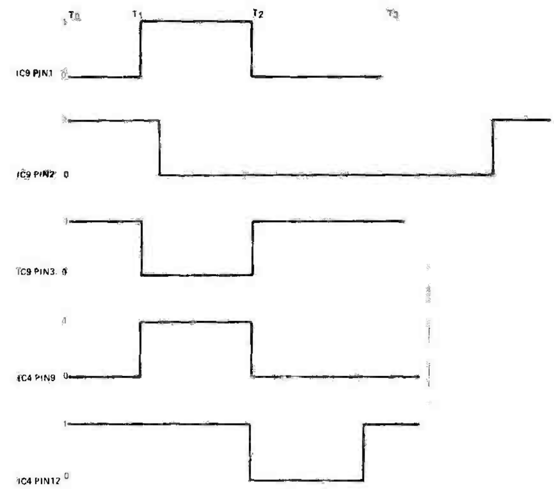


Fig.2 Pulse timing diagram.

BUYLINES

Most of the components required can be ordered from suppliers advertising in this issue. In case of difficulty, advertisers specialising in computer hardware may be of assistance.

The variable regulator (RC4149D) is a Radiospares component — RS No. 306-011.

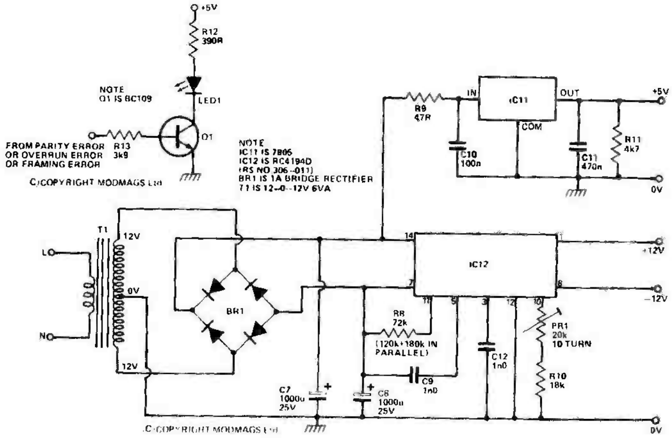


Fig.3 Circuit diagram of the power supply and LED indicators if required.

PARTS LIST

Resistors all ¼ W 5% unless otherwise stated

R1	10M
R2, 3	2k2
R4, 5, 6, 7	22k
R8	72k (120k + 180k in parallel)
R9	47R 2 W
R10	18k
R11	4k7
R12	390R (six if required)
R13	3k9 (six if required)

Potentiometer

PR1	20k 10-turn preset

Capacitors

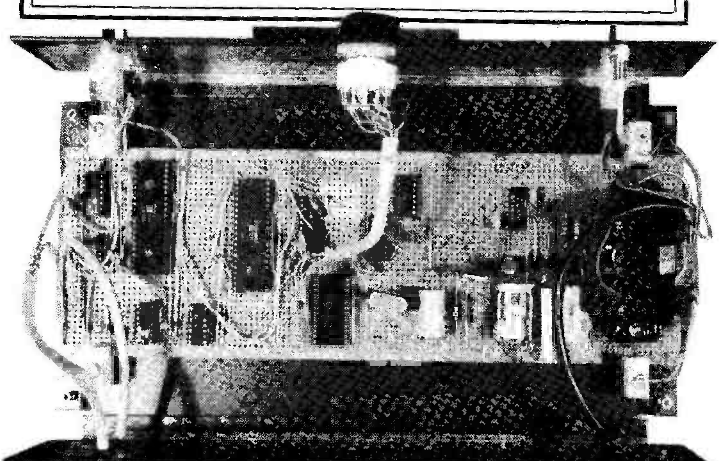
C1, 11	470n polyester
C2	2u2 35 V tantalum
C3, 4, 5, 6	47n ceramic
C7, 8	1000u 25 V axial electrolytic
C9, 12	1n0 ceramic
C10	100n ceramic

Semiconductors

IC1	75152
IC2	75150
IC3, 6	AY-3-1014A
IC4, 5	74123
IC7	MC14411P
IC8	74121
IC9, 10	7400
IC11	7805
IC12	RC4194D
Q1	BC109 (six if required)
ZD1, 2	BZY88 4V7
BR1	1 A bridge rectifier
LED1	0.2" LED (six if required)

Miscellaneous

XTAL MPL18 (1.843 MHz), 12-0-12 6 VA transformer, Veroboard, SW1 SPCO pushbutton, SW2 DPDT toggle, case.



The method of construction is not critical. The author's board is shown above.

Pin No.	Function	User Baud Rate
1	F1	9600
2	F3	4800
3	F5	2400
4	F7	1200
5	F8	600
6	F10	200
7	F9	300
8	F11	150
9	F14	75
10	$\overline{\text{Reset}}$	
11	NC	
12	Ground	
13	F13	109.9
14	F12	134.5
15	F6	1800
16	F4	3600
17	F2	7200
18	F15	921.6 kHz
19	F16	1.843 MHz
20	Crystal	
21	Crystal	
22	rate select	
23	rate select	
24	+5 V	

Table 1
MC14411P pin connections and clock speeds

Pins	Logic 0	Logic 1
35	Parity	No parity
39	Odd parity	Even parity
36	One stop bit	Two stop bits

Character Lengths	Pin 37	Pin 38
5 bits	Logic 0	Logic 0
5 bits	Logic 0	Logic 1
7 bits	Logic 1	Logic 0
8 bits	Logic 1	Logic 1

Table 2.
UART control connections (IC3,6).

1	Vcc Power Supply (+5 V)	
2	NC	
3	Ground	
4	$\overline{\text{Received Data Enable}}$	$\overline{\text{RDE}}$
5-12	Received Data Bits	(RD8-RD1)
13	Parity Error	(PE)
14	Framing Error	(FE)
15	Over run	(OR)
16	$\overline{\text{Status Word Enable}}$	$\overline{\text{SWE}}$
17	Receiver Clock	(RCP)
18	$\overline{\text{Reset Data Available}}$	$\overline{\text{RDAV}}$
19	Data Available	(DAV)
20	Serial Input	(SI)
21	External Reset	(XR)
22	Transmitter Buffer Empty	(TBMT)
23	$\overline{\text{Data Strobe}}$	$\overline{\text{DS}}$
24	End Of Character	(EOC)
25	Serial Output	(SO)
26-33	Data Bit inputs	(DB1-DB8)
34	Control Strobe	(CS)
35	No Parity	(NP)
36	Number of stop bits	(TSB)
37-38	Number of bits per character	
39	Odd/Even parity select	
40	Transmitter Clock	(TCP)

Table 3.
AY-3-1014A pin connections.

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EXP 300	550 contacts with two 40-point bus-bars. 152mm (6.0")	ONLY £6·61
EXP 650	For Micro-processors. 91mm (3.6")	ONLY £4·14
EXP 4B	More bus-bars. 152mm (6.0")	ONLY £2·65
EXP 600	As EXP 300 but accepts 24 pin DIL and over. 152mm (6.0")	ONLY £7·25

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1943	15 watt quality soldering iron with 3/32" bit	£4·88
1947	Replacement element for 1943	£2·18
1944	Iron coated bit 3/32" for 1943	£0·53
1945	Iron coated bit 1/8" for 1943	£0·53
1946	Iron coated bit 3/16" for 1943	£0·53
1948	18 watt iron with iron coated bit	£4·59
1952	Replacement element for 1948	£2·18
1949	Iron coated bit 3/32" for 1948	£0·53
1950	Iron coated bit 1/8" for 1948	£0·53
1951	Iron coated bit 3/16" for 1948	£0·53
1931	X25 25 watt iron, ceramic shaft and another shaft of stainless steel to ensure strength	£4·88
1935	Replacement element for 1931	£1·84
1932	Iron coated bit 1/8" for 1931	£0·57
1933	Iron coated bit 2/16" for 1931	£0·57
1934	Iron coated bit 3/32" for 1931	£0·57
1953	SK1 soldering Kit – contains 15 watt soldering iron with 3/16" bit plus two spare bits, a reel of solder, heat-sink and a booklet 'How to Solder'	£6·38
1939	ST3 iron stand made from high grade bakelite chrom plated steel spring, suit all models – includes accommodation for six bits and two sponges to keep the iron bits clean	£1·86
1724	Model MLX as X25 iron but 12 volts	£5·29

CASES AND BOXES

VERO plastic case box. These boxes consist of top and bottom sections which include fixings points for horizontal mounting PC boards/chassis plates, the two sections are held together by four screws which enter through the base and are concealed by plastic feet.

No.	Length	Width	Height	Price
170	140mm	40mm	205mm	£4·35
171	140mm	75mm	205mm	£4·85
172	140mm	110mm	205mm	£6·30

INSTRUMENT CASES in two sections vinyl covered top and sides, aluminium bottom, front and back.

No.	Length	Width	Height	Price
155	8in	5¼in	2in	£2·01
156	11in	6in	3in	£3·10
157	6in	4¾in	1¾in	£1·93
158	9in	5¼in	2½in	£2·59

ALUMINIUM BOXES made from bright alli, folded construction each box complete with half inch deep lid and screws.

No.	Length	Width	Height	Price
159	5½in	2½in	1½in	£0·98
160	4in	4in	1½in	£0·98
161	4in	2¼in	1½in	£0·98
162	5¼in	4in	1½in	£1·10
163	4in	2½in	2in	£0·98
164	3in	2in	1in	£0·67
165	7in	5in	2½in	£1·54
166	8in	6in	3in	£1·98
167	6in	4in	2in	£1·32

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

169	2½in	5½in	2½in	12in	3½in	8in	£5·45
168	2½in	7½in	4in	16in	4½in	11in	£8·21

AUDIO MODULES

AMPLIFIERS

AL10	3 watt Audio Amplifier Module 22-32v supply	£3.63
AL20	5 watt Audio Amplifier Module 22-32v supply	£4.73
AL30A	7-10 watt Audio Amplifier Module 22-32v supply	£5.51
AL60	15-25 watt Audio Amplifier Module 30-50v supply	£6.81
AL80	35 watt Audio Amplifier Module 40-60v supply	£10.67
AL120	50 watt Audio Amplifier Module 50-70v supply	£17.38
AL250	125 watt Audio Amplifier Module 50-80v supply	£25.91

STEREO PRE-AMPLIFIERS

PA12	Supply voltage 22-32v input sensitivity 300mv suit: AL10/AL20/AL30	£9.63
PA100	Supply voltage 24-36v inputs:- Tape, Tuner, Mag P.U., Suit: AL60/AL80	£20.30
PA200	Supply voltage 35-70v inputs:- Tape, Tuner, Mag P.U., Suit: AL80/AL120/AL250	£20.98

MONO PRE-AMPLIFIERS

MM100	Supply voltage 40-65v inputs: Mag, P.U., Tape Microphone Max. output 500mv	£14.29
MM100G	Supply voltage 40-65v inputs: 2 Guitars, Microphones Max. output 500mv	£14.29

POWER SUPPLIES

PS12	24v Supply suit 2 - AL10, 2 - AL20, 2 - AL30 & PA12/S.450	£1.90
SPM80	33v Stabilised supply – suit 2 - AL60, PA100 to 15 watts	£5.57
SPM120/45	45v Stabilised supply – suit 2 - AL60, PA100 to 25 watts	£7.34
SPM120/55	55v Stabilised supply – suit 2 - AL80, PA200	£7.34
SPM120/65	65v Stabilised supply – suit 2 - AL120, PA200 1 - AL250, PA200	£7.34
SG30	15-0-15 Stabilised power supply for 2 - GE100MKII	£4.37

MISCELLANEOUS

MPA30	Stereo Magnetic Cartridge Pre-Amplifier-input 3.5mv Output 100mv	£3.76
S 450	Stereo FM Tuner Supply Voltage 20-30v – Varicap tuned	£29.39
STEREO30	Complete 7 watt per Channel Stereo Amplifier Board – includes amps, pre-amp, power supply, front panel, knobs etc – requires 2050 Transformer	£24.25
BP124	5 watt 12v max. - Siren Alarm Module	£4.43
GE100MKII	10 channel mono-graphic equaliser complete with sliders and knobs	£26.45
VPS30	Variable regulated stabilised power supply 2-30v 0-2 amps	£8.74

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2035	2 amp 55v	£7.30	£1.47
2036	750mA 17v suit PS12	£3.68	
2040	1.5 amp 0-45v-55v suit SPM120/45, SPM120/55v	£5.98	£1.21
2041	2 amp 0-55v-65v suit SPM120/55, SPM120/65v	£7.82	£1.47
2050	1 amp 0-20v suit Stereo 30	£3.74	£0.75
1725	150mA 15-0-15v suit SG30	£2.04	

ACCESSORIES

139	Teak Cabinet suit Stereo 30, 320 · 235 · 81mm	£9.72
140	Teak Cabinet suit STA15 425 · 290 · 95mm	£8.97
FP100	Front Panel for PA100 & PA200	£2.07
BP100	Back Panel for PA100 & PA200	£1.84
GE100FP	Front Panel for one GE100MKII	£2.05
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2206	3.75" · 17"	.1	copper	£2.76
2207	4.75" · 17.9"	.1	copper	£3.61
2208	2.5" · 1"	.5	in pack	£0.85
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2211	2.5" · 3.75"	.15	copper	£0.53
2212	3.75" · 17"	.15	copper	£2.39
2213	3.75" · 5"	.15	copper	£0.90
2217	3.75" · 17.9"	.1	Plain	£1.79
2218	3.75" · 2.5"	.1	Plain	£0.44
2219	5" · 3.75"	.1	Plain	£0.68
2223	2.5" · 5"	.15	Plain	£0.37
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200	TR12A/200	£0·59	200	TR110A/200	£1·06
400	TR12A/400	£0·82	400	TR110A/400	£1·29

6 amp volts	No.	Price	10 amp volts	No.	Price
100	TR16A/100	£0·59	400	TR110A/400P	£1·29
200	TR16A/200	£0·70			
400	TR16A/400	£0·88			

DIACS
BR100 £0·23 D32 £0·23

SILICON RECTIFIERS

200mA		3 Amp	
IS920 50V	£0.07	IN5400 50V	£0.16
IS921 100V	£0.08	IN5401 100V	£0.17
IS922 150V	£0.09	IN5402 200V	£0.18
IS923 200V	£0.10	IN5404 400V	£0.19
IS924 300V	£0.11	IN5406 600V	£0.24
		IN5407 800V	£0.28
		IN5408 1000V	£0.34

1 Amp		10 Amp	
IN4001 50V	£0.05	IS10/50 50V	£0.21
IN4002 100V	£0.05	IS10/100 100V	£0.24
IN4003 200V	£0.07	IS10/200 200V	£0.26
IN4004 400V	£0.08	IS10/400 400V	£0.40
IN4005 600V	£0.09	IS10/600 600V	£0.48
IN4006 800V	£0.10	IS10/800 800V	£0.58
IN4007 1000V	£0.11	IS10/1000 1000V	£0.69
		IS10/1200 1200V	£0.79

1.5 Amp		30 Amp	
IS015 50V	£0.10	IS30/50 50V	£0.64
IS020 100V	£0.11	IS30/100 100V	£0.79
IS021 200V	£0.12	IS30/200 200V	£1.06
IS023 400V	£0.14	IS30/400 400V	£1.43
IS025 600V	£0.16	IS30/600 600V	£2.02
IS027 800V	£0.18	IS30/800 800V	£2.23
IS029 1000V	£0.23	IS30/1000 1000V	£2.65
IS031 1200V	£0.28	IS30/1200 1200V	£3.31

60 Amp			
IS70/50 50V	£0.86	IS70/400 400V	£2.01
IS70/100 100V	£0.96	IS70/600 600V	£2.58
IS70/200 200V	£1.38	IS70/800 800V	£2.87
		IS70/1000 1000V	£3.45

THYRISTORS

600ma Volts	TO 18 Case No.	Price
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20	THY600/20	£0.18
30	THY600/30	£0.23
50	THY600/50	£0.25
100	THY600/100	£0.29
200	THY600/200	£0.44
400	THY600/400	£0.51

1 amp Volts	TO 66 Case No.	Price
50	THY1A/50	£0.30
100	THY1A/100	£0.32
200	THY1A/200	£0.37
400	THY1A/400	£0.44
600	THY1A/600	£0.52
800	THY1A/800	£0.67

3 amp Volts	TO 66 Case No.	Price
50	THY3A/50	£0.32
100	THY3A/100	£0.35
200	THY3A/200	£0.38
400	THY3A/400	£0.48
600	THY3A/600	£0.58
800	THY3A/800	£0.75

5 amp Volts	TO 66 Case No.	Price
50	THY5A/50	£0.41
100	THY5A/100	£0.52
200	THY5A/200	£0.58
400	THY5A/400	£0.66
600	THY5A/600	£0.79
800	THY5A/800	£0.93

5 amp Volts	TO 220 Case No.	Price
400	THY5A/400P	£0.86
600	THY5A/600P	£0.79
800	THY5A/800P	£0.93

7 amp Volts	TO 48 Case No.	Price
50	THY7A/50	£0.55
100	THY7A/100	£0.59
200	THY7A/200	£0.66
400	THY7A/400	£0.71
600	THY7A/600	£0.90
800	THY7A/800	£1.06

10 amp Volts	TO 48 Case No.	Price
50	THY10A/50	£0.59
100	THY10A/100	£0.66
200	THY10A/200	£0.71
400	THY10A/400	£0.81
600	THY10A/600	£1.14
800	THY10A/800	£1.40

16 amp Volts	TO 48 Case No.	Price
50	THY16A/50	£0.62
100	THY16A/100	£0.67
200	THY16A/200	£0.71
400	THY16A/400	£0.89
600	THY16A/600	£1.04
800	THY16A/800	£1.60

30 amp Volts	TO 94 Case No.	Price
50	THY30A/50	£1.38
100	THY30A/100	£1.64
200	THY30A/200	£1.87
400	THY30A/400	£2.06
600	THY30A/600	£4.03

No.	Price
BT101/500R	£0.92
BT102/500R	£0.92
BT106	£1.44
BT107	£1.07
BT108	£1.13
2N3228	£0.81
2N3525	£0.89
BTX30/50L	£0.38
BTX30/400L	£0.53
C106/4	£0.69
BT116	£1.73

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1w 1·5w Plastic and metal encapsulated. Range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. **No. Z13 18p**

10w Metal stud type SO10 case. Range of voltages available. 1·3v, 2·2v, 2·7v, 3·3v, 3·9v, 4·3v, 4·7v, 5·1v, 5·6v, 6·2v, 6·8v, 7·5v, 8·2v, 9·1v, 10v, 11v, 12v, 13v, 15v, 16v, 18v, 20v, 22v, 24v, 27v, 30v, 33v, 43v, 47v, 51v, 68v, 72v, 75v, 82v, 91v, 100v. **No. Z10 44p**

BRIDGE RECTIFIERS

SILICON 1 amp Type	No.	Price	SILICON 2 amp Type	No.	Price
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100v RMS	BR1/100	£0·25	100v RMS	BR2/100	£0·55
200v RMS	BR1/200	£0·29	200v RMS	BR2/200	£0·60
400v RMS	BR1/400	£0·41	400v RMS	BR2/400	£0·67
			1000v RMS	BR2/1000	£0·78

SILICON 10 amp Type	No.	Price	SILICON 25 amp Type	No.	Price
50v RMS	BR10/50	£1·50	50v RMS	BR25/50	£1·90
200v RMS	BR10/200	£1·70	200v RMS	BR25/200	£2·20

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GIRO A/C No 3887006

LED TACHO

A unique two-range tacho that gives an analogue RPM display on a bar of 21 LEDs. The display flashes to indicate an alarm condition when the RPM exceed a preset limit. Design by Ray Marston. Project development by Steve Ramsahadeo.

The ETI Tacho/Alarm is an all solid-state project. It displays engine speed in analogue form (like a conventional tacho) as an illuminated section of a line of 21 LEDs. The length of the illuminated section is proportional to the engine speed, so that half of the scale is illuminated at half of full-scale speed, and so on. In other words, the display is in bar rather than dot form.

The Tacho/Alarm can be used with virtually any type of multi-cylinder petrol engine. It has two speed ranges, each of which can be calibrated by a preset pot to give any full-scale speed range required by the individual owner. Our prototype is calibrated to give full scale readings of 10,000 RPM and 1,000 RPM on a four-cylinder, four-stroke engine. The lower range is of great value when adjusting the engine's ignition and carburation for recommended tick-over speeds. The upper range has adequate resolution (500 RPM per step in our case).

A unique feature of our product is the provision of a visual over-speed alarm facility, which causes the LED display to rapidly flash on and off when the RPM exceed a preset level; the tacho continues to indicate the actual RPM under the alarm condition. Tachos are normally placed directly in front of the driver in sports/racing cars, so this visual alarm system is a highly effective 'attention getter' in such vehicles.

The unit is designed for use only on vehicles fitted with 12 V electrical systems. It can be used with conventional or capacitor-discharge (CD) ignition systems and is wired into the vehicle with three connecting leads. It can be used on vehicles fitted with either negative or positive earth electrical systems.

Construction

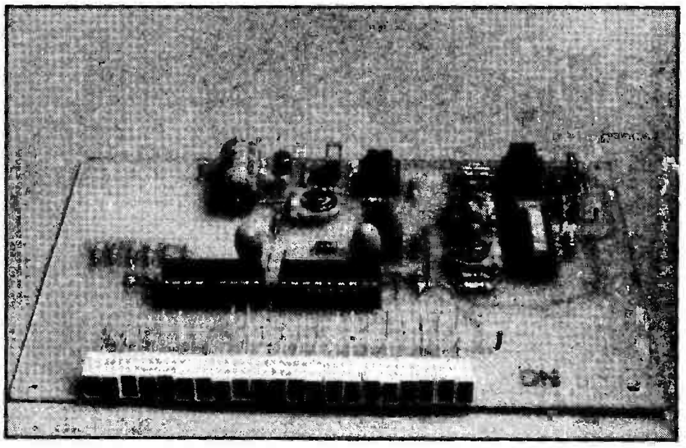
The complete unit, including the 21 LED display, is mounted on a single PCB. Take care over the construction, paying special attention to the following points:

(1) Our prototype uses a display comprising a linear row of 21 square LEDs, mounted horizontally on the PCB. You may prefer to use a semicircular display of LEDs, in which case you can mount the display on a separate board of your own design, with suitable connections to our board. In either case confirm the polarity and functioning of each of the 21 LEDs, by connecting in series with a 1k0 resistor and testing across a 12 V supply, before wiring into place on the PCB. Note that the LED colours can be mixed, if required.

If you use the same display form as our prototype, bend and adjust the LED leads so that each LED slightly overhangs the edge of the PCB when soldered into place.

(2) Seven link connections are made on the PCB. Also note that the external connections to the unit (0 V, +ve and CB) are made via solder terminals (Veropins).

(3) Range-changing is achieved via a three-pole two-way switch. On our prototype we've used a DIL slide switch, mounted directly on the PCB, for this purpose. Some readers may prefer to mount this switch off-board.



(4) Note that the values of C2 and C3 must be chosen to suit the engine type and full-scale RPM ranges required (see the conversion graph). Our prototype, calibrated to read 10,000 RPM and 1,000 RPM on a four-cylinder four-stroke engine, uses C2 and C3 values of 22nF and 220nF respectively.

When the construction is complete, connect the unit to a 12 V supply and check that only LED 1 illuminates. If all LEDs illuminate, suspect a fault in the wiring of IC1.

Calibration

The unit can be calibrated against either a precision tachometer or against an accurate (2% better) audio generator that gives a square wave output of at least 3 V peak-to-peak. The method of calibration against an audio generator is as follows.

Connect the tacho to a 12 V supply and connect the square wave output of the audio generator betweeen the 0 V and CB terminals of the unit. Check against the conversion graph to find the frequency needed to give the required high range full-scale RPM reading on the type of engine in question and feed this frequency into the tacho input. Switch SW1 to its high range (10,000 RPM on our prototype) and adjust PR1 for full-scale reading. Now set the generator to the alarm frequency and adjust PR3 so that the display flashes. Recheck both adjustments.

Now switch SW1 to its low range (1,000 RPM on our prototype), set the required full-scale frequency and adjust PR2 for a full-scale reading on the tacho. Note that the alarm facility is inoperative on this range.

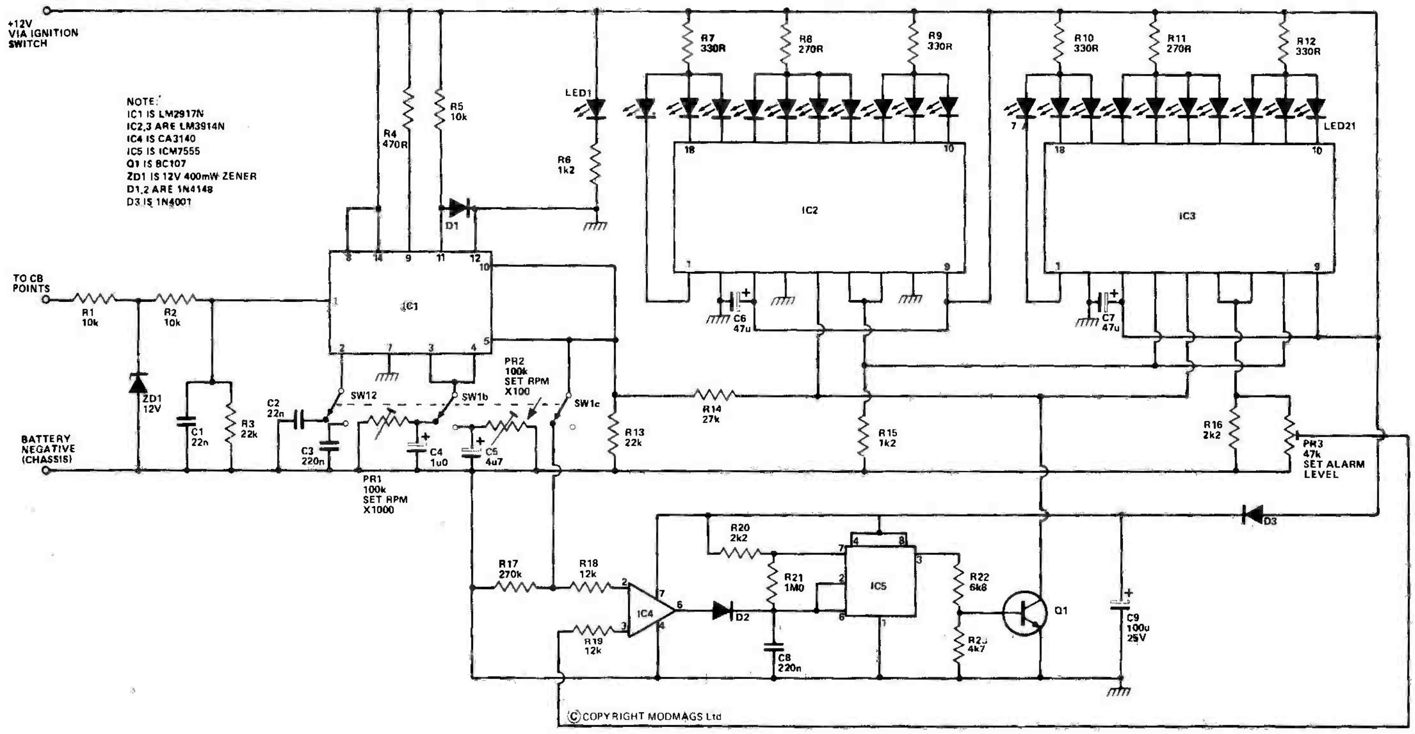


Fig. 1 Circuit diagram.

HOW IT WORKS

The ignition signal appearing on a vehicle's contact-breaker (CB) points has a basic frequency that is directly proportional to the RPM of the engine. Our tacho works by picking up the CB signal, extracting its basic frequency, converting the frequency to a linearly-related DC voltage and then displaying this voltage (and thus the RPM) on a line of 21 LEDs. The basic tacho can thus be broken down, for descriptive purposes, into an input signal conditioner section, a frequency-to-voltage converter section and a LED voltmeter display section.

The input signal conditioner section comprises R1-R2-R3-ZD1-C1. The CB signal of a conventional ignition system consists of a basic RPM-related rectangular waveform that switches alternately between zero and 12 V, onto which various ringing waveforms with typical peak amplitudes of 250 V and frequencies up to 10 kHz are superimposed. The purpose of the input signal conditioner is to cleanly filter out the basic rectangular waveform and pass it on to the F-to-V converter. It does this first by limiting the peak amplitude of the signal to 12 V via R1 and ZD1 and then filtering out any remaining high frequency components via R2-R3-C1. The resulting clean signal is passed on to the input (pin 1) of IC1.

IC1 is a frequency-to-voltage converter chip with a built-in supply voltage regulator. The operating range of the IC is determined by the value of a capacitor connected to pin 2 and by a timing resistor and smoothing capacitor connected to pins 3-4. In our application, two switch-selected presettable ranges are provided. The DC output of the IC is made available across R13 and is passed on to the high-impedance input terminals of the IC2-IC3 LED voltmeter circuit via series resistor R14. R14 is essential to the operation of the alarm section of the tacho.

IC2 and IC3 are LED display drivers. Each IC can drive a chain of 10 LEDs, the number of LEDs illuminated being proportional to the magnitude of the IC's input signal. Put simply, the ICs act as LED voltmeters.

In our application, the two LM3914 ICs are cascaded in such a way that they perform as a single 20-LED voltmeter with a full-scale range of 2V4. This full-scale value is determined by precision voltage references built into the ICs. The full-scale reference voltage (2V4) is generated across R16 and PR3. The configuration of our voltmeter is such that it gives a bar display, in which LEDs 1 to 11 are illuminated at half-scale or LEDs 1 to 21 are illuminated at full-scale. R7 to R12 are wired in series with the display LEDs to reduce the power dissipation of the two ICs. LED 1 is permanently illuminated so that the RPM display does not blank out completely when the engine is stationary with the ignition turned on.

The alarm section of the tacho is fairly simple. IC4 is wired as a voltage comparator with a stable reference voltage fed to its non-inverting (pin 3) input from PR3 and with an RPM-related voltage fed to its inverting (pin 2) input from R13 via SW1c. The output of IC4 is used to enable or disable astable multivibrator IC5 and the output of IC5 is used to enable or disable the inputs to the IC2-IC3 voltmeter via Q1 and R14.

At low engine speeds (below the alarm level) the input of IC4 is driven high, thereby disabling the IC5 astable by preventing C8 from discharging. Under this condition the output of IC5 is driven low, cutting off Q1 and enabling the tacho circuit to operate in the normal way.

At high engine speeds (at or above the alarm level) the output of IC4 is driven low, thereby enabling the IC5 astable to operate at a rate of roughly 2 Hz and alternately drive Q1 on and off. In the moments that Q1 is cut off, the tacho operates in the normal way, but in the moments that Q1 is driven on its collector pulls the pin 5 input terminals of IC2 and IC3 to near-zero volts and thereby effectively blanks the LED displays. The LEDs flash rapidly under the alarm condition, but continue to indicate RPM values.

The alarm point can be set in any position on the tacho scale by PR3. SW1c is used to disable the alarm section when the tacho is set to its low (1,000 RPM in our prototype) range. Note that the power supply to the alarm is decoupled from the main supply by D3 and C9.

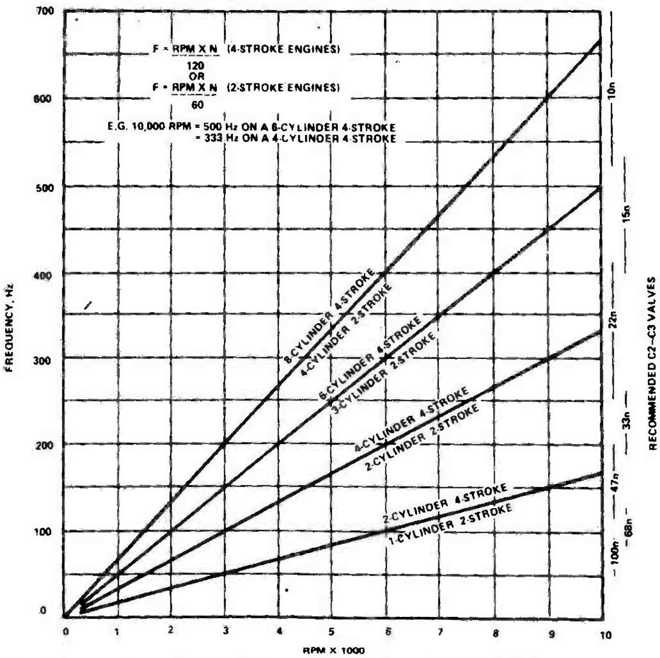


Fig. 2 Conversion graph to determine the values of C2 and C3.

Installation

The completed unit can either be mounted in a special cut-out in the vehicle's instrument panel or (preferably) can be assembled in a home-made housing and clipped on top of the instrument panel. In either case try to fit some kind of light shield to the face of the unit, so that the LEDs are shielded from direct sunlight.

To wire the unit into place, connect the supply leads to the tacho via the vehicle's ignition switch and connect the unit's CB terminal to the CB terminal on the vehicle's distributor. Note that the unit can be fitted to vehicles using either positive or negative earth systems.

The lower range of the tacho is of great value when adjusting the engine for correct tick-over. It is thus advantageous to arrange the tacho housing so that it can be easily dismounted from the instrument panel.

BUYLINES

All components used in the LED Tacho are common types and should present few problems. The dual-in-line slide switch is stocked by the major mail order companies that advertise in this issue.

PARTS LIST

Resistors all ¼ W 5%		C3,8	220n polycarbonate
R1,2,5	10k	C4	1u0 35 V tantalum
R3,13	22k	C5	4u7 35 V tantalum
R4	470R	C6,7	47u 16 V tantalum
R6,15	1k2	C9	100u 25 V electrolytic
R7,9,10,12	330R		
R8,11	270R	**Semiconductors**	
R14	27k	IC1	LM2917N
R16,20	2k2	IC2,3	LM3914
R17	270k	IC4	CA3140
R18,19	12k	IC5	ICM7555
R21	1M0	Q1	BC107
R22	6k8	ZD1	BZY88 12 V
R23	4k7	D1,2	1N4148
		D3	1N4001
Potentiometers		LED1-21	Red, square type.
PR1,2	100k miniature horizontal preset		
PR3	47k miniature horizontal preset	**Miscellaneous**	
		SW1	4-pole 2-way dual-in-line slide switch
Capacitors		PCB, case.	
C1,2	22n polycarbonate		

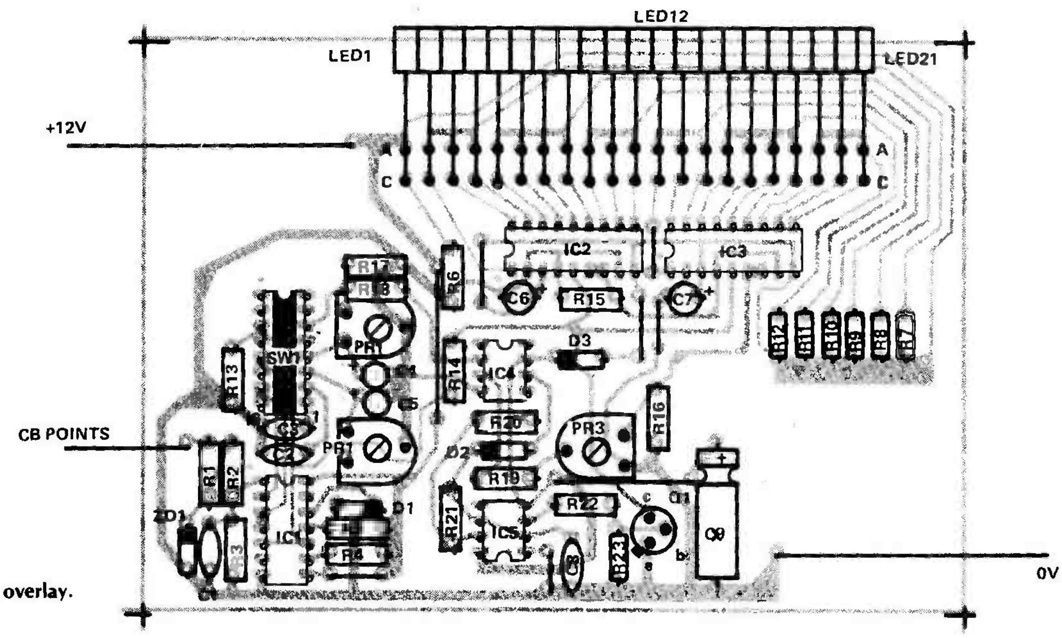


Fig. 3 Component overlay.

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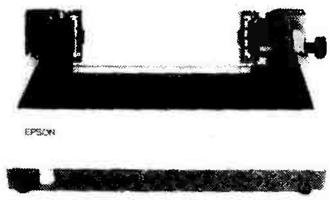

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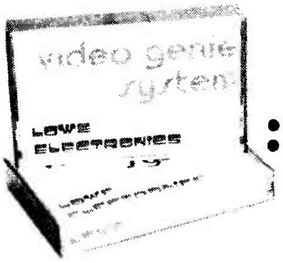

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4024	0.76
4025	0.17
4026	1.80
4028	0.72
4029	1.00
4030	0.58
4035	1.20
4040	0.83
4042	0.85
4043	0.85
4044	0.80
4046	1.30
4047	0.99
4049	0.52
4050	0.55
4051	0.65
4052	0.65
4053	0.65
4063	1.09
4066	0.56
4068	0.25
4069	0.20
4070	0.20
4071	0.20
4072	0.20
4073	0.20
4075	0.20
4076	0.90
4077	0.20
4078	0.20
4082	0.20
4093	0.78
4175	0.95
4503	0.69
4506	0.51
4510	0.99
4511	1.49
4512	0.98
4514	2.55
4518	1.03
4520	1.09
4521	2.36
4522	1.49
4529	1.41
4539	1.10
4549	3.50
4554	1.53
4560	2.18
4566	1.59
4568	2.18
4569	3.03
4572	0.30
4585	1.10

TTL N and LSN

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

VOLTAGE REGULATORS

78series	0.95
79series	1.00
78Mseries	0.65
78Lseries	0.35
79L05	0.85
78MGT2C	1.75
79MGT2C	1.75
723CN	0.65
L200	1.95
TDA1412	0.75
NE5553N	1.25
LM317MP	1.48
LM337MP	1.48

MICROMARKET

8080A/2	7.50
8212	2.30
8214	3.50
8216	1.95
8224	3.50
8251	6.25
8255	5.40
6800P	7.50
6810	5.95
6820	7.45
6850	4.90
6852	4.85
MC2708	7.50
2114	6.50
4027	5.78
2102	1.70
2112	3.40
2513	7.54
RM4716	4.50
81LS97	1.25

VARICAP TUNING DIODES

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

SWITCHING AND PIN DIODES

SHOTTKY DIODES

1N6263	0.62
BA182	0.19
BA244	0.17
BA379	0.35
TDA1061	0.95

SIGNAL DIODES & RECTIFIERS

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

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10RBH series 120mH-1.5H	0.55
PIEZO SOUNDER PB2720	0.44

CRYSTAL FILTER PRODUCTS

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

RADIO CONTROL CRYSTALS

(No splits available)

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

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4.000MHz	2.00
4.19439MHz	2.30
6.5536MHz	2.10
10.0MHz	2.50
10.6985MHz	2.50
10.7015MHz	2.50
10.245MHz	2.50
10.7MHz	3.00
11.52MHz	2.50
100MHz	3.00

LEDs

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

LCDs

3.5 digit	9.45
4 digit	8.95
5 digit	8.95

SCHOTTKY DIODE BAL MIXERS (SBL1=MD108)

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

TRANSISTORS

AUDIO DEVICES

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

AUDIO POWER DEVICES

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

SMALL SIGNAL RF DEVICES

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

RF POWER DEVICES

VN66AF	0.95
2N3866	0.85

SMALL SIGNAL RF FET/MOSFET

BF256	0.38
2SK55	0.28
2SK168	0.35
J310	0.69
J176	0.65
40823	0.65
40673	3SK51
3SK45	0.49
3SK51	0.54
3SK60	0.58
MFM680	0.75
BF961	0.70
BF960	1.24
3SK48	1.64

LCD Module

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

CAPACITORS

All 5mm or less spacing

CERAMIC 50v	
2P2,3P3,4P7,6P8	
8P2,10P,15P,18P	0.04
22P,27P,33P,47P	
56P,68P,82P,100P	0.05
150P,220P,270P	
330P,390P,470P	0.055
1N0,2N2,3N3,4N7	0.06
10N (0.01uF)	0.05
22N,47N	0.06
100N,220N	0.09
MONOLITHIC CERAMIC	
10N,100N	0.16
FEEDTHRU	
1N0 SOLDER IN	0.09
POLYESTER (SIEMENS)	
10mm LEAD SPACING	
10N,22N,33N	0.17
47N,68N,100N	0.19
220N,470N	0.22
1uF	0.29
POLYESTER (GENERAL)	
10mm LEAD SPACING	
10N,15N,22N,33N	0.06
47N,68N,100N	0.08
220N	0.11
20mm LEAD SPACING	
220N,330N,470N	0.18
MYLAR	
5mm LEAD SPACING	
1N0,10N,22N,33N	0.08
100N	0.09
20mm LEAD SPACING	
220N,470N	0.17
POLYSTYRENE	
10P,15P,18P,22P,	
27P,47P,56P,68P	0.08
100P,180P,220P,	
270P,330P,390P	0.09
470P,680P,820P	0.10
1N0,1N2,1N5,1N8	0.11
2N2,2N7,3N3,3N9	0.12
4N7,5N6,6N8,10N	0.13
TANTALUM BEAD CAPS	
16v: 0.22,0.33,	
0.68,1.0	0.18
16v: 2.2,4.7,10	0.19
6v3: 22,47	0.30
10v: 22,100	0.35

ALUMIN ELECTROLYTICS RADIAL (VERT. MOUNT)

(uF/voltage)	
1/63,2.2/50,4.7/35	
10/16,15/16,22/10	
33/6.3	0.08
22/16,33/10,	
47/10	0.09
10/63,22/50,33/50,	
47/16,100/16	0.10
47/63,100/25,220/16	
470/6.3	0.12
100/63,470/16,	
1000/10	0.18
1000/16,470/63	0.23
1000/63,2200/16	0.30
3300/25	0.69
1000/100	0.88
10000/70	3.00
AXIAL (HORIZ. MOUNT)	
1/25,4.7/16,6.4/25	
10/16	0.08
4.7/63,22/10,22/16	
33/16	0.09
47/25,100/16	0.10
100/25	0.11
1000/16	0.25
2200/16,1000/25	0.36
1000/35,4700/16	0.45
1000/50	0.58

RESISTORS

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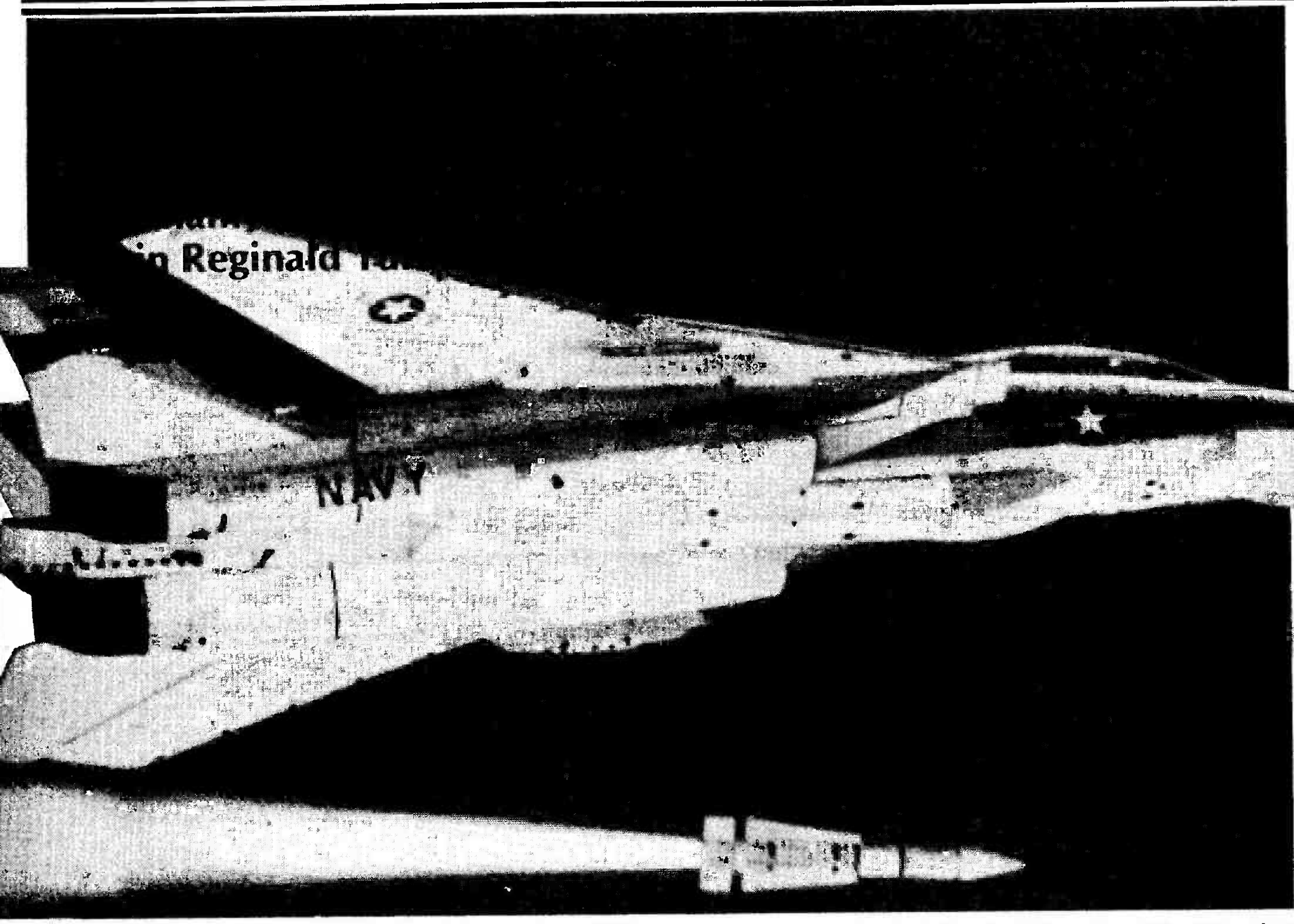

Trials of the improved AIM-54C Phoenix missile continue. This US Navy photo shows an engineering development model being fired from an F-14 Tomcat fighter at the Pacific Missile Range. Once again, the new model, teamed with the Hughes' AWG-9 RADAR fire control system, behaved perfectly, passing well within the lethal distance of the drone target. The Phoenix is regarded as one of the world's most technologically advanced tactical missiles.

The cause of the Ariane rocket accident in May 1980 has been found. As I reported in October's Astrologue, the second test flight of the European launcher lasted only two minutes. The vehicle broke up in flight and exploded.

Extensive tests, simulation and examination of wreckage recovered from the sea were necessary to narrow down the range of hypotheses and eventually reproduce on the test-stand the behaviour of the faulty engine.

It was proved that the cause of the engine failure was not external to the engine itself, or due to a foreign body present at ignition or an acoustic 'ground efect' during lift-off.

Accident investigators have found that the failure was due to combustion instability at high frequency (above 2 kHz) in one of the four first stage engines 5.75 S after ignition. The vibration lasted only 0.3 S, but it was so violent that it abruptly altered the characteristics of the fuel injector. Damage to the injector destroyed the engine 64 S after ignition, starting a propulsion bay fire, which destroyed the vehicle 108 S after lift-off.

Fuel Injection

The fuel injector is a very complex element of the rocket design. It is used to deliver almost 250 kg of fuel and oxidant to the combustion chamber through nearly 1,000 orifices. Its failure was probably due to slight variations in component manufacture, although the injectors behaved normally in nearly 200 engine development tests. To resolve the problem, injector manufacturing tolerances are to be altered and injectors will be selected by static firings on the engine test-stand.

The third Ariane vehicle should be equipped with the new injectors and ready for launch by the end of March 1981, if testing proceeds satisfactorily. The fourth and last test flight would then be scheduled for June 1981. The first operational launch could take place in October.

AWOL Satellite

Late last year, RCA's multi-million dollar Satcom III satellite disappeared 14.5 S into the 28 S apogee kick motor burn (to place the satellite in geostationary orbit). A study of the incident has suggested two possible causes.

If, when the motor fired, the exhaust cone broke, hot gases would have melted the back end of the satellite, destroying the communications equipment. Alternatively, if, after the motor fired, the solar array was deployed prematurely, suffering structural damage due to thrust, a total power loss would ensue. As exhaust overheating was observed prior to loss of contact, the review board has opted for the first alternative.

In addition to the cost of the launch and hardware involved, RCA may lose a further $20 million in expected revenue. However, the venture was insured for around $77 million.

In the meantime, Satcom III's customers can use 11 transponders on another satellite (Comstar D-2) for $40,000 per transponder — the same as the Satcom usage charge. Comstar D-2's full charge is normally $70,000 per transponder. RCA will launch a replacement satellite in June 1981.

In Print

Reginald Turnill has been covering spaceflight since the Soviet-US missile race in the post-war years, which developed into the race to land a man on the moon. He reported for the BBC on every manned spaceflight from Gagarin to the joint Apollo-Soyuz mission in 1975, including the first moon landing.

His wealth of first-hand knowledge of the major space projects reflects in his authoritative writing on the subject. In nearly 400 pages, The Observer's Spaceflight Directory updates and augments the smaller Observer's books on manned and unmanned spaceflight. It includes sections on space programmes in 14 countries, tabulations of manned and unmanned flights and blow by blow accounts of satellites and launch vehicles from Oscar to Skylab and Surveyor to the Space Shuttle. Soviet projects are also covered extensively.

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Closing date for entries — January 31st 1981.

If you don't win the competition, you can get hold of your own copy of The Observer's Spaceflight Directory by Reginald Turnill, published by Frederick Warne, for £7.50 from any good bookshop.

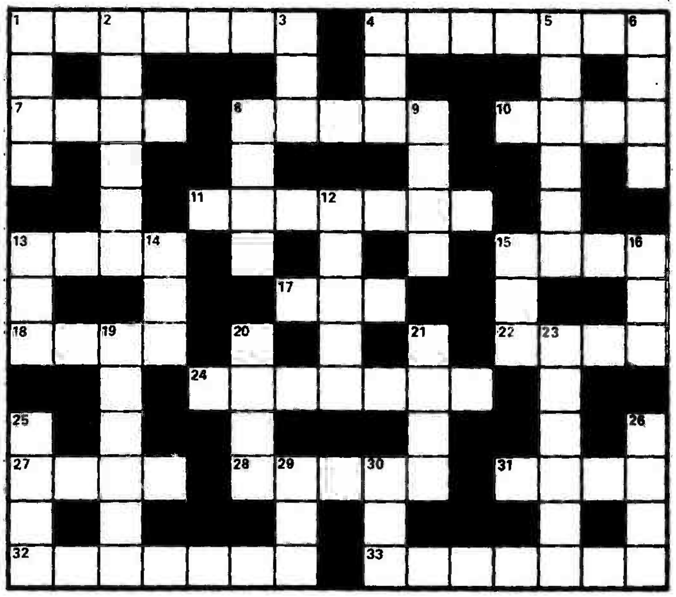
CROSSWORD CLUES

Across

1. Messenger of the Gods, first in line from the Sun. (7)
4. Car step seen through prisms. (7)
7. One of those returned from the Moon in a rocket. (4)
8. Such a wing on a variable geometry aircraft. (5)
10. Major or minor, a friend of Goldilocks. (4)
11. In Scorpio and in plant a resistor. (7)
13. Benny's friends in the sky send out streams of gas. (4)
15. Getting up and down shortly giving lots back. (4)
17. Getting on course for the Moon initially in fast limousines. (3)
18. LEM — 4: Neil Armstrong — 2, giving support. (4)
22. Imitates Bonny and Sam. (4)
24. Troubled SOS in grim for first Mercurial Gemini man. (7)
27. National Oceanic and Atmospheric Administration. (4)
28. Peenemunde led to Saturn for him. (5)
31. Join Oriental take-off for one. (4)
32. The seriousness of the downward pull. (7)
33. Enterprise will never be this, Columbia. (7)

Down

1. The Vikings headed here and returned in express ramjets. (4)
2. Company trek carrying a payload. (6)
3. Plane turn about vertical axis way back. (3)
4. In part, it's unlikely to provide a shining example. (3)
5. Propulsive force through American street. (6)
6. Shepard or Bean in a Lancaster bomber. (4)
8. Liberty Bell did this, we hear — five accross the channel. (4)
9. Geostationary Operational Environmental Satellite leaves. (4)
12. At Los Angeles south missile. (5)
13. Pasadena's famous laboratories — tenth, sixteenth and twelfth. (3)
14. So, point to call for help. (3)
15. A damp reception for astronauts partly due to phase angle. (3)
16. The French southern Launch Escape System. (3)
19. French place of departure for Ariane. (6)
20. Graduate back with credit for nebula. (4)
21. Brief moment on our satellite. (4)
23. Scheme and French celestial body. (6)
25. A single letter pulling down at sea level. (3,1)
26. Southern seaman only coming out at night. (4)
29. Narrow beam fired by futuristic gun. (3)
30. Nameless aircraft alias airborne crockery. (3)



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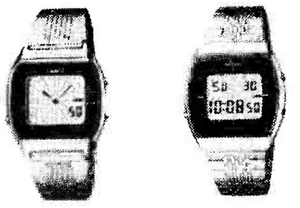

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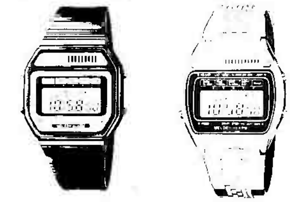
Hours, minutes, seconds, am-pm, 12 or 24 hour. Day, date and month auto calendar.
Alarm. 7 melodies, one for each day of the week.
Hourly time signal. With "Big Ben" type tune.
Date memory. Select either "Wedding March" or "Trinklied" to be played.
Birthday and Christmas Memory.
Countdown alarm. From 1 second to 1 hour. After zero count continues positively.
Stopwatch. 1/10 second to 1 hour. Net, lap, etc.
Picturesque moving display of notes played. Light. Lithium. Glass. Water-resistant cases.
M-12 Resin, s/s trim. **M-1200** all s/s 9.0 mm thick.

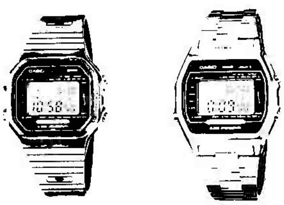


£24.95 **£29.95**

for around 40 functions

100 METRE WATER RESISTANT

Alarm chronographs with countdown
Amazing 5-year lithium battery life. Hours, minutes, seconds, am/pm, day, date and month. 12 or 24 hour. Time is always visible regardless of display mode.
Stopwatch. 1/100 second to 1 hour Net, lap, and 1st and 2nd. Start/stop signal 10 minute signal.
Alarm. Sounds for 30 seconds.
Countdown Alarm. Normal and net times to 12 hours. Start/stop and 10 minute signals.
Time signal. Half-hourly and hourly chimes.
W-100. All resin. **W-150B** All s/s. **W-150C** (not illustrated) s/s case/resin strap. **£29.95**



£19.95 **£32.50**

A250. As above but with standard water-resistant case **£24.95**

S220. As above but with dual tune in lieu of alarms and chimes **£25.00**

F300 Sports Chronograph (right). 8 digits, hours, minutes, seconds, date and day indicator. 1/100 second stopwatch; net, lap and 1st and 2nd place times, to 12 hours. Resin case, s/s trim. Water-resistant. Glass. Light.
110QS-37B Metal version **£17.95**

F81 Alarm Chronograph (far right). 8 digit display of hours, minutes, seconds, am/pm and date. 24-hour alarm, hourly chimes, 1/10 second stopwatch to 12 hours; net, lap, 1st & 2nd place. Resin case/strap. Water resist. Mineral glass. Nightlight.
83QS-41B. S/s jacket version **£19.95**

£12.95 **£15.95**

OTHER CASIO WATCHES Remember we will BEAT lower prices by 5% *
8 digit basic watches. F7C £8.95. 111QS-34B £14.95.
Chronographs. 95QS-36B £19.95. 56QS-38B Digital/analogue £14.95.
Calculator/Chronographs. C80 £24.95. C801 £29.95.
Alarm chronos. 81QS-35B all s/s £29.95. 83QGS-41B. Gold plated. £29.95.
81QGS-35B Gold plated £29.95. 79QS-39B calendar. £29.95. 79CS-51B Calendar, all s/s £39.95.

LADIES' MODELS with stopwatch or dual time.

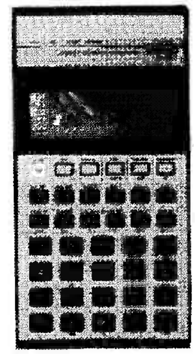
87QGL-13B gold plated £24.95. 87QL-13B chrome £16.95. Other ladies' models from £10.95 to £34.95.
Ladies' Alarm Watches. Hourly chimes, calendar
LA550 all s/s £24.95. LA551, chrome £19.95.
Details on request.

★ Providing the advertiser has stocks and we make a small profit!

CHRISTMAS POST Our return of post service means that orders received by 18th December should reach you in time for Christmas, subject to availability.

RETURN OF THE SUPERCALCS!

★ NEW MODEL! FX-6100
Clock. Hours, minutes, seconds, am/pm.
Alarm. Alarm signal at pre-set time.
Hourly chimes. Every hour, on the hour. Easily switched off.
Countdown alarm. (Repeater time).
Stopwatch. Normal, net, and lap times to 1/100 second.
Calculator. 39 scientific functions. True algebraic logic. 5 level parenthesis, cube roots, standard deviations, R-P and P-R coordinate conversions, sexagesimal conversions, full memory, %.
Approx. 14 months on 2 penlight batteries (AA type). ¾ x 3 x 5⅞inches. (RRP £22.95). **£19.95**



FX-7100. Card version of above with kiss-touch keys. 3/16 x 2⅛ x 3⅜. (£27.95). **£24.95**

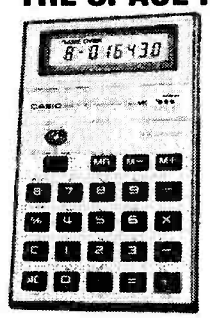
FX-8100. Specifications as above plus permanently programmed calendar (1976-1999), day, date, month and year. Also has hyperbolics. ¼ x 2¾ x 5⅛. **£24.95**

CASIOTONE KEYBOARDS

★ NEW MODEL! CT-301 Domestic Keyboard
Polyphonic playing of 14 instruments plus 16 rhythm voices. Dimensions, etc are similar to the CT-201. Woodgrain only. **Provisional price; under £300.**

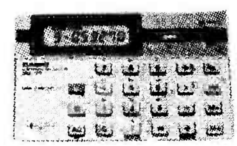
CT-201. 29 polyphonic instruments over 4 octaves, 4-sound memory function. 3 x 33½ x 9⅜. Weight 15 lbs. Integral amplifier and speaker. AC only. (£285) **£245**

THE SPACE INVADERS ARE BACK!



This time right in your pocket. An action-packed speed game that will give you hours of skilful entertainment and chair-gripping excitement. Never another dull spare moment. Also an 11-note melody calculator, pre-programmed "When The Saints Go Marching In". Full memory, %. Auto power-off facility.

MG-880 (left)
¼x2⅝x4½"
£10.95
(£12.95)

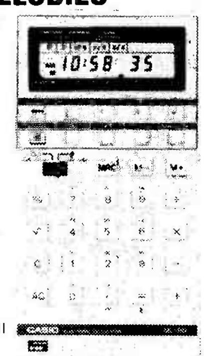


MG-770 (right)
Kiss touch keys.
5/32x3⅜x2⅛
£12.95
(£14.95)

12 PRE-PROGRAMMED MELODIES

Clock, calendar, 11-note melody maker, calculator, square roots, %. Alarm 1; 7 tunes, one for each day. Alarm 2: a fixed tune. Hourly chimes. Date memories; 4 anniversary tunes.
MQ-1200 (below). Desk or bedside. Built-in speaker, Volume control. Nightlight. Powered by three AA size batteries. 1 9/16 x 6 x 2¾ inches.

£19.95
(£22.95)



ML-90 (right)
Kiss keys
Stopwatch
7/32 x 2½ x 4½"
£19.95
(£22.95)

Other Casio calculators, P.O.A. Remember, we will **BEAT lower prices by 5%**

SEIKO ALARM CHRONOGRAPHS FROM £37.50

DFT 048 (left) Alarm, countdown alarm, hourly chimes, stopwatch to 1/100 second, net, lap, 1st & 2nd.
DFT 038 100 metre water-resistant version
£49.95
DER 048 Solar powered (right). Weekly programmable alarm, 16-hour interval count-down alarm timer, hourly chimes, 1/100 second stopwatch.
DER 018 100 metre water-resistant version.
£69.95

£37.50 **£52.50**

DUO DISPLAY Analogue/digital watches from £57.50

Send 25p for our illustrated catalogue of latest Casio and Seiko products. Offers are subject to availability.

Price includes VAT and P&P. Send your company order, cheque, P.O. or phone your ACCESS or BARCLAYCARD number to:

TEMPUS

Dept. ETI, FREEPOST
164-167 East Road,
Cambridge CB1 1DB
Tel: 0223 312866

ETI READER SURVEY

Time for the big one again — our annual nationwide survey of ETI readers. It's your chance to say what you think of us and do your bit to influence what we publish.

All you have to do is fill in the questionnaire overleaf and consign it to its fate at the hands of the Royal Mail. Even now we're preparing for office life to grind to a halt as thousands of questionnaire-laden pigeons start arriving.

Your replies are read and your comments noted. They all go towards shaping ETI in the eighties.

ETI Survey,
Modmags Ltd.,
145 Charing Cross Road,
London WC2H 0EE.

1) Please rate the following articles on a scale of 1 (awful to 9 (brilliant). If you didn't read the feature, please score 0.

	SCORE	READ FULLY	SCANNED OVER	COMMENTS?
FM TUNER				
LED TACHO				
MULTI-OPTION SIREN				
POLYSYNTH				
UNIVERSAL TIMER				
ELECTRONICS TOMORROW				
I/O INTERFACE				
DESIGNER'S NOTEBOOK				
MICROBASICS				
ASTROLOGUE				
TECH TIPS				
SLR ELECTRONICS				
SPOT DESIGNS				
DIGEST				
AUDIOPHILE				

Asterisk the single best feature in your estimation.

In addition please make any comments you would like to in the space provided. (Go on — don't be shy!)

ISSUE ISSUES

2) Do you consider yourself a regular reader? Yes/No
If yes — how long?

Six months or less/1 year/2 years/3 years/longer.

3) If you've been a reader for longer than a year, how does ETI now compare with ETI a year ago? Circle appropriate comment.

Much better Slightly better No different Slightly worse Much worse Oh my God!

4) How long do you keep your past copies of ETI?
1 month 3 months 6 months 1 year longer

5) How did you become a reader of ETI?
By accident Friend's copy Impulse buy Advertisement Other (please specify)

6) How many people read your copy?

PROJECTS

7) Have you ever built a project from ETI? Yes/No
If yes which did you construct in the last year — please list

1.
2.
3.
4.
5.
6.

16) Which of ETI's special offers did you purchase in the past year?

Is there anything you'd like to see appear as an offer in ETI? Yes/No
If yes, please specify

17) Have you ever bought any goods from ETI mail order? Yes/No
If yes how was the service you received?
Good Fair OK Poor Bad Atrocious

Any problems? (Please specify below)

ADVERTISING

18) Do you read advertisements in ETI?
Frequently Occasionally Never

19) Do you find the advertisements in ETI useful when purchasing goods?
Yes No Neither

20) Have you ever purchased goods from mail order advertisements in ETI? Yes/No

21) If so:-
(a) Approx. how many times in the last year have you ordered goods from a mail order company?
(b) How many mail order companies have you used during that period?

22) Approx. how much have you spent on electronics in the last year? £

23) Approx. how much of this amount was spent as a direct result of seeing an advertisement in ETI? £

AUDIO

24) Do you own a stereo system? Yes/No

25) If yes, how much did your present system cost? £

26) Approx. how much do you spend annually on audio equipment? £

27) Please list your present system

VIDEO

28) Do you own or rent a videocassette recorder? Yes/No

29) If not, do you intend owning or renting a VCR within the next year? Yes/No

HOME COMPUTING

30) Do you own a home computer or microprocessor system? Yes/No

31) If yes, how much did it cost? £

32) Did you buy it through:-
(a) Recommendation by other/shop
(b) Article in ETI/other magazine
(c) Advertisement in ETI/other magazine.
Delete where not applicable.

READER PROFILE

These are personal questions which you may find objectionable. Please feel free to tell us to mind our business in that case. Answering them would help us greatly, however, and your co-operation would be appreciated. All info treated strictly as statistics and in confidence.

8) Are there any you intend to build from this issue? Yes/No
If yes which?

9) Is there anything you would especially like to see as a project in ETI? Yes/No
Please specify.

10) In general, if there is a kit available for a project would you purchase that rather than assembling the components yourself? Yes/No

11) Do you construct using PCBs? Yes/No
If yes, do you etch your own? Yes/No

12) In general again, do projects constructed from ETI work first time? Yes/No

SUBJECTIVE MATTER

13) Please read the list of topics below and indicate how you think coverage of them measures up in the appropriate box

	About right now	Should cover less in future	Should cover more in future	Totally ignore
PROJECTS				
FEATURES				
HOME COMPUTING				
AUDIO				
EQUIPMENT REVIEWS				
SPACE FACT				
SCIENCE FICTION				
GENERAL SCIENCE				
MILITARY ELECTRONICS				
ANY OTHER (SPECIFY)				

13) More specifically, there are many types of project we can present in ETI. What is your interest in these examples, and what sort of emphasis should we place on each?

	LESS NEEDED	RIGHT NUMBER NOW	LET'S HAVE MORE
TEST GEAR			
SOUND EFFECTS			
GAMES			
MUSIC			
AUDIO			
BIOFEEDBACK			
MOTORING			
COMPUTING			

15) Have you ever used the ETI postal enquiry service? Yes/No
If yes how did you find it?
Brilliant Good Fair Poor Atrocious Non-existent
Please outline below any problems you have encountered when dealing with us below

33) How old are you?

34) Sex (Male/Female/Undecided)

35) Total annual income (if in full time employment) £

36) What is your job title?

37) Do you hold any of these credit cards?
Barclaycard Access American Express

38) To what level were you in full time education?
CSE 'O' Level 'A' Level ONC HNC Degree

39) What do you like about ETI?

40) . . . . and dislike?

41) Any suggestions for improvement?

42) Any comments to make? (Please include separate sheet if necessary!)

43) The competition. (Otherwise known as the Bad Guys!)

On an arbitrary scale of 100 with ETI scoring 50, please rate the competition against us.

	READ REGULAR	SOMETIMES	USED TO	NEVER	RATING
RADIO CONSTRUCTOR					
WIRELESS WORLD					
TELEVISION					
VIDEO					
PRACTICAL COMPUTING					
COMPUTER AGE					
PRACTICAL WIRELESS					
PRACTICAL ELECTRONICS					
PERSONAL COMPUTER WORLD					
BYTE					
ELEKTOR					
EVERYDAY ELECTRONICS					
COMPUTING TODAY					
HOBBY ELECTRONICS					
VIDEO TODAY					
WHAT VIDEO					
ETI					50

Thank you for your time and patience!

Name

Address

TEKTRONIX STORAGE OSCILLOSCOPE. Type 434, as new. 12 months' warranty **£1,950.**
TEKTRONIX OSCILLOSCOPE. Type 647, with 10A2 and 3B11 **£500**
TEKTRONIX STORAGE OSCILLOSCOPE. Type 564 with 3A6 and 3B4 **£360.**
TELEQUIPMENT STORAGE OSCILLOSCOPE. Type DM53A **£285.**
TELEQUIPMENT OSCILLOSCOPE. Type D32. Portable, mains/battery **£275.**
HAMEG OSCILLOSCOPE. Type 512 DB, 50MHZ. **£350.**
TELEQUIPMENT OSCILLOSCOPE. Type S54A SB 10MHZ. **£190.**
SE LABS OSCILLOSCOPE. Type SM111 DB 20MHZ. **£325.**
ADVANCE OSCILLOSCOPE. Type OS1000 DB 15MHZ. **£250.**
TEKTRONIX OSCILLOSCOPE 547 with 1A1 plug-in Dual TB. 50MHZ. **£375.**
TEKTRONIX OSCILLOSCOPE. Type 561A with 3A1 and 2B67 10MHZ. **£300.**
TEKTRONIX OSCILLOSCOPE. Type 533A with CA. DB 24MHZ **£140.**
HEWLETT PACKARD AC CONVERTOR. Type 3461A **£120.**
MARCONI FM SIG. GEN. Type TF1066B/6S. **£295.**
G. & E. BRADLEY LTD. R.F. MILLIVOLTMETER. Type 112 **£75**
ADVANCE A.C. VOLTMETER. Type VM77E **£60**
MARCONI WAVE ANALYSER. TF2330. Good condition. **£150**
AVO R.F. SIG. GEN. Model HF135. **£75**
MARCONI WIDE RANGE R.C. OSCILLATOR. TF1370. **£95.**
MARCONI AM/FM SIG. GEN. Type TF1066/1. **£225.**
MARCONI SENSITIVE VALVE VOLTMETER. TF2600. **£50.**
MARCONI SIG. GEN. MK2. TF995A/3/S (CT402) **£275.**
PHILIPS F.M. STEREO GENERATOR. Type PM6456. **£120**
TEKTRONIX type 1L30 SPECTRUM ANALYSER PLUG-IN. (works, slight corrosion) **£325**
AIRMEC SIGNAL GENERATOR. Type 204 AM/FM 320MHZ **£150**
WAYNE KERR UNIVERSAL BRIDGE. Type B221 **£50**
B&K AUTOMATIC VIBRATION EXCITER CONTROL. Type 1018 **£50**
B&K AUTOMATIC VIBRATION EXCITER CONTROL. Type 1019 **£50**
MARCONI UNIVERSAL BRIDGE. Type TF868B **£100**
SOLARTRON TRUE RMS VOLTMETER. Type VM1484 **£75**
TAYLOR VALVE TESTER. Type 45D **£65**
ADVANCE LF OSCILLATOR. Type H1E **£45**
ADVANCE SIGNAL GENERATOR S62B 150KHZ-220MHZ **£60**
MARCONI UNIVERSAL BRIDGE. Type TF868A **£50**
TAYLOR METER MODEL 128. £15
R&S SELEKTOMAT USWY BN 15221/2 **£100**
B&K LEVEL RECORDER. Type 2304 **£50**
RACAL HF SELECTIVE ANALYSER. Type 9056. **£375**
SCHLUMBERGER AUTO COUNTER. Type FB2602. **£150**
MARCONI F.E.T. MULTIMETER. Type TF2650 (new) **£95**
AVO MULTIMETER 8 Mk 11 £60
LEVELL MULTIMETER. Type TM11 **£50**
ICE MULTIMETER SUPERTESTER 680R £18
AVO MULTIMETER 8 MK111 £45
MARCONI SIGNAL GENERATOR. Type TF144H. **£225**
MARCONI SIGNAL GENERATOR. Type TF801D/1/S. **£195**
MARCONI UNIVERSAL BRIDGE. Type TF1313. **£250**
RACAL SIGNAL GENERATOR. Type 365A, 1 to 320MHZ AM/FM. **£175**
R&S Z-g DIAGRAPH BN3562 300-2400MHZ £85
R&S POLYSKOP 1 SWOB BN 4244/2/50 £350
WAYNE KERR COMPONENT BRIDGE. CT375 (B521) **£75**
R&S UNBALANCED STANDARD ATTENUATOR 500hm. BN) 8942/50 **£45**
STODDART AIRCRAFT Radio Interference and Field Intensity Meter, type NM-52A 375-1000MHZ (2 pieces) **£325**
MARCONI SIGNAL GENERATOR. Type TF801B **£85**
R&S DIRECT CAPACITANCE METER £50
B&K HETERODYNE VOLTMETER (RECEIVER) Type 2005 **£250**
MARCONI VARIABLE ATTENUATOR. TF1073A/2S **£40**
MARCONI DOUBLE PULSE GENERATOR. Type TF1400/S **£50**
RADIOMETER (COPENHAGEN) WAVE ANALYSER. Type FRA 2CT3a **£80**

SOLARTRON DIGITAL VOLTMETER. Type LM1867 **£75**
HEWLETT PACKARD DIGITAL RECORDER. Type 5050B **£50**
HATFIELD PSOPHOMETER. Type DRG 657167A **£50**
ADVANCE DUAL STABILISED D.C. SUPPLY PP3. 0-30V 1A **£25**
MARCONI COUNTER FREQUENCY METER TF1417/2 with 10-500MHZ Convenor TF2400. **The Pair £50.**
PICTURE MONITOR MODEL PM-52T (5in screen) As new **£55**
HEWLETT PACKARD POWER SUPPLY 6214A 0-12V, 0-1.2A, new, boxed. **£85.**
H.P. TRIPLE OUTPUT POWER SUPPLY 6236A, 0-6V, 0-2.5A/0-20V, 0-0.5A, new boxed **£175**
H.P. DC POWER SUPPLY 6209B, 0-320V, 0-0.1A, new boxed. **£140**
T.O.A. ELECTRONICS LTD Electronic Polyrecorder EPR-2T. Mains **£120**
THE JAMES KING COMPANY FS-1100T FREQUENCY STANDARD £50
MARCONI CARRIER DEVIATION METER. Type TF891D **£50**
SOLARTRON PULSE GENERATOR. type GO1101.2 **£40**
MI SANDERS LEVELLING AMPLIFIER. Type 6587 **£175**
SCOPEX OSCILLOSCOPE. Type 4D10 DB 10MHZ **£170**
ADVANCE OSCILLOSCOPE. Type OS240 DB 10MHZ **£175**
COSSOR OSCILLOSCOPE. Type CDU150 DB 35MHZ **£225**
TELEQUIPMENT OSCILLOSCOPE. Type D61 DB 10MHZ **£195**
HEWLETT PACKARD OSCILLOSCOPE. Type 120B X-Y. **From £85**
FLUKE DIFFERENTIAL AC/DC VOLTMETER. Model 832A **£60**
ADVANCE AUDIO SIGNAL GENERATOR. Type H1. Sine/Square **£25**
R & S TUNABLE INDICATING AMP. BN 12121/2 45-600MHZ **£100**
LYONS PULSE GENERATOR PG71N Bipolar. **£85**
MUIRHEAD WAVE ANALYSER 30-31HZ **£50**
HEWLETT PACKARD DIGITAL VOLTMETER. Type 3460B **£75**
WAYNE KERR THERMOMETER. Type LT100 with probe. **£50**
HATFIELD RADIO FREQUENCY BRIDGE. Type LE300A/1 **£50**
SOLARTRON OSCILLOSCOPE. Type CD1400. DB 15MHZ. **From £75**
HAMEG OSCILLOSCOPE. Type HM412. **£250**
KNIGHT RF SIG. GEN. KG686 with Sweep Marker Gen. KG687. **The Pair £100.**

HEWLETT PACKARD DISPLAY 143A with 1424A Sampling Timebase and 1411A Sampling Vertical Amplifier. Up to 4GHZ Large Display. **£350.**
H.P. MEMORY DISPLAY 5480B with 5486A Control TB and 5488A Y System. **£275**
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R&S UHF TEST RECEIVER 0.9-2.7GHZ BN1524 **£150**
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KEITHLEY REGULATED HIGH VOLTAGE SUPPLY. Type 241. **£250**
HEWLETT PACKARD D.C. CURRENT SOURCE. Type 6181B **£175**
MARCONI XY MEMORY Type TK2214. **£140**
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PHILIPS PAL COLOUR TV PATTERN GENERATOR. PM5508. **£150**
GPO DATEL TESTER NO IC. £100
LEVELL BROADBAND VOLTMETER. Type TM6B. **£40.**
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R&S UHF/VHF FREQUENCY METER. BN442 30-3000MHZ **£60**
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MARCONI VALVE VOLTMETER. Type TF1300. **£15**
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JUST IN
TORODIAL TRANSFORMER

Input 0-120-240 Volts. Output 0-12V; 0-12V. 10VA per winding. Encapsulated, identical to R.S. Components at **£8.90.**
OUR SPECIAL PRICE. P&P £1.50

TANTALUM CAPACITORS — all at 10p each 22mfd 6V; 39mfd 10V; 22mfd 35V; 1mfd 35V.

TANDY TRS 80

Level 2 Microprocessor System comprising of Display. Keyboard with processor and 16K memory; Expansion Interface with 32K additional memory; two Floppy Disk Drives; Tandy Printer; manuals, books, disks, etc — including Updated DOS Disks. Hardly used. EXCEPTIONAL CONDITION. Will separate off

THE LOT £1,600

INFRA RED IMAGE CONVERTER Type 9606 (CV 144)

1¾in diameter. Requires single low current 3KV to 6KV supply individually boxed. With data.

£12.50 each
Infra Red Lamps also advertised

GARRARD DIRECT DRIVE TURNTABLE MOTORS

Made in Japan. With internal electronic speed control. 24 volt. Connections supplied.
£3.50 each. P&P £1.50

EX-MINISTRY SOLID STATE 400 HZ INVERTOR

28 VDC input. 115V output. Size 7 x 2½ x 15in approx. Connection details supplied.
£18 each. P&P £2

TRANSISTOR INVERTOR

115V AC 1.7 Amp Input. Switching is at 20Khz. Output windings from Pot Core. Can be rewound to suit own purpose or unit can be broken for host of components. Circuits supplied.
£1.25 each. P&P £2

CONVERT THIS UNIT TO A
SUPER BATTERY CHARGER

Attractive green ministry quality case with removable top and bottom plates — heavy duty power switches, high powered resistors to control current, good quality centre mounted amp meter, strip of wing nut terminals on front panel which can be used for connecting leads. All this for **£3.50.** P&P £2. Four units £12. Carriage £5.

SOME TEKTRONIX 500 range oscilloscopes

with Single Trace Plug-ins. Working.
From £100. Phone for details

DIODES

All new full spec. devices IN3063 BAX 13. 1S44, 1N4148; 1N3470; 1N4151.
100 off **£1.50,** 1,000 off **£10**

STEPPING MOTORS

6/12 position with additional where the rotor is coils. Device can be used as a tacho. Diagram supplied. Will actually work on 5 volts. 12/24 recommended.
£1.50 each P&P 75p
or 5 for **£5** P&P £1.50.

STEPPING MOTORS

200 Steps. 20 oz/in. torque. 12/24 volt input 4-wire
£12 each. P&P £1.50

KEYBOARD PAD

Size 3x2½x2" high with 12 Alma Reed Switches. Blue keys marked in green 0-9 and a star with one blank.
£4 each, P&P £1, or 5 for **£15** P&P £2.

MINIATURE KEYBOARD

Push contacts, marked 0-9 and A-F and 3 optional function keys. **£1.75 each.**

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		74C74	18p		

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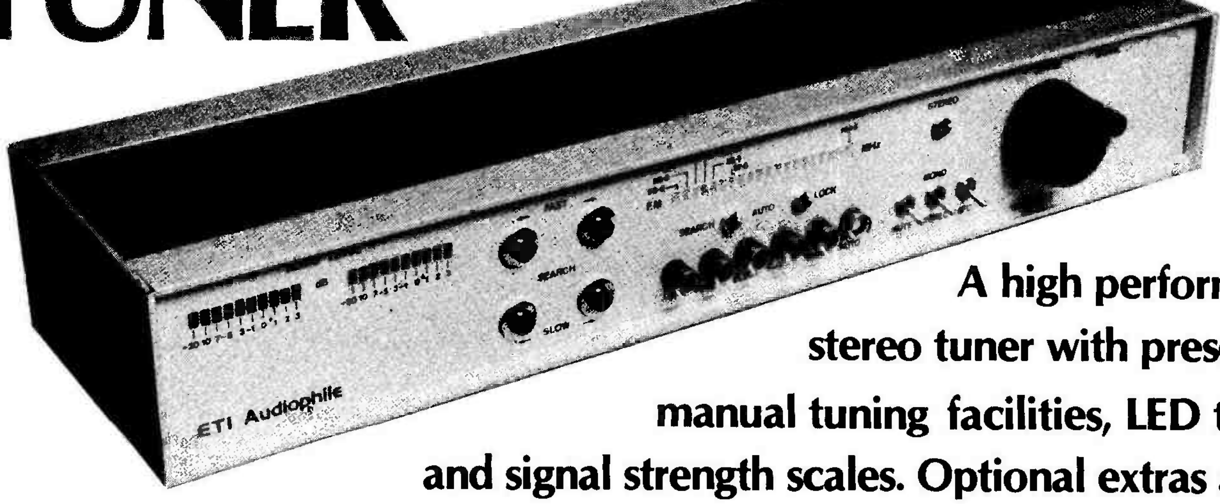
AUDIOPHILE FM TUNER



A high performance stereo tuner with preset and manual tuning facilities, LED tuning and signal strength scales. Optional extras are an automatic search-and-lock tuning facility and a stereo LED audio level indicator. Design by Ray Marston. Development by Steve Ramsahadeo.

The heart of this unusual FM stereo tuner project is a ready-built type 7254 tuner module available from Ambit International. This module has built-in varicap diodes and is tuned by an externally applied DC voltage. It requires a mere handful of external components, plus a regulated 12 V power supply, to make a ready-to-run tuner unit with switch selection of muting, AFC and mono/stereo functioning. The audio output of the module (about 200 mV RMS) can be fed directly to the input of any stereo audio preamp.

Construction

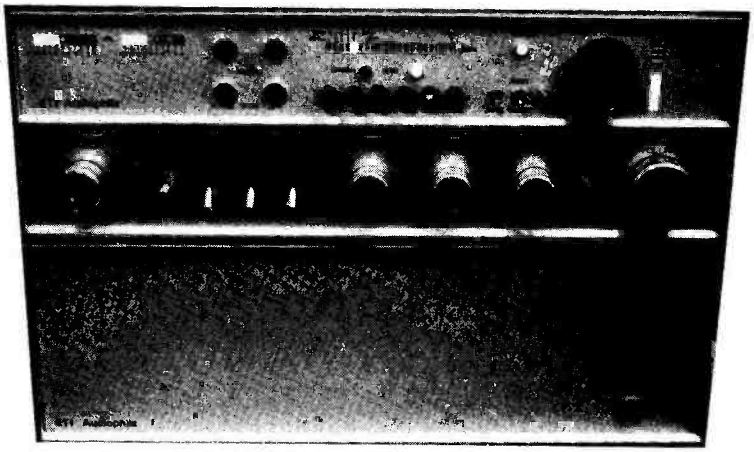
We strongly recommend that you build up the individual units of this project one at a time and interconnect and test them on the open bench before fitting the full set of modules (with or without the optional 'extras') into the final case. Start off by building the power supply unit and check that a stable 12 V is available at the output of IC1.

Next, refer to the basic wiring and interconnection diagram and temporarily wire up the 7254 module as shown,

Spot the Tune

In our Audiophile tuner unit we've provided the basic 7254 module with switch-selected tuning either with one of four preset pots for fixed station selection, or with a 10-turn pot for normal manual tuning. As an optional extra, you can also tune with a special search-and-lock circuit which automatically locates and locks on to strong FM broadcast stations. This circuit is provided with 'search' buttons that can be used to rapidly find the approximate location of a wanted station or reject an unwanted station.

We've designed our FM tuner to cover the 87.5 MHz to 104.5 MHz frequency range, with tuning indication provided on a linear 20-LED frequency scale. We've also provided the unit with a 10-LED signal-strength meter and with an optional stereo audio level indicator with 10 LEDs on each channel. The completed 'full option' unit is exceptionally attractive, with lots of fixed and moving lights, and gives a very impressive performance in the automatic 'search-and-lock' mode.



The Audiophile FM Tuner has been designed to match the Audiophile 4000 preamp and power amplifier (featured in ETI October 1979).

connecting the following components in place: R1, R2, R3, LED 1, SW1, SW2, SW3, SW4, PR1 to PR4, RV1, R4, R5. Note that on our prototype unit we used six interlocking push buttons (including one for the 'automatic' tuning mode) to make SW4 and mounted them on their own PCB, together with multi-turn preset pots PR1-4. Connect the unit to the 12 V power supply, connect an antenna (a few feet of wire should be adequate) and connect the audio outputs of the module to a preamp/power amplifier combination.

Switch the unit on, turn SW4 to position five (manual tuning), SW1 (muting) on, SW2 (AFC) off, SW3 (mono/stereo) to mono and check that the unit can be tuned with RV1. Check that interstation noise is suppressed to a reasonable level when mute switch SW1 is on. If necessary, trim the 100k pot on the 7254 module to obtain satisfactory muting. Check that the unit is functional in the four preset positions of SW4. Finally switch SW3 to the stereo mode and check that LED 1 turns on when a stereo station is tuned in and that stereo noise is not excessive. If necessary, trim the 10k pot on the 7254 to obtain the correct stereo operation.

Now make up the 20-LED frequency scale on PCB 'A'. Note that this board uses square LEDs, mounted horizontally. Fit the LEDs in place with great care, ensuring that their front faces are all in line and overhang the edge of the PCB by the thickness of the front panel of your proposed tuner case. When construction is complete, make the connections to the power supply and to pin 1 of the 7254 module. Switch on and adjust PR2 to set 1V75 between point 'A' and ground. Check that the frequency scale can be fully scanned via RV1 in the manual tuning mode, noting that the PCB is fitted upside down in the final tuner case, so that the display moves to he right with increasing tuning voltage and frequency.

Signal Strength Meter

Next, build up the optional LED signal strength meter on PCB 'C', noting that R39 is mounted on the underside of the PCB and that square LEDs are again used. In this instance the LEDs are mounted vertically on the PCB and special care must be taken to establish the LED heights, as follows. Make a mock-up of the signal strength meter section of your final front panel, complete with a cut-out for the 10-LED display, temporarily fit the PCB in its final 'fixed' position behind the front panel, push the two end LEDs into position on the PCB with their faces flush with the front of the panel and then solder into place. Now fix the remaining eight LEDs in place, using a straight edge across the two end LEDs to give the correct height adjustment. When construction is complete, connect the unit to the power supply and to the 7254 module, scan the band in the manual mode and adjust PR3 so that the lowest signal strength LED is barely on with the weakest of input signals; you'll find that only the lowest three to seven LEDs illuminate under most signal conditions.

Auto Search And Lock

The search and lock circuit is an optional 'extra' and requires some care in setting up. Construct the PCB as shown in the overlay, taking care to use good quality (low leakage) tantalum components in the C7 position. Temporarily remove the link from the completed PCB, connect the board into the tuner circuit, TURN THE AFC OFF (SW2), turn SW4 to auto position and switch the unit on. Check that the frequency scale can be scanned up and down using the fast and slow search buttons (PB1-4) and that a selected station remains in tune for a

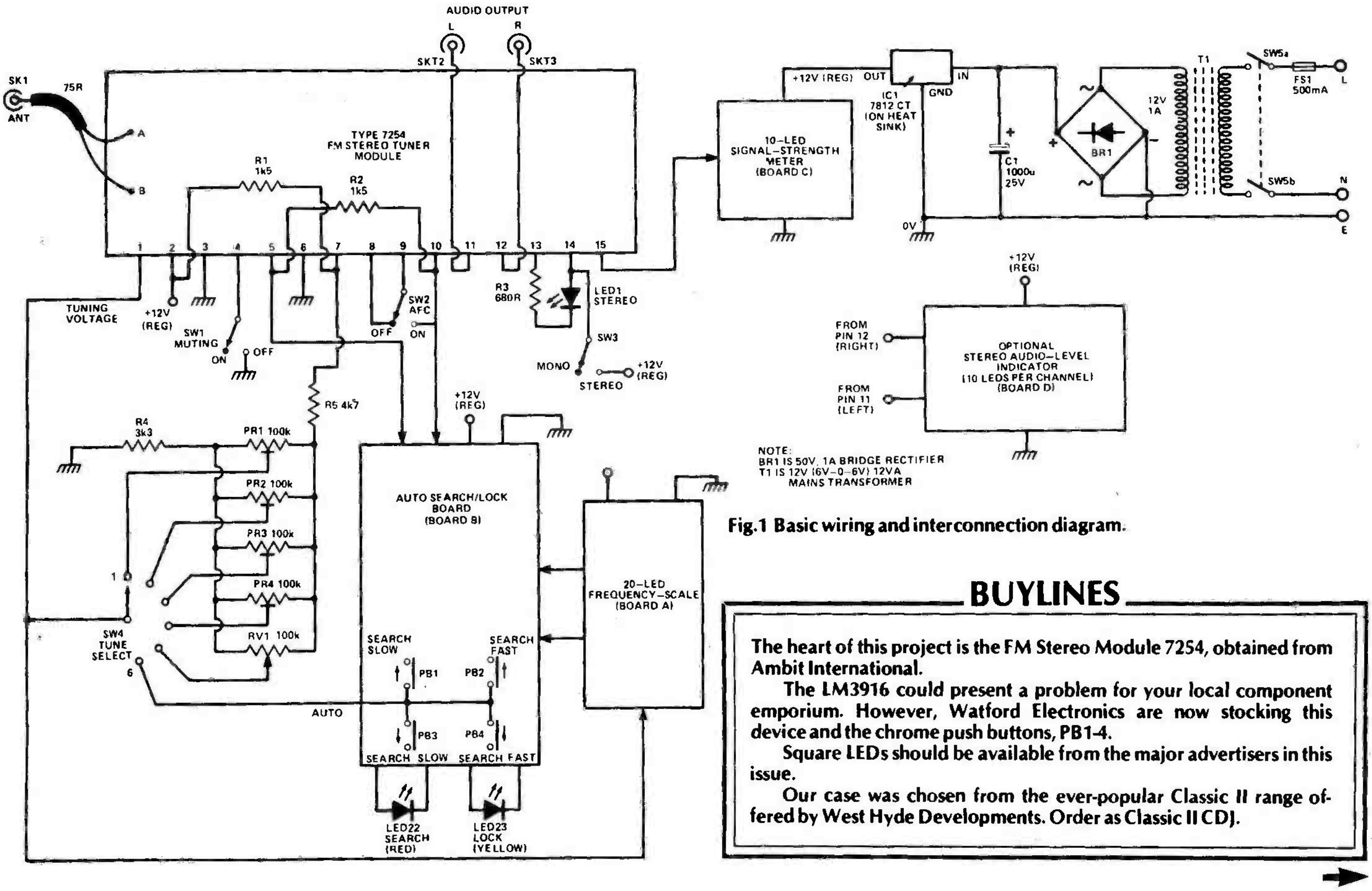


Fig.1 Basic wiring and interconnection diagram.

BUYLINES

The heart of this project is the FM Stereo Module 7254, obtained from Ambit International.

The LM3916 could present a problem for your local component emporium. However, Watford Electronics are now stocking this device and the chrome push buttons, PB1-4.

Square LEDs should be available from the major advertisers in this issue.

Our case was chosen from the ever-popular Classic II range offered by West Hyde Developments. Order as Classic II CDJ.

reasonable time (at least a minute) when the buttons are released. If all is well, insert the link on the PCB.

Switch SW4 to the manual tuning position, tune upwards (with RV1) towards a reasonably strong station and very carefully adjust PR2 so that the search LED (LED 22) is normally on, but turns off and switches lock LED 23 on just as the signal strength indicator goes past its peak reading position. Repeat the action several times, checking that the lock LED acts as an effective 'optimum tuning' indicator.

Now switch SW4 to the auto tuning position, drive the tuning scale fully to the left with the PB4 fast left button and then release PB4. The circuit will now start slowly scanning up the band (to the right), looking for a strong station. When a suitable station is located, the circuit will scan fractionally past the peak signal strength position and then lock on, driving on LED 23. The search LED will subsequently give an occasional flash as a correction pulse is generated to maintain correct tuning. If necessary, trim PR2 very slightly to obtain the same action.

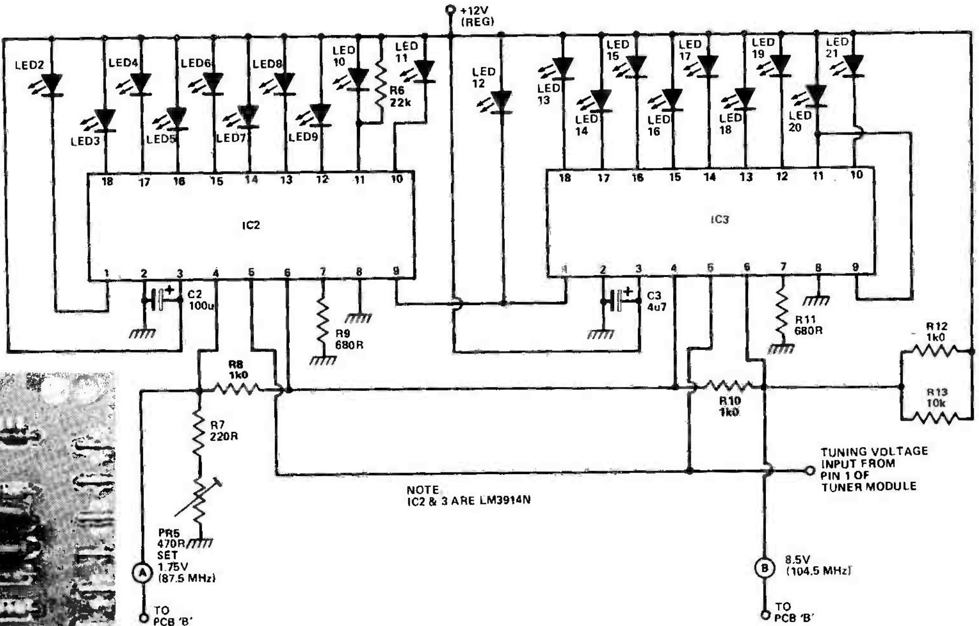
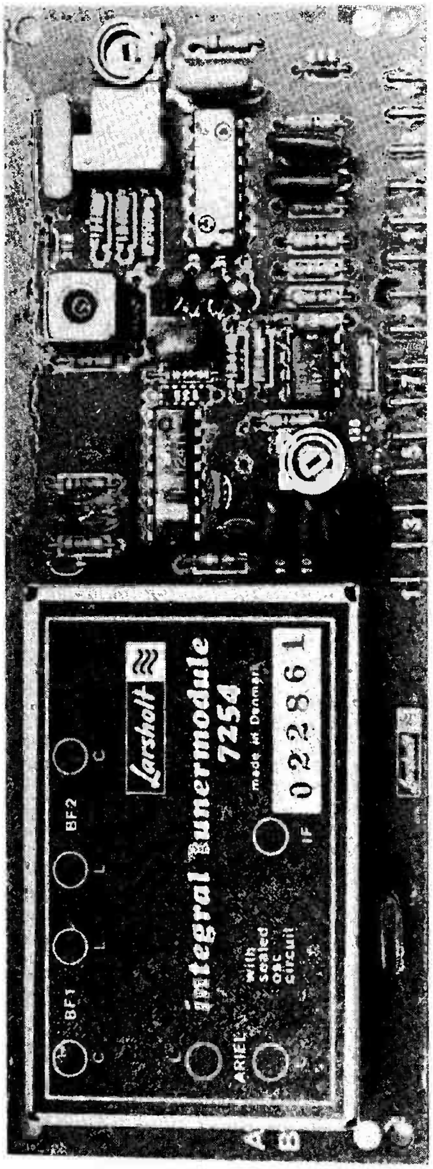


Fig.2 Circuit diagram of the 20 LED frequency scale. This circuit is driven by the timer module (with its ancillary components) and so the component numbering follows on from the module.

The design is built around the assembled 7254 timer module (below).



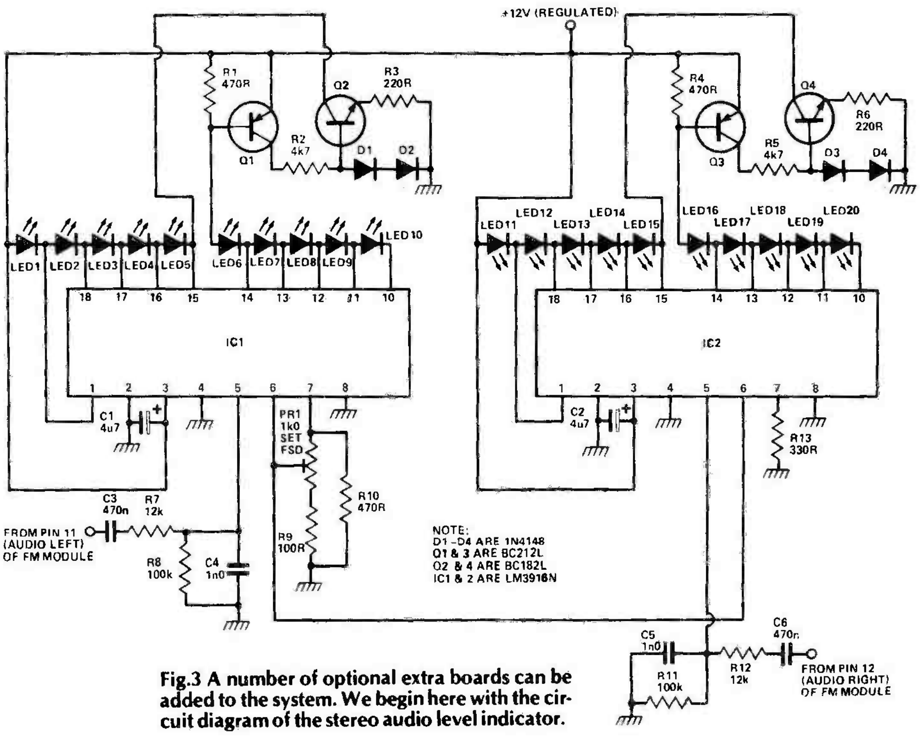


Fig.3 A number of optional extra boards can be added to the system. We begin here with the circuit diagram of the stereo audio level indicator.

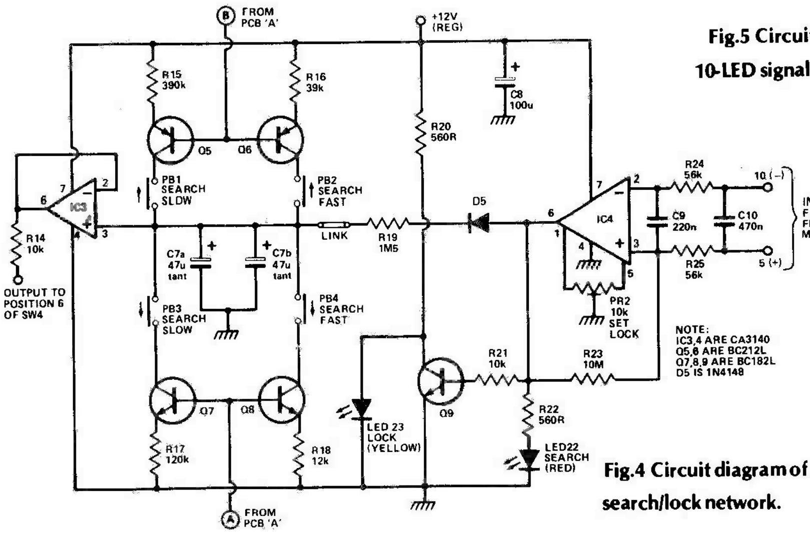
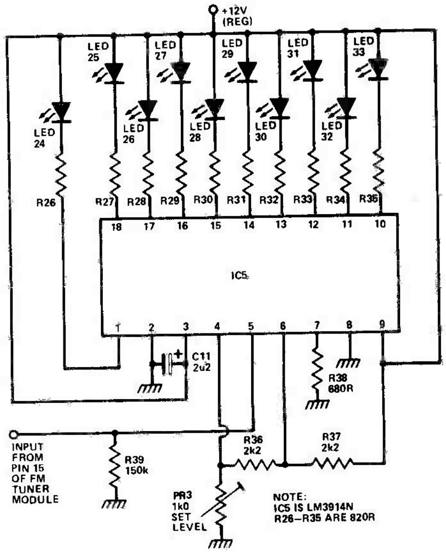


Fig.4 Circuit diagram of the auto search/lock network.

Fig.5 Circuit diagram of the 10-LED signal strength meter.



HOW IT WORKS

The heart of the ETI Audiophile FM Tuner is a ready-built type 7254 FM stereo tuner module with built-in varicap diodes, designed to be tuned with an external DC voltage applied to pin 1. In our application this tuning voltage can be derived from the 12 V regulated power supply line via the R1-R5-PR1-to-PR4-RV1-R4 potential divider or via an auto search-and-lock board. In either case, we use a 20-LED 'voltmeter' circuit to monitor the pin 1 voltage and to thus act as an effective frequency or tuning scale.

The 7254 tuner module has a number of useful output pins. Pin 7 includes an AFC voltage which can be used (via the tuning potential divider) to hold stations on-tune. A voltage proportional to the tuned signal strength is generated at pin 15 and is used in our circuit to drive a 10-LED indicating meter. Tuning meter 'nulling' signals are generated between pins 5 and 10 and are used in our application to control an automatic search-and-lock circuit. Decoded stereo output signals are available at pins 11 and 12 and can be used to drive an optional stereo audio-level indicator as well as for feeding audio signals to an external preamp power amplifier combination. The 20-LED frequency scale is simply an expanded scale LED voltmeter circuit designed around two series-connected LM3914 bargraph ICs operated in the 'dot' mode. The lower and upper limits of the voltmeter scale are determined by fixed reference voltages fed to pin 4 of IC2 (1V75) and pin 6 of IC3 (8V5) respectively via the PR6-R7-R8-R10-R12-R13 potential divider. The input to the voltmeter is fed to pin 5 of the two ICs from the pin 1 tuning voltage of the FM tuner module. This voltage is directly proportional to the tuned frequency, so the voltmeter acts as an effective tuning scale.

The 10-LED signal strength meter is also an expanded scale LED voltmeter designed around an LM3914 bargraph IC, but in this case the IC is operated in the 'bar' mode. The lower and upper limits of the voltmeter scale are determined by fixed reference voltages fed to pins 4 and 6 respectively of the IC. The input voltage to the meter is derived from the pin 15 'signal-strength' output of the FM tuner module.

The stereo audio-level indicators take the form of a pair of virtually identical 10-LED voltmeters with semi-log scales. Each voltmeter is designed around an LM3916 bargraph IC, a VU-scaled version of the LM3914. The full-scale sensitivity of the meters is set at a few hundred millivolts peak (to suit individual tastes) by preset PR1 and audio inputs are fed to pin 5 of each IC from the outputs of the 7254 tuner module via a simple filter network. The audio signals are AC-coupled and the meters respond to the positive halves of the waveform only.

The LEDs are connected to the LM3916 ICs in a most unusual manner in this particular application. The actual ICs are operated in the 'dot' mode, with only one output being low at any moment of time, but the LEDs are connected to each IC in two series-connected groups of five and produce a 'bar' form of display. The purpose of this configuration is to provide current conservation. In a normal 'bar' display, if all 10 LEDs are on and each LED consumes 10 mA, the total current consumption is 100 mA. In the configuration shown in the diagram the currents of each group of five LEDs pass through the series-connected LEDs, so that the circuit consumes a total of only 20 mA when all 10 LEDs are on and consuming 10 mA each.

To understand the operation of the circuit, let's take the example of IC1, remembering that only one output pin can be low at any moment. If pin 1 is driven low by an audio output signal, LED 1 goes on and draws (say) 10 mA from the supply. If pin 18 goes low, series-connected LEDs 1 and 2 both go on and each passes the same 10 mA of current. Similarly, if pin 15 goes low, series-connected LEDs 1-5 all go on and each passes the total of 10 mA that flows into pin 15 of the IC. If pin 14 goes low only LED 6 is turned on by the IC and passes 10 mA into the chip. This current flows via R1 and Q1 base, however, so Q1 conducts and turns on constant-current generator Q2, which, in turn, draws 20 mA (say) through the whole of the series-connected LED 1 to LED 5 'bar'; six LEDs are thus driven on under this condition and the circuit consumes a total of 20 mA. Similarly, if pin 10 goes low the whole LED 6 to LED 10 'bar' is driven on by the chip and the LED 1 to LED 5 'bar' is driven on by the constant-current generator, so all 10 LEDs are on and the circuit consumes a total of only 20 mA.

The search circuit is quite simple. To understand its operation, assume that the link is broken. Capacitor(s) C7 is a low-leakage tantalum type and is used to store a tuning voltage that can be fed to pin 1 of the 7254 tuner module via the IC3 high-impedance unity-gain buffer amplifier and via SW4. Transistors Q5 to Q8 are all wired as low-level constant-current generators and can be used to charge or discharge C7 via 'search' buttons PB1 to PB4 and thus scan the frequency band of the tuner module. When the buttons are released, C7 tries to store the tuning voltage, but in practice the voltage slowly leaks away via the capacitor imperfections and the operating frequency of the tuner very slowly decays downwards. The 'lock' section of the circuit is driven from the pin 5 and pin 10 outputs of the 7254 module. These pins are intended to drive an analogue tuning meter. If you connect a sensitive volt or current meter between these pins in the polarity shown (it is recommended that you do so to check circuit operation) you'll find that the meter will normally give a positive reading, but that the reading will null or go slightly negative when the 7254 module is precisely tuned to a reasonably strong broadcast station. In our circuit, the pin 5 and 10 outputs of the tuner module are fed to voltage comparator IC4 via a simple filter network in such a way that the IC4 output goes high when a station is not present or is off-tune, but switches low when a reasonably strong station is correctly tuned. Thus, when a station is not present the high output of IC4 slowly charges C7 via R19 and D5 and causes the 7254 tuning voltage to slowly increase as the module 'searches' for a station. Under this condition search LED 22 is driven on via R22. Q9 is also driven on via R21 and turns lock LED 23 off. When a reasonably powerful station is located and correctly tuned the output of IC4 switches low, so C7 is no longer charged via R19. D5 is back-biased under this condition, so C7 does not discharge back into IC4. Simultaneously, LED 22 and Q9 are disabled and lock LED 23 is driven on via R20. Once a station is 'locked' in this manner, C7 very slowly discharges via leakage currents, so the tuning voltage slowly decreases. As soon as a station goes fractionally off-tune, however, the IC4 output switches momentarily high and generates a brief 'correction' or 're-charge' pulse which brings the C7 tuning voltage back up to the correct value. This action is indicated by a brief flash of LED 22.

Note in the IC4 comparator circuit that a small amount of hysteresis is provided by R23. Also note that the trip point of IC4 can be varied over a narrow range with PR2, to compensate for slight offsets in the pin 5 to 10 outputs of the 7254 module and allow correct locking to be obtained. If a circuit fails to lock correctly, it may be that the offset of these outputs is excessive. This effect may be overcome by wiring a shunt resistor (value determined by experiment) between the relevant pins of the tuner module.

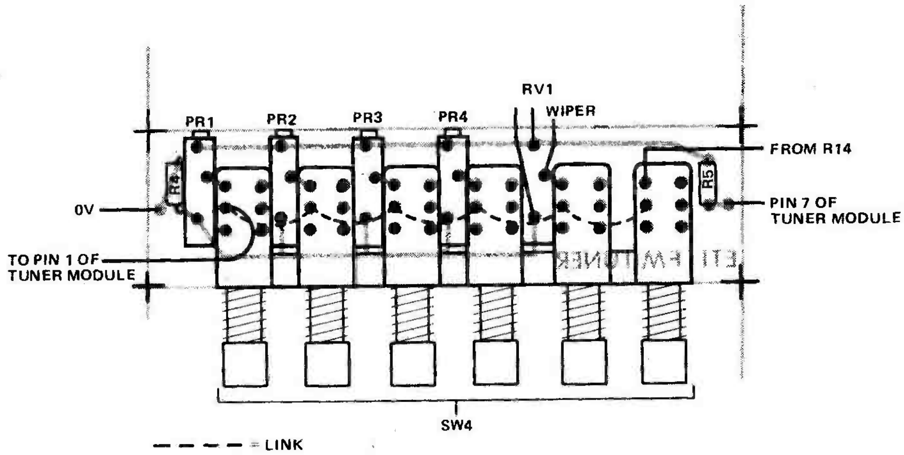
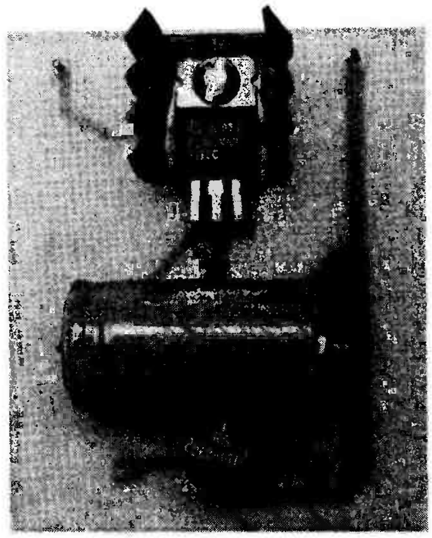


Fig.6 (above) Component overlay of the SW4 six-way switch assembly.



The power supply board — couldn't be simpler.

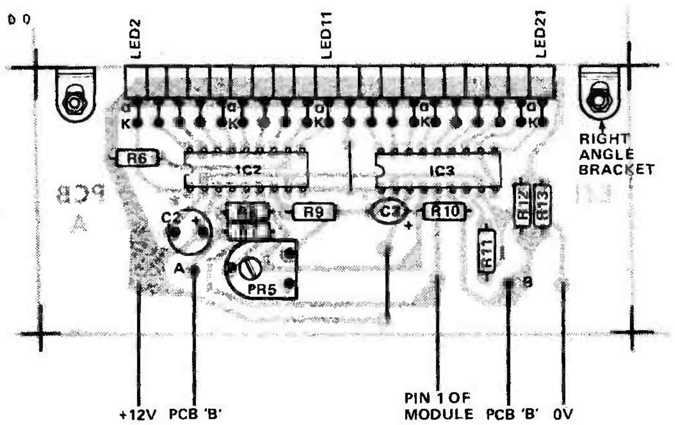


Fig.7 (above) Component overlay of the LED tuning scale.

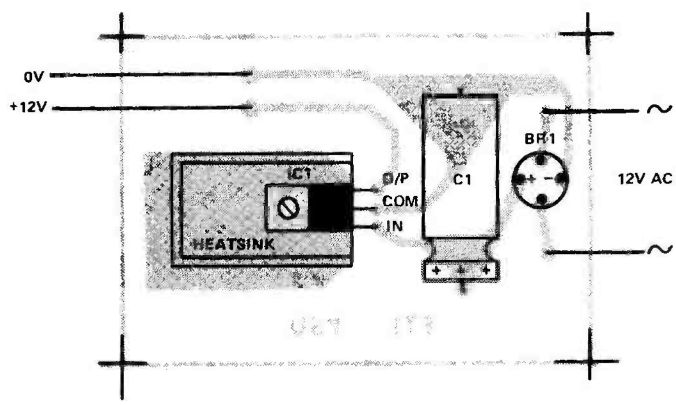


Fig.8 (above) Component overlay of the PSU.

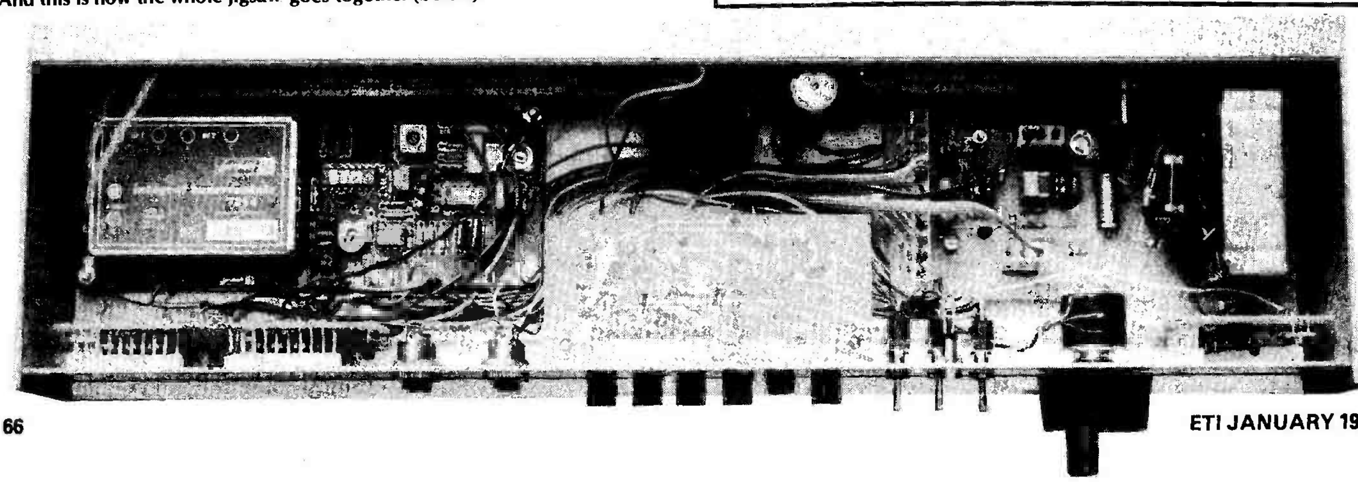
PARTS LIST

FM Module and Tuning Scale

Resistors all ¼ W 5%	
R1,2	1k5
R3,9,11	680R
R4	3k3
R5	4k7
R6	22k
R7	220R
R8,10,12	1k0
R13	10k
Potentiometers	
PR1-4	100k ¾ in. 20-turn cermet preset
PR5	470R miniature horizontal preset
RV1	100k 10 turn linear
Capacitors	
C1	1000u 25 V electrolytic
C2	100u 16 V electrolytic PCB type
C3	4u7 35 V tantalum
Semiconductors	
IC1	7812
IC2,3	LM3914N
BR1	50 V 1A bridge rectifier
LED 1	TIL209
LED 2-21	square LEDs (yellow)
Miscellaneous	
T1	6-0-6 12 VA transformer
SW1-3	SPDT miniature toggle
SW4	2 pole changover interlocking push button (6-way assembly)
SW5	DPDT miniature toggle (optional)

7254 FM module (see Buylines), PCB 'A', fuse and holder, phono sockets (X2).

And this is how the whole jigsaw goes together (below).



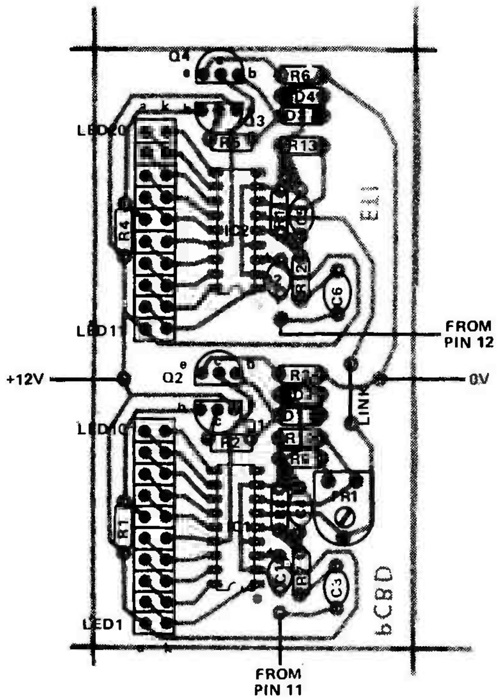


Fig.9 Component overlay of the stereo audio level indicator.

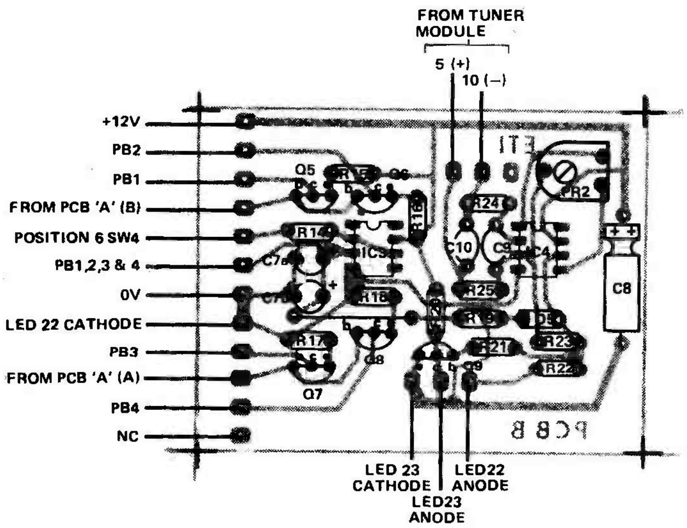


Fig.10 Component overlay of the auto search-lock network.

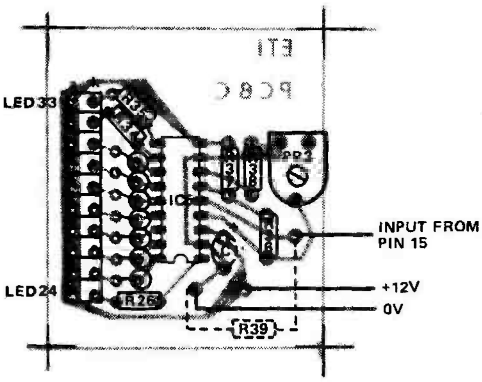


Fig.11 Component overlay of the signal strength meter.

PARTS LIST

Stereo audio level indicator

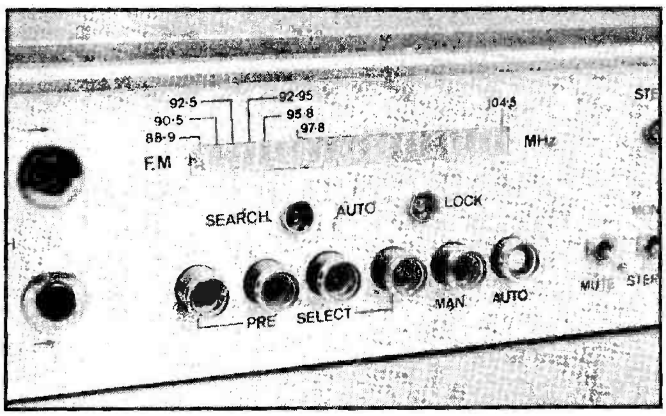
Resistors all ¼ W 5%	
R1,4,10	470R
R2,5	4k7
R3,6	220R
R7,12	12k
R8,11	100k
R9	100R
R13	330R
Potentiometers	
PR1	1k0 miniature horizontal preset
Capacitors	
C1,2	4u7 35 V tantalum
C3,6	470n polycarbonate
C4,5	1n0 polycarbonate
Semiconductors	
IC1,2	LM3916N (see Buylines)
Q1,3	BC212L
Q2,4	BC182L
D1-D4	1N4148
LED 1-20	square LEDs (red)
Miscellaneous	
PCB 'D'	

Auto search/lock

Resistors all ¼ W 5%	
R14,21	10k
R15	390k
R16	39k
R17	120k
R18	12k
R19	1M5
R20,22	560R
R23	10M
R24,25	56k
Potentiometers	
PR2	10k miniature horizontal preset
Capacitors	
C7a,b	47u 16 V tantalum
C8	100u 25 V electrolytic
C9	220n polycarbonate
C10	470n polycarbonate
Semiconductors	
IC3,4	CA3140
Q5,6	BC212L
Q7,8,9	BC182L
D5	1N4148
LED 22,23	TIL209
Miscellaneous	
PB1-4	momentary push buttons (see Buylines)
PCB 'B'.	

Signal Strength Meter

Resistors all ¼ W 5%	
R26-35	820R
R36,37	2k2
R38	680R
R39	150k
Potentiometers	
PR3	1k0 miniature horizontal preset
Capacitors	
C11	2u2 35 V tantalum
Semiconductors	
IC5	LM3914N
LED 24-33	square LEDs (green)
Miscellaneous	
PCB 'C'.	



The tuning scale is mounted above the switch assembly, which takes care of manual and auto timing. The search and lock indicators can also be seen.

When using the auto search-and-lock facility, note that the circuit always scans (searches) to the right and will only fully lock on to signals of reasonable strength (it may temporarily lock to weak signals). To rapidly locate a required station, the search buttons may be used to set the tuning scale slightly to the left of the known position. The search buttons can also be used to unlock from an unwanted station. Also note that the AFC facility must be turned off when the auto search-and-lock circuit is in use.

Stereo Audio Level Indicator

The stereo audio level indicator is an optional item and gives an attractive visual indication of the tuner's audio output signals. The circuit is built on PCB 'D' and uses 10 square LEDs on each channel. These LEDs are mounted vertically on the PCB, their heights being adjusted in the same way as for the signal strength indicator board. When construction is complete, wire the unit into place (connect its 0 V rail directly to the power supply common terminal) and give the unit a functional check. PR1 (on PCB 'D') is simply adjusted so that the display does not run off the scale when strong peak audio signals are present.

Casing The Tuner

When all of the modules have been fully tested on the open bench they can be fitted together in a suitable cabinet, noting that all supply connections must be taken directly to the power supply module (to avoid hum loops, etc.). If you decide to use the 'Classic II' case that we have used in our prototype, note the following constructional points.

The 'Classic II' case is provided with PCB mounting slots and these are used to hold the power supply and the signal strength and audio level boards in place. The basic 7254 tuner module, the SW4 PCB, the search-and-lock board (PCB 'B') and mains transformer T1 are all mounted on the case baseplate with ¼ inch stand-off pillars. The tuning scale (PCB 'A') is mounted on the front panel with angle brackets that are epoxied to the rear face of the panel. **ETI**

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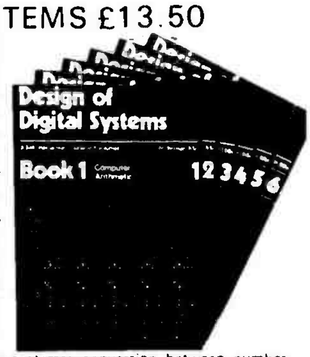

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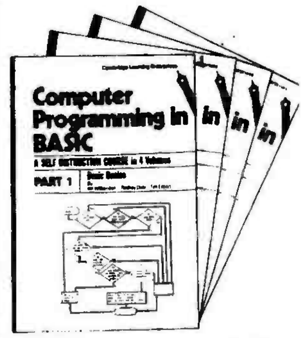

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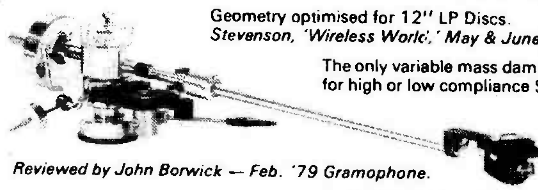

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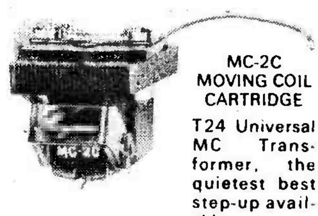

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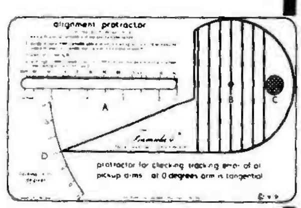

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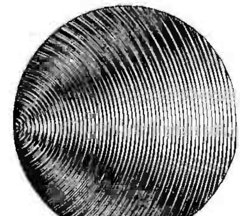

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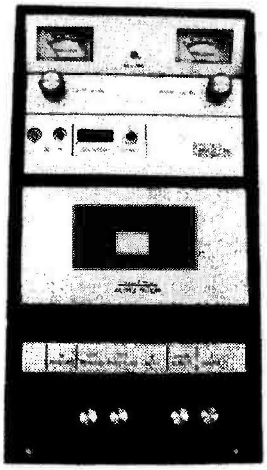

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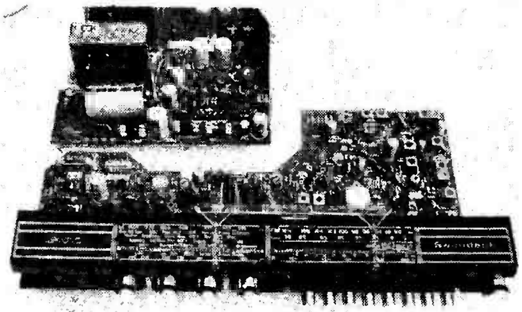

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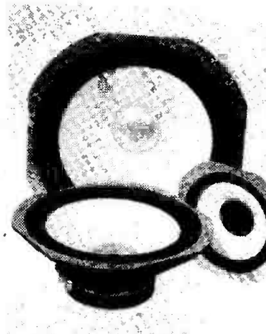

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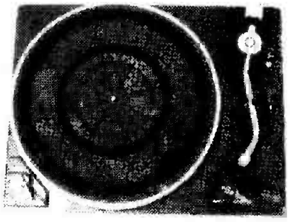

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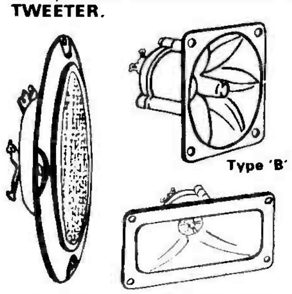

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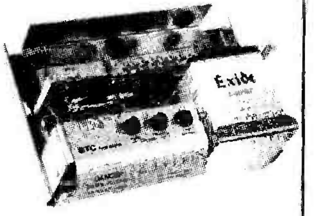

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VISA

DESIGNER'S NOTEBOOK

Ray Marston devotes this month's Notebook to a discussion of special applications for 555 or 7555 astable circuits.

The old-fashioned 555 timer, or its modern CMOS counterpart, the ICM7555, can readily be used as a highly stable and cost-effective astable multivibrator. Usually, the device is merely used to generate simple square waves, but in practice it is readily capable of performing some fairly fancy tricks: it can, for example, be used to generate useful ramp and sine waveforms and can be gated on and off in a variety of ways.

Gating The 555/7555 Astable

The 555/7555 astable can be gated on and off in a variety of ways, to produce a variety of output waveforms. Figure 1 shows the basic connections and the equivalent circuit of the standard 555/7555 astable, it is necessary to understand the operation of this basic circuit in order to appreciate the action of the various gating methods. In the following discussions, a 12 V supply rail is assumed in all circuits.

The first point to note about the Fig. 1 equivalent circuit is that the IC contains a three-resistor potential divider, two voltage comparators, a flip-flop, a transistor and an output buffer. The divider ratios are such that one-third of the supply voltage (ie. 4 V) is set on the lower comparator and two-thirds of the supply voltage (ie. 8 V) is set on the upper comparator. The circuit action is such that, in each operating cycle, C1 first charges up to 8 V through R1-R2, at which point the upper comparator activates the flip-flop and turns the pin 7 transistor on; the transistor then discharges C1 through R2 until the C1 voltage falls to 4 V, at which point the lower comparator activates the flip-flop and turns the pin 7 transistor off, causing C1 to recharge through R1-R2. The operating cycle is then complete and repeats ad infinitum. A ramp waveform with an amplitude that swings between 4 V and 8 V is generated across C1 and a rectangular waveform is generated at output pin 3.

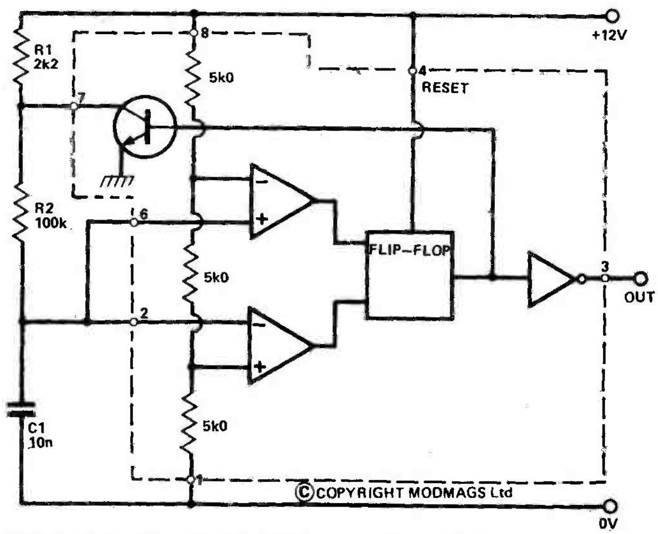

Fig.1b Equivalent circuit of the 555-type astable multivibrator.

The conventional way of gating the 555/7555 astable is with the pin 4 reset terminal, as shown in Fig. 2. When this pin is pulled to ground (by a 1k0 resistor), the flip-flop output is driven high, thus discharging C1 through R2 and the transistor and also driving the pin 3 output low. The resulting circuit waveforms are shown in the diagram. Note that, when the astable is gated on, the first half cycle is considerably longer than the succeeding half cycles. Also note that, when the astable is first gated off, the C1 voltage takes a substantial time to decay to zero. The pin 3 output is zero under the off condition.

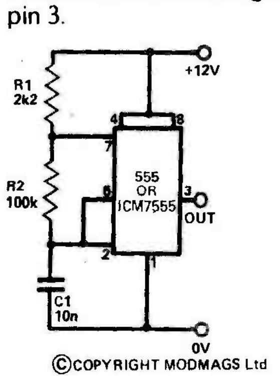

Fig.1a Basic circuit of the 55-type astable multivibrator.

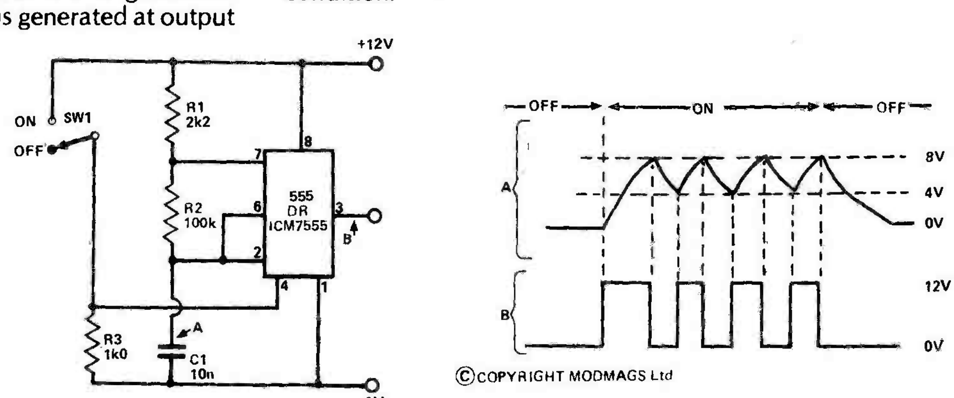

Fig.2 Conventional way of gating the 555 astable, with resultant waveforms.

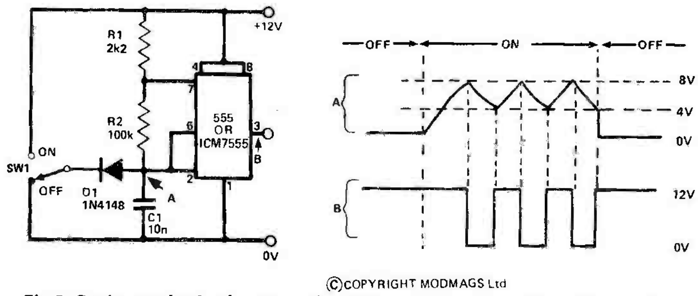

Fig.3 Basic method of gating the 555 astable using C1, with resultant waveforms. Note that the period of the first half-cycle is longer than that of the succeeding half-cycles.

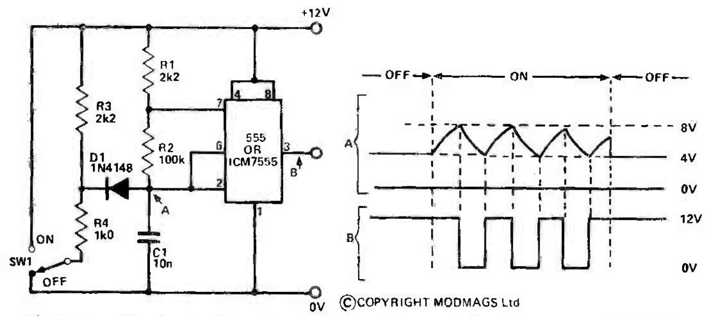

Fig.4 Modification of the C1 gating scheme, giving constant-period half-cycles.

Alternative Methods

One alternative method of gating the 555/7555 is shown in Fig. 3. Here, when the circuit is gated on, D1 is back-biased and the astable operates in the normal way, but when the circuit is gated off D1 shorts out C1 and pulls point A to ground; in practice, of course, SW1 can be replaced by an electronic switching waveform (the output of a CMOS gate, etc.) Note in this circuit that, when the astable is gated on, the first half cycle is again considerably longer than the succeeding half cycles, but that the C1 voltage falls abruptly to zero at gate-off. Also note that the pin 3 output is high in the off state.

Figure 4 shows how the above circuit can be modified so that the duration of the first half cycle is almost equal to that of the succeeding half cycles. This is achieved by choosing the R3-R4 values so that the C1 voltage is only a fraction below 4 V (one-third of supply volts) under the off condition. A substantially different set of waveforms can be obtained by choosing the R3-R4 values so that the C1 voltage is a fraction below 8 V (two-thirds of supply volts) under the off condition, as shown in Fig. 5.

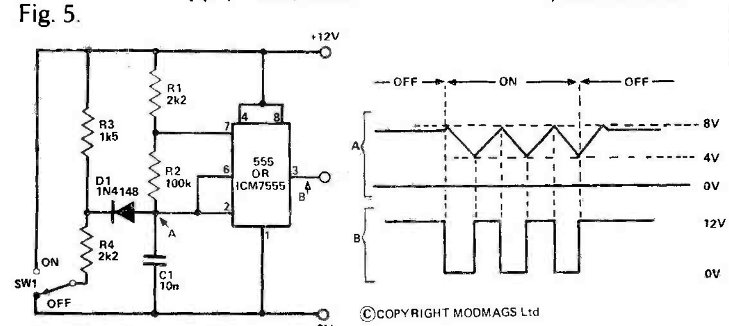

Fig.5 This slight modification of the C1 gating scheme produces a considerable change in the circuit output waveforms.

It should be appreciated that the 555/7555 astable can only oscillate if its timing capacitor (C1) is free to swing between the 4 V and 8 V switching levels. This simple fact makes it possible to voltage-gate the astable by using the circuit of

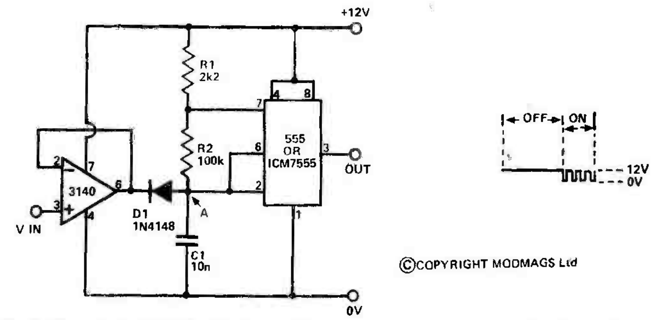

Fig.6 The voltage-controlled astable produces an output only when V_{IN} exceeds two-thirds supply (8 V in this example).

Fig. 6. Here, the circuit produces output waveforms only when the input voltage exceeds 8 V. The circuit can be made to trigger at other levels by giving the op-amp an appropriate voltage gain factor.

Finally, an alternative method of gating the 555/7555 astable is shown in Fig. 7. Here, the circuit is gated off by driving the C1 voltage above 8 V by D1. A feature of this circuit is that its 'B' output is low under the off condition.

Asymmetrical Astables

The basic 555/7555 astable generates near-symmetrical output waveforms, provided that R2 is large relative to R1 (giving near-equal C1 charge and discharge time constants). Figures 8 to 10 show alternative methods of generating non-symmetrical waveforms. In Fig. 8, C1 charges through R1-R2 but discharges through R2 in parallel with R3-D1, to produce the waveforms shown. In Fig. 9, C1 charges through R1 and R2 in parallel with R3-D1, but discharges through R2 only; this circuit is useful for providing narrow output pulses at the 'B' terminal.

Finally, in Fig. 10, C1 charges through R1-R3-D2 and discharges through D1-RV1-R1-R2, to produce narrow output pulses at the 'B' terminal. This circuit is useful for generating variable-frequency constant-width pulses.

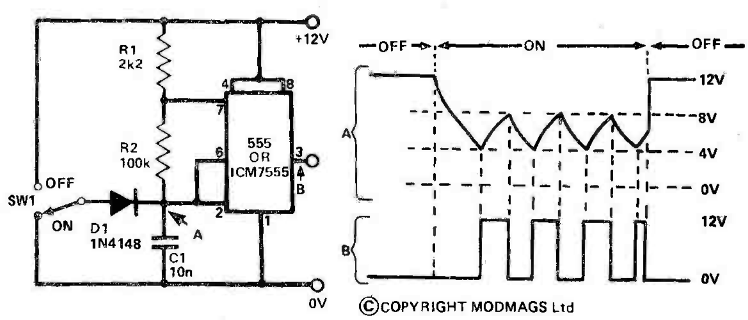

Fig.7 This C1 gating scheme produces a 'B' output that is low in the off condition.

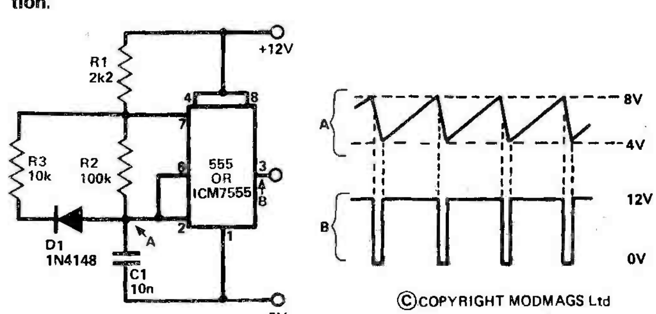

Fig.8 A method of producing a non-symmetrical fixed-ratio from the 555 astable.

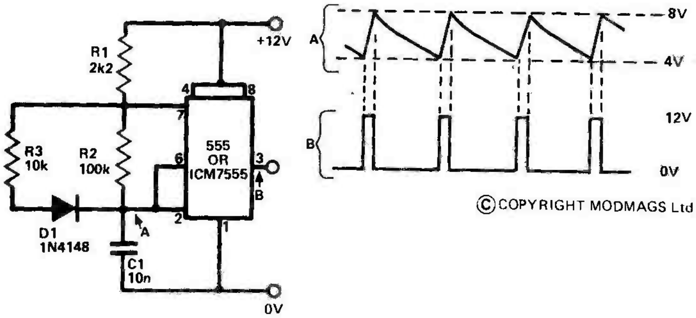

Fig.9 Alternative method of producing a non-symmetrical fixed-ratio output from the 555 astable.

555/7555 Sine Wave Generation

Figure 11 shows how a sine wave signal can be obtained from a 555/7555 astable. Here, the symmetrical ramp waveform of C2 is buffered by Q1 and then AC coupled to the R1-R2-D1-D2 divider/limiter network. This network attenuates the ramp signal and then non-linearly removes the ramp's positive and negative peaks, to produce a sine-shaped waveform of about 1 V peak-to-peak amplitude at the output terminal. The distortion level of the resulting sine wave is typically of the order of 3% and its frequency can be varied from a few cycles per minute to several hundred kilohertz by suitable choice of the C2 value.

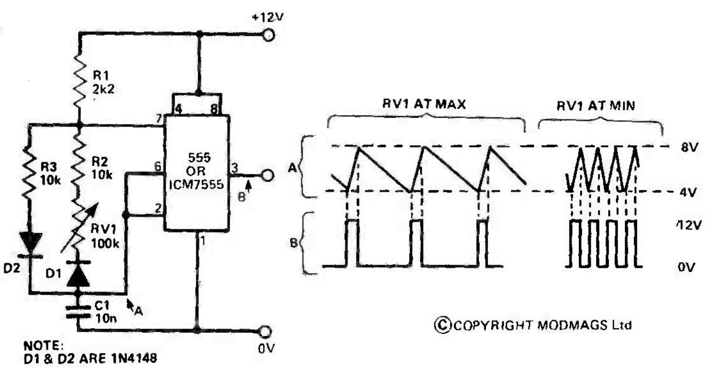

Fig.10 A method of producing a non-symmetrical variable-ratio output from the 555 astable.

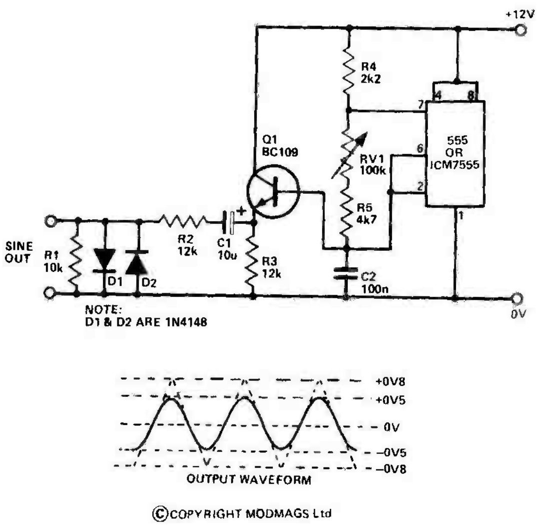

Fig.11 A 555 sine-wave generator with a range of 83 Hz to 1.4 kHz (via R1).

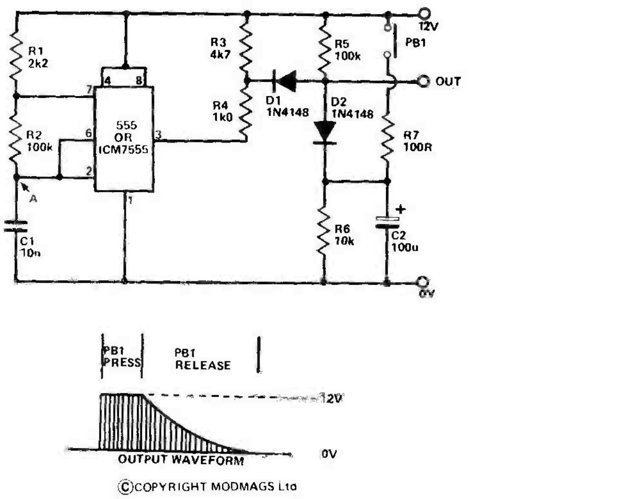

Fig.12 A method of amplitude-modulating the pin 3 output of the 555 astable in music and sound generator applications.

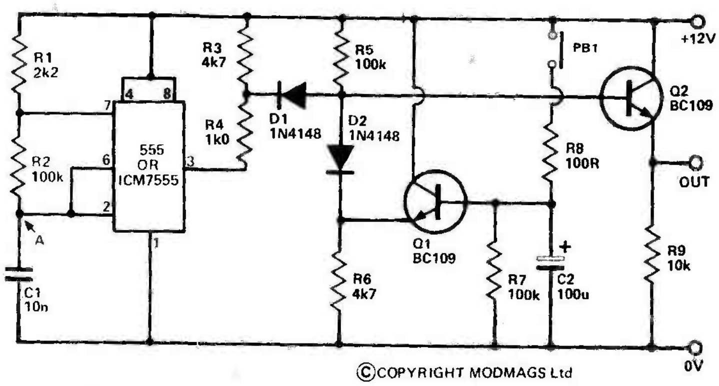

Fig.13 A modification of the Fig.12 circuit to give extended decay times and a buffered output.

AM Output

Figure 12 shows how the pin 3 square wave output of the 555/7555 astable can be amplitude-modulated to produce the typical attack-hold-decay envelope of a simple musical instrument or of a special-effects sound generator. The heart of the unit is the diode AND gate, or mixer, formed by D1-D2-R5. One input of this gate is fed from the output of the astable via R3-R4 and the other from across R6. The basic action of this gate is such that (ignoring the diode volt drops) its output amplitude is equal to the lesser of the two inputs.

Thus, when D1 is fed with the square wave output of the astable, the peak output of the unit will be zero when the R6 voltage is zero, or 5 V when the R6 voltage is 5 V, etc. In our circuit, R6 is shunted by electrolytic capacitor C2. Thus, when PB1 is pressed, a large voltage is applied to R6 and a large-amplitude square wave output is available. When PB1 is released, the R6 voltage and the square wave output amplitude decay exponentially to zero (with a time constant of R6-C2), as shown in the diagram. The R3-R4 network is used to apply a slight offset bias to the rectangular input waveform, to ensure a full cut-off of the output waveform after PB1 is released.

Finally, Fig. 13 shows how the above circuit can be modified to give extended display times (via emitter follower Q1) and a buffered audio output (via emitter follower Q2). **ETI**

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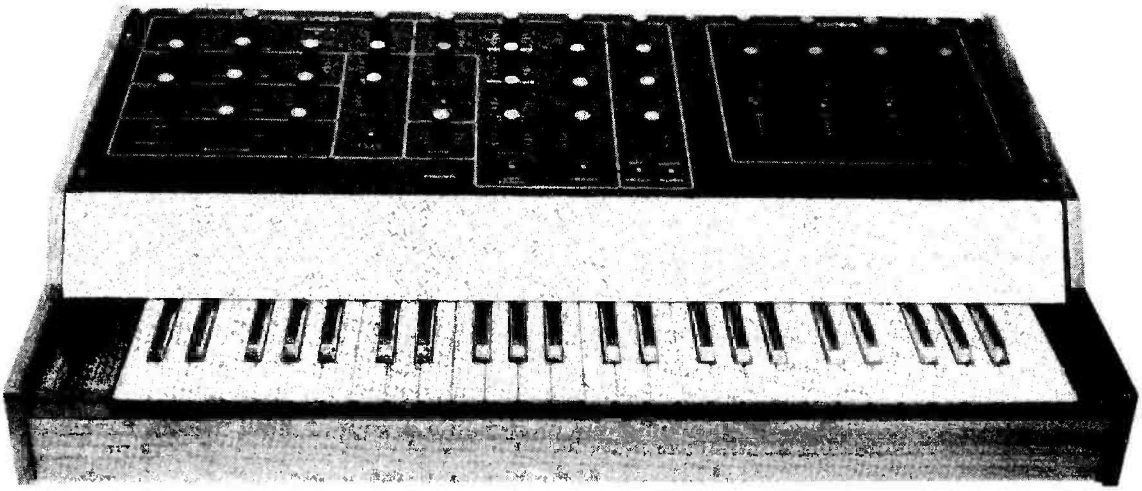
POLYSYNTH

Part 2: This month we continue the Polysynth project with details of the motherboard and control boards. Design and development by Tim Orr



Polyphonic portamento has been provided by using a voltage controlled slew limiter for each pitch voltage (Fig.10,11). The slew rate is controlled by the I_{ABC} current and the timing capacitor C_B.

$$\text{Slew Rate} = \frac{I_{ABC}}{C_B} \quad VS^{-1}$$

An LM13600 OTA is used to charge and discharge C_B. The OTA is contained in a feedback loop of two op-amps to reduce the differential offset voltage change between the input and the output. The circuit generates a voltage change of about 100 uV over its full range of 0 to −4 V at all slew rate settings.

With the portamento pot fully clockwise, the pitch of the notes will not be noticeably slewed. As the pot is rotated anticlockwise the slew limiting will become very obvious. At its slowest rate, a four octave transition will take about 2 S.

Volume Control

The audio outputs from all voices are mixed into IC13, Fig.10. This is a voltage controlled amplifier. With the master volume control anticlockwise the output will be fully off.

Pitch Bend

The pitch bend joystick is shown in Fig.12. Note that the offset lever has to be cut short to avoid fouling the pitch bend plate. This lever is adjusted so that with the joystick in the centre, the voltage on the pot wiper is zero.

Panel Boards

Board PS5 generates all the common synthesiser parameters and PS6 the individual parameters. Most of the panel controls merely generate DC voltages. However, there are three modulation oscillators which are used to produce VCO vibrato, VCF sweep and pulse width modulation of the VCO square wave output. Note that the pulse width modulation pots (RV2,4) are dual function.

Clockwise they are connected to the modulation oscillator and anticlockwise they produce a manual control ranging from one-to-one square wave to a very thin pulse. In the centre of the pot movement there is a mechanical 'click'.

A pseudo-random noise source (IC5,6) with a low frequency boost has also been included as a sound source. Boards PS5 and PS6 connect to PS4 via preformed 12" flexible jumper links. Make certain that these links are clamped to the boards with self-adhesive ribbon cable clamps, as these will take the strain of the cables as they are flexed.

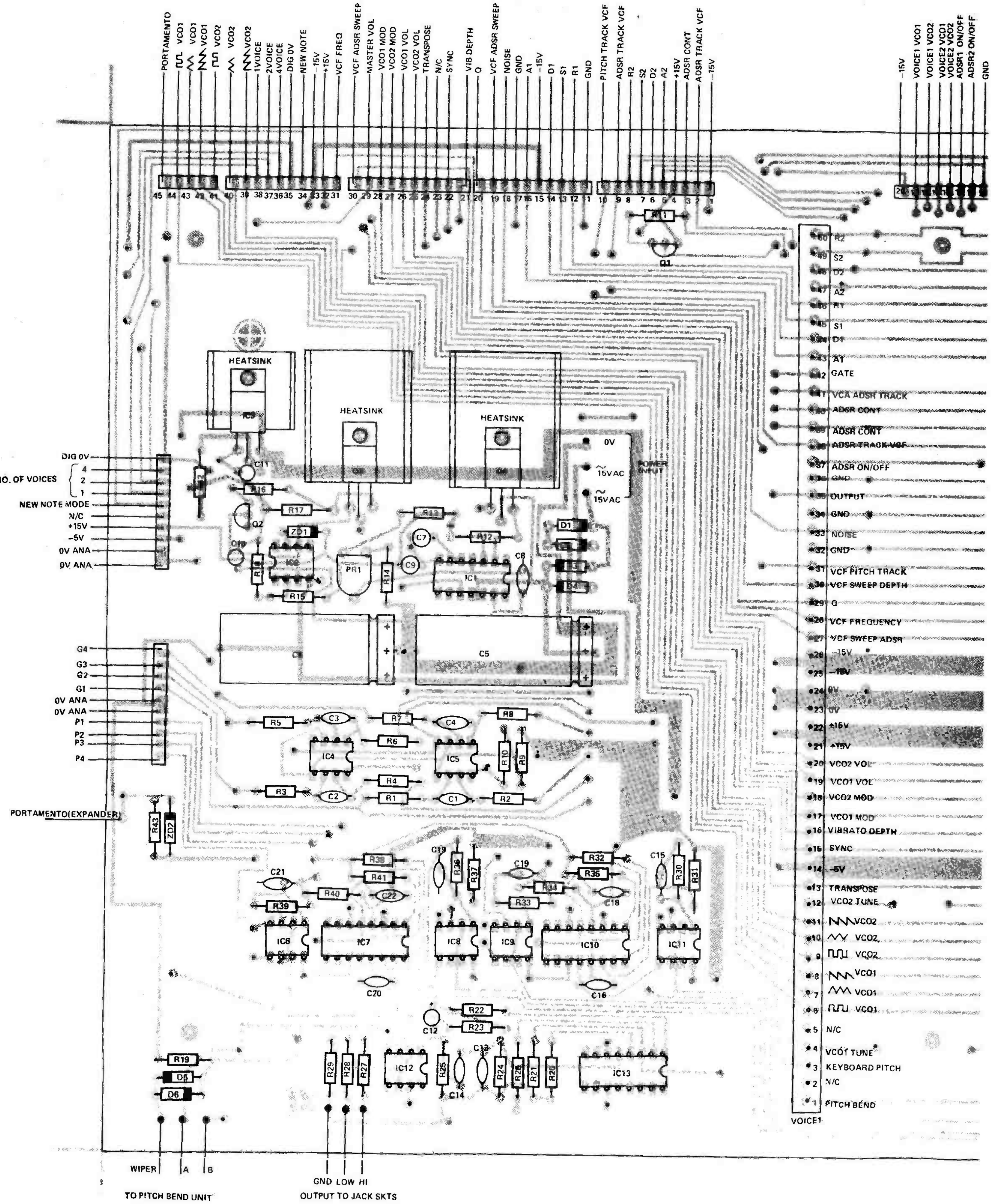
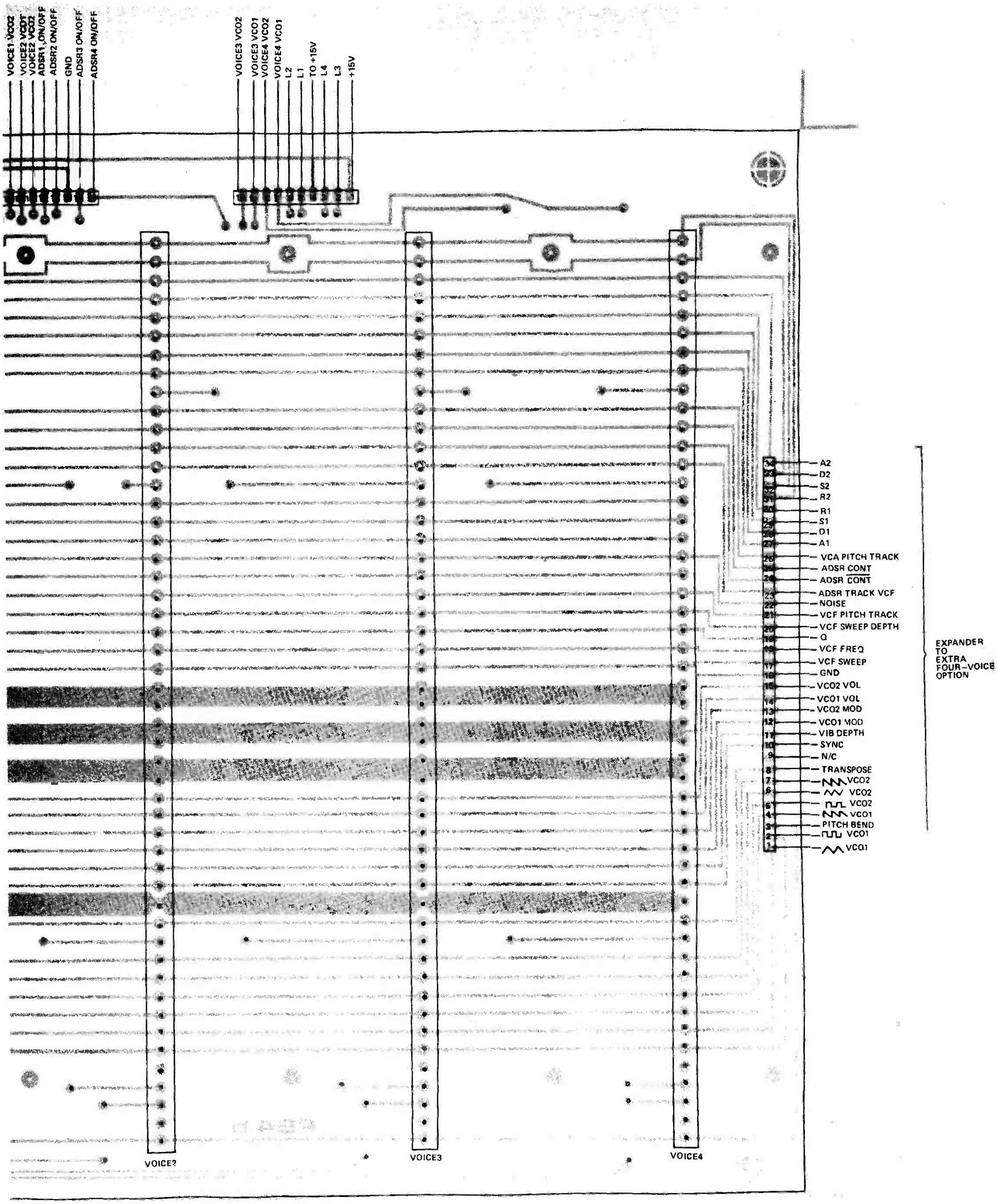


Fig.1 Component overlay of the motherboard (PS4). The circuit diagram was published last month.


VOICE1 VCO2
VOICE2 VCO1
VOICE2 VCO2
ADSR1 ON/OFF
ADSR2 ON/OFF
GND
ADSR3 ON/OFF
ADSR4 ON/OFF
VOICE3 VCO2
VOICE3 VCO1
VOICE4 VCO2
VOICE4 VCO1
L2
L1
TO +15V
L4
L3
+15V
A2
D2
S2
R2
R1
S1
D1
A1
VCA PITCH TRACK
ADSR CONT
ADSR CONT
ADSR TRACK VCF
NOISE
VCF PITCH TRACK
VCF SWEEP DEPTH
Q
VCF FREQ
VCF SWEEP
GND
VCO2 VOL
VCO1 VOL
VCO2 MOD
VCO1 MOD
VIB DEPTH
SYNC
N/C
TRANSPOSE
VCO2
VCO2
VCO2
VCO1
PITCH BEND
VCO1
VCO1
EXPANDER TO EXTRA FOUR-VOICE OPTION
VOICE2
VOICE3
VOICE4

PARTS LIST : PS4

Resistors all ¼ W 5% unless otherwise stated

R1,3,5,7	1M0
R2,4,6,8	1k5
R9	1k2
R10,26,30,33,36,39	15k
R11,32,35,38,41	100k
R12,17	1R0 2 W
R13	12k 2% metal oxide
R14	10k 2% metal oxide
R15,18	10k 0.5% metal film
R16,20,21,27,29,31, 34,37,40	1k0
R22,23,25	22k
R19,24,28	10k
R42	100R 1 W
R43	270k

Potentiometers

RV33	10k linear (single axis joystick)
PR1	10k cermet preset

Capacitors

C1,2,3,4	1n0 ceramic
C5,6	2200u 25 V electrolytic
C7,9,10,11,12	10u 16 V tantalum
C8	330p ceramic
C13	1n0 polycarbonate
C14,16,18,20,22	220n polycarbonate
C15,17,19,21	470p ceramic

Semiconductors

IC1	723 (DIL)
IC2,12	741
IC3	7905
IC4,5	1458
IC6,8,9,11	LF353
IC7,10,13	LM13600
Q1,2	BC212L
Q3	TIP30A
Q4	TIP29A
ZD1	10 V
ZD2	5V1
D1,2,3,4	1N4002
D5,6	1N4148

Miscellaneous

PCB PS4, 8 off 8 pin DIL sockets, 14 pin DIL socket, 3 off 16 pin DIL sockets, 2 off heatsinks (RS 401-964 or equivalent), TV5 heatsink, connecting pins, self-adhesive clips.

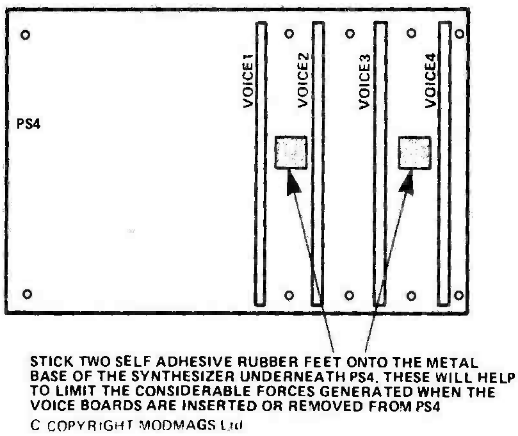


Fig.2 Plugging in the voice boards could damage the motherboard if it is not cushioned as shown.

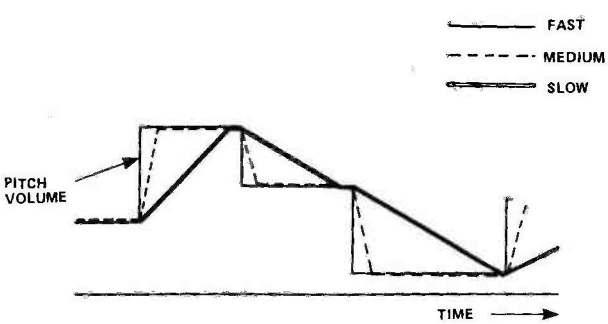


Fig.3 The effect of variable slew limiting (portamento) on pitch voltage.

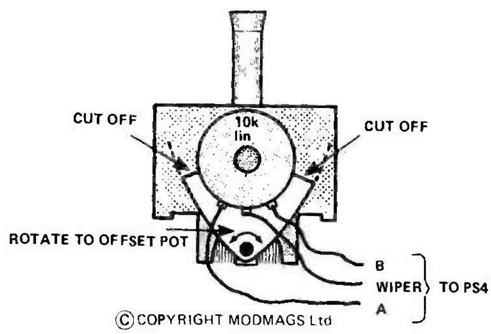


Fig.4 Mechanical details of the joystick pitch bend control.

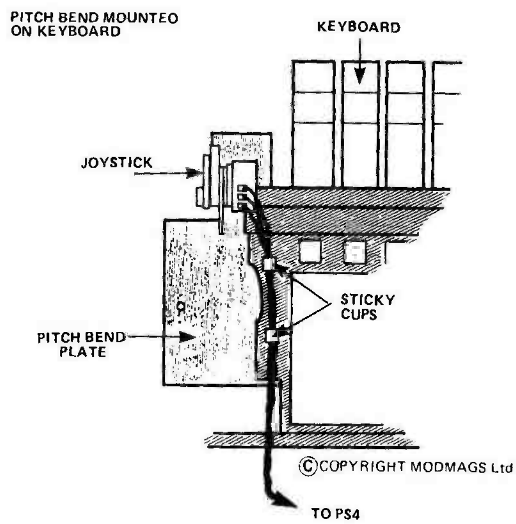


Fig.5 Mounting the joystick pitch bend control (RV33) on the end of the keyboard.

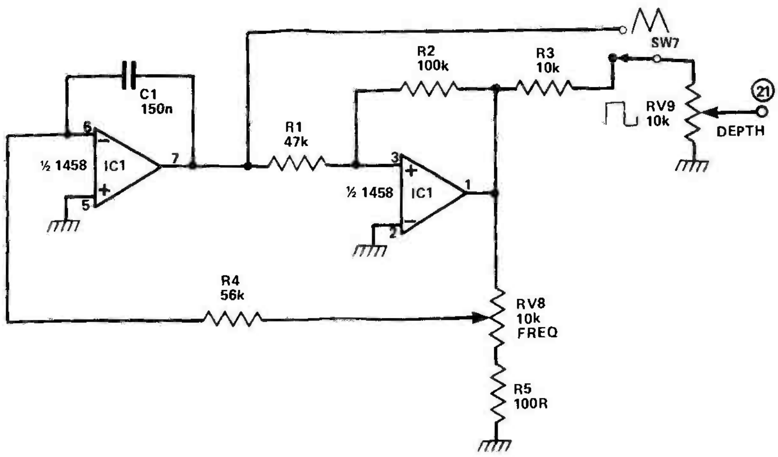


Fig.6 (left) Circuit diagram of the vibrato oscillator on Control Board PS5 (0.5 Hz — 50 Hz).

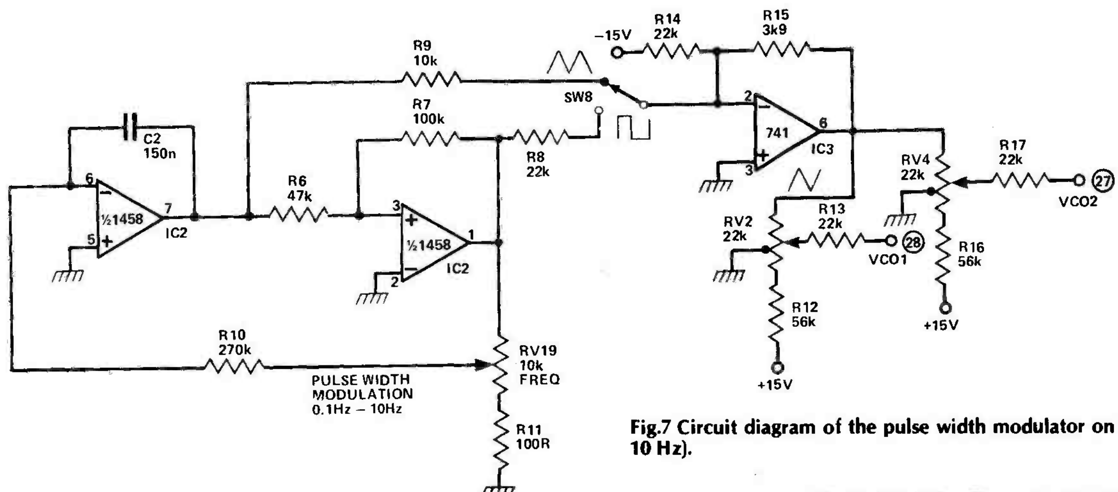
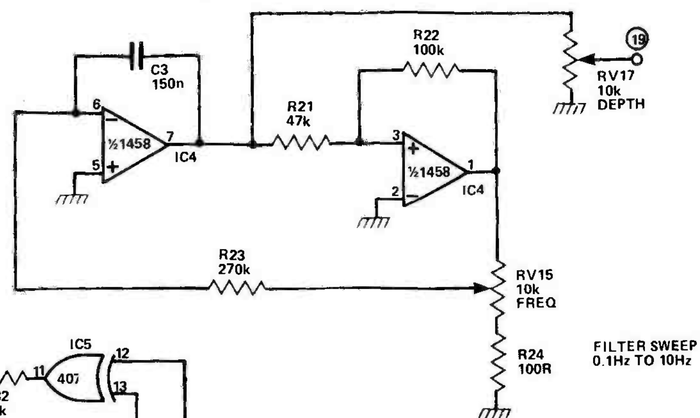


Fig.7 Circuit diagram of the pulse width modulator on PS5 (0.1 Hz — 10 Hz).

Fig.8 (right) Filter sweep circuit on PS5 (0.1 Hz — 10 Hz).



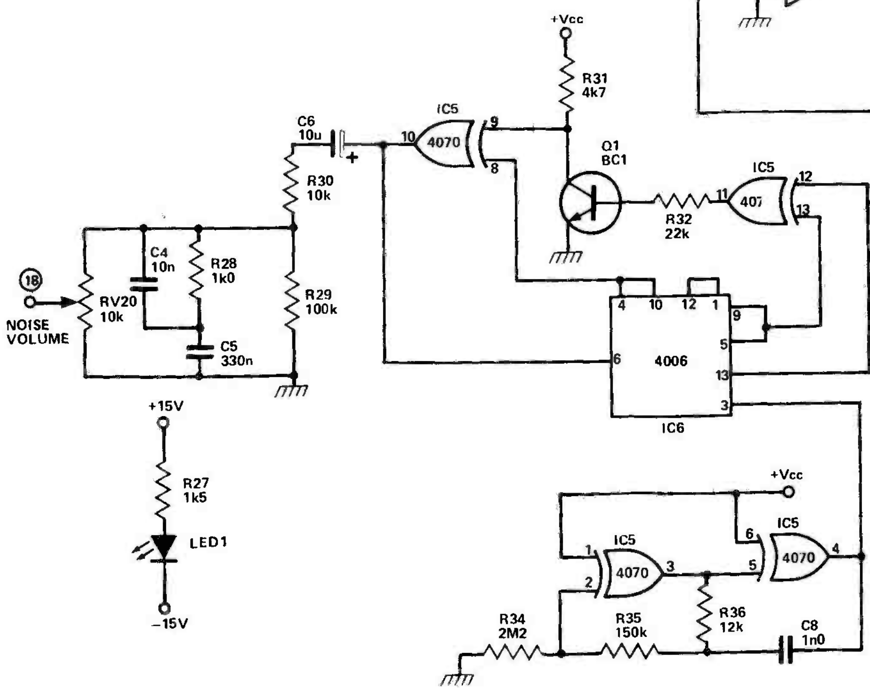
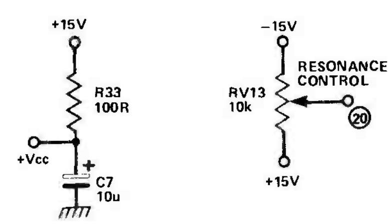
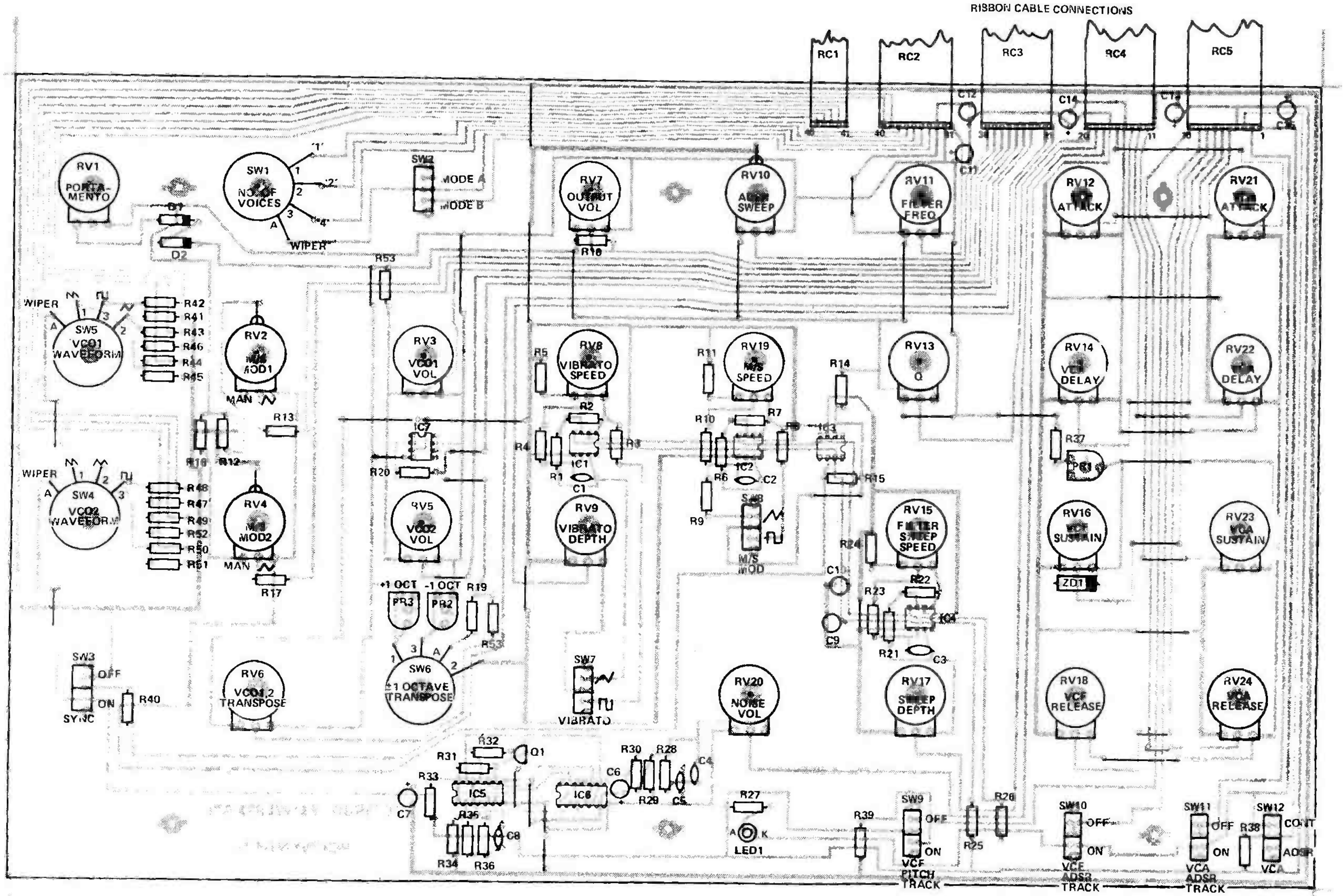


Fig.9 (left and below) Noise volume and resonance control networks on PS5.





RIBBON CABLE CONNECTIONS

1	–15v
2	ADSR TRACK VCA
3	ADSR CONT VCA
4	+15V
5	A } VCF
6	D
7	S
8	R
9	PITCH TRACK VCF ADSR
10	PITCH TRACK VCF
11	GND
12	R } VCA
13	S
14	D
15	–15V
16	A–VCA
17	GND
18	NOISE
19	VCF SWEEP ∿
20	Q
21	VIBRATO
22	SYNC
23	N/C
24	TRANSPOSE
25	VCO2 VOL
26	VCO1 VOL
27	VCO2 M/S MOD
28	VCO1 M/S MOD
29	MASTER VOL
30	VCF ADSR SWEEP
31	VCF FREQ
32	+15V
33	–15V
34	NEW NOTE
35	DIG 0V
36	VOICE4
37	VOICE2
38	VOICE1
39	VCO2
40	VCO2
41	VCO2
42	VCO1
43	VCO1
44	VCO1
45	PORTAMENTO

Fig.10 Component overlay of control board PS5.

PARTS LIST : PS5

Resistors all ¼ W 5% unless otherwise stated	
R1,6,21,39	47k
R2,7,22,29,38,40-52	100k
R3,9,30	10k
R4,12,16	56k
R5,11,24,33	100R
R8,13,14,17,32	22k
R10,23	270k
R15	3k9
R18,31	4k7
R19	100k 2% metal oxide
R20	10k 2% metal oxide
R25,26,53	47R
R27	1k5
R28	1k0
R34	2M2
R35	150k
R36	12k
R37	6k8
Potentiometers	
RV1,8,15,19,20	10k logarithmic
RV2,4,10	22k linear with central click and central tapping
RV3,6,5,7,9,11,13, 16,17,23	10k linear
RV12,14,18,21,22,24	4k7 linear
PR1	10k preset
PR2,3	10k cermet preset
Capacitors	
C1,2,3	150n polycarbonate
C4	10n polycarbonate
C5	330n polycarbonate
C6,7,9,10-15	10u 16 V tantalum
C8	1n0 polycarbonate
Semiconductors	
IC1,2,4	1458
IC3,7	741
IC5	4070B
IC6	4006B
Q1	BC182L
D1,2	1N4148
ZD1	5V1
LED1	0.2" green
Switches	
SW1	3-pole 4-way rotary
SW2,3,7,8,9,10,11,12	Single-pole double-throw slide
SW4,5,6	4-pole 3-way rotary
Miscellaneous	
PCB PS5, connectors, self-adhesive clips	

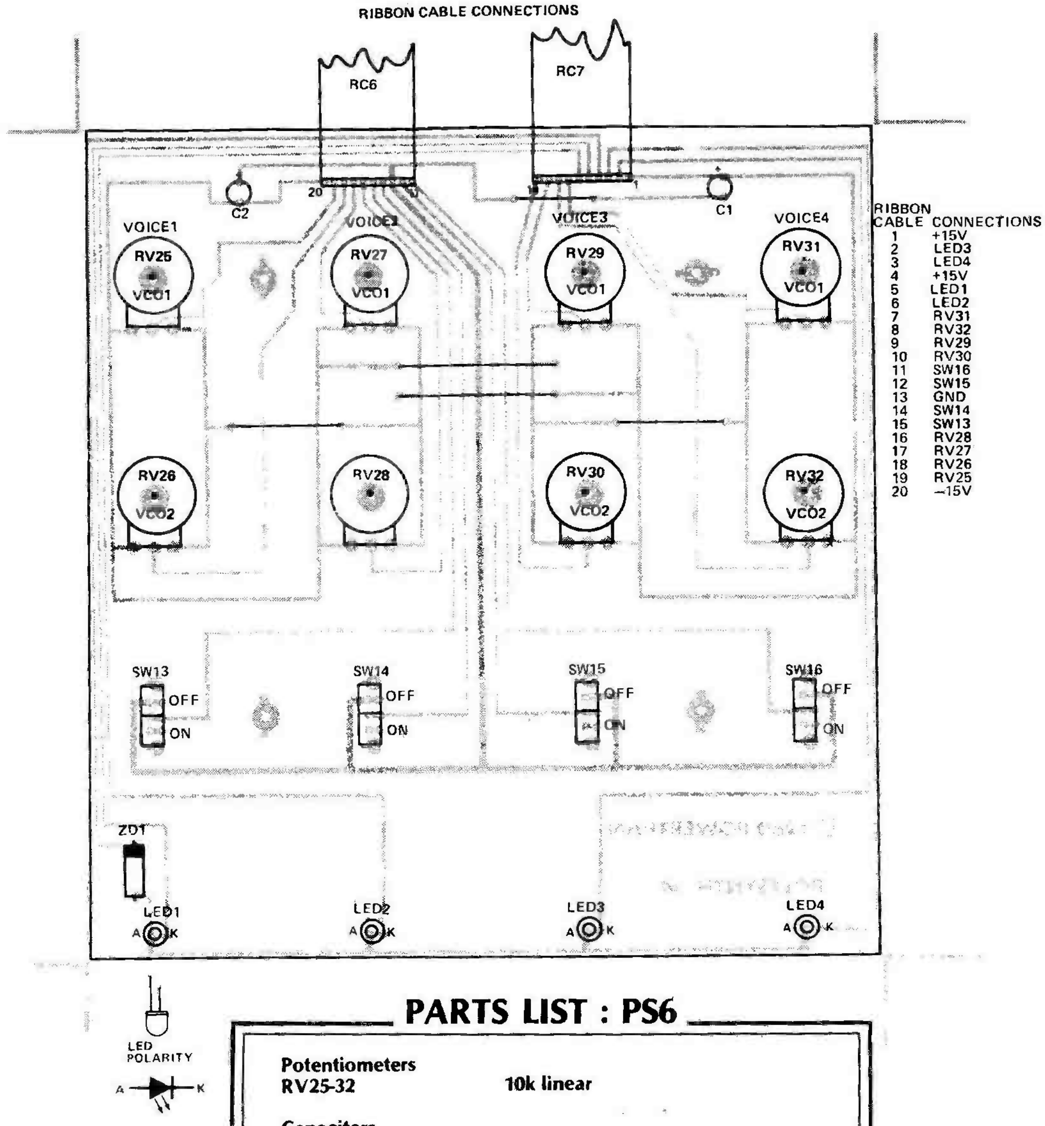


Fig.11 Component overlay of control board PS6.

PARTS LIST : PS6

Potentiometers	
RV25-32	10k linear
Capacitors	
C1,2	10u 16 V tantalum
Semiconductors	
ZD1	10 V
LED1-4	0.2" red
Switches	
SW13-16	Single-pole double-throw slide
Miscellaneous	
PCB PS6, ribbon cable connectors, self-adhesive cable clamps	

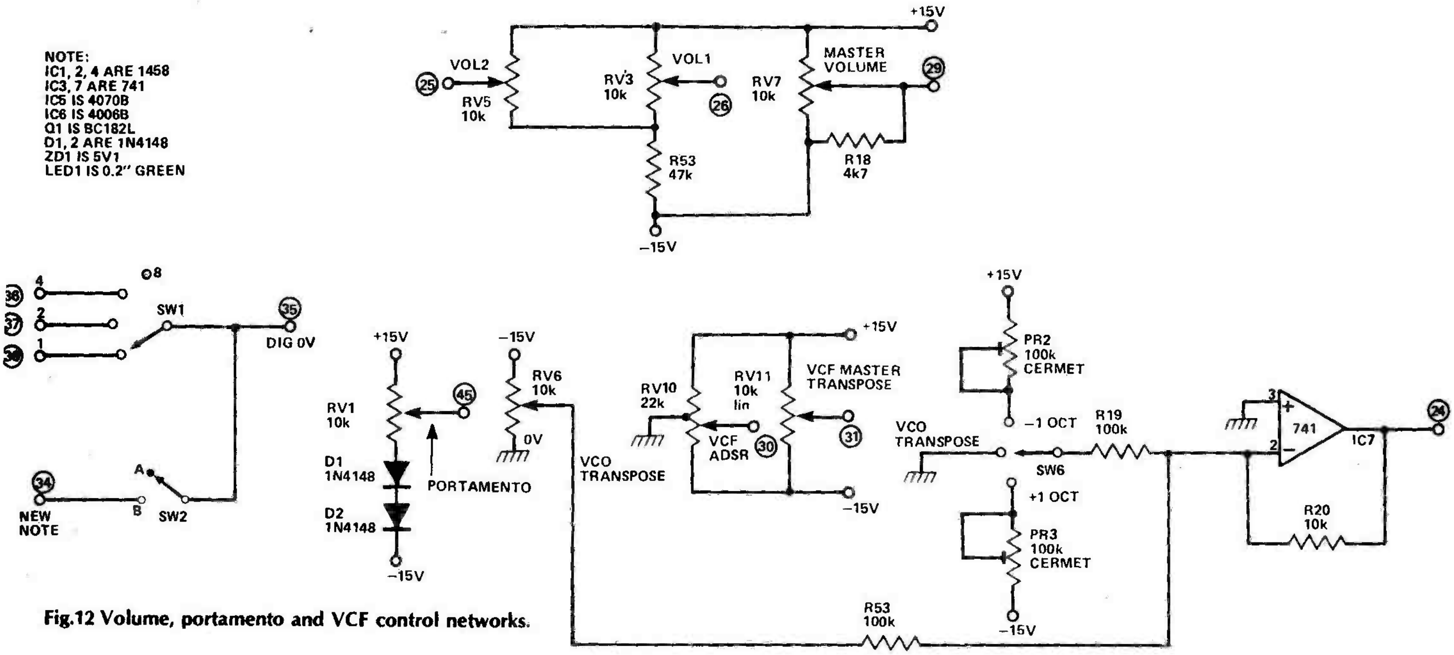


Fig.12 Volume, portamento and VCF control networks.

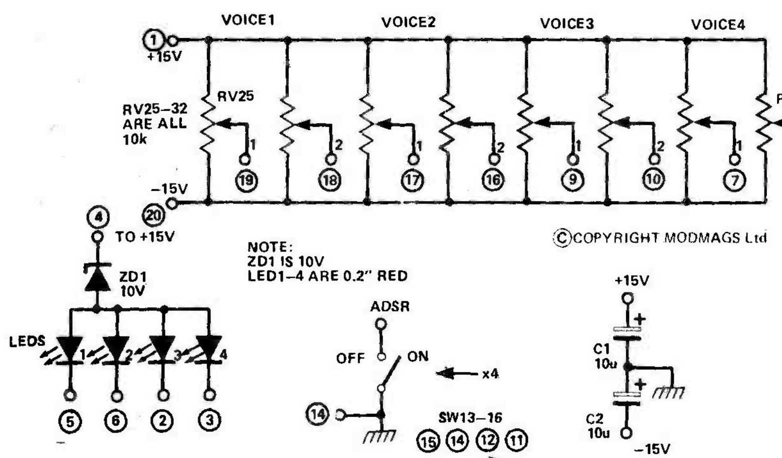


Fig.13 RV25 to RV32 are the VCO1,2 controls on control board PS6.

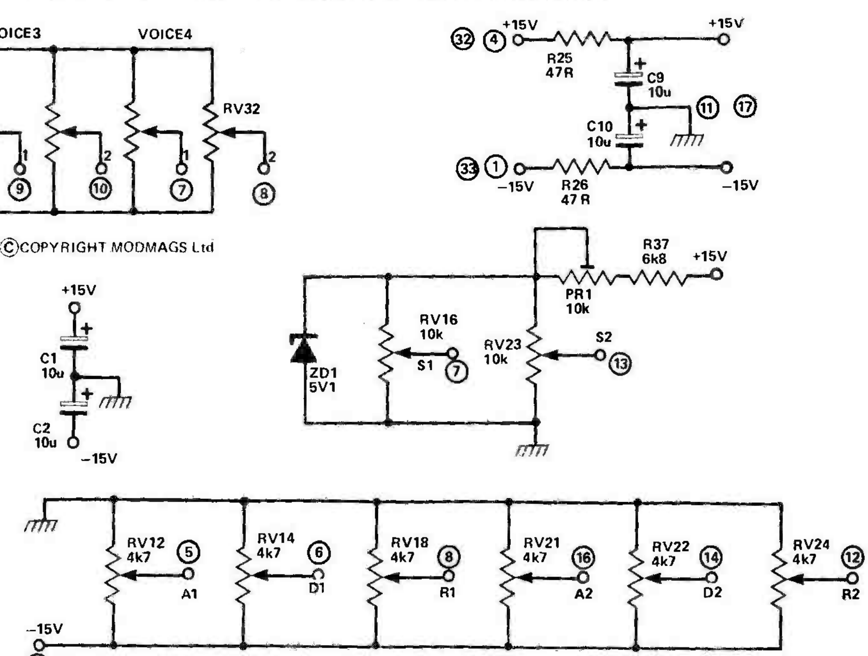
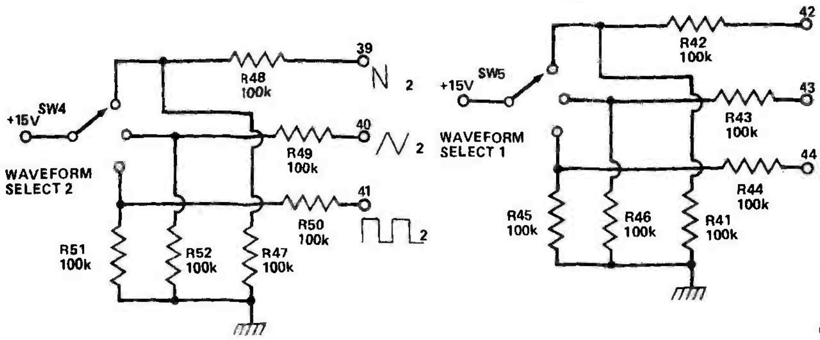


Fig.14 ADSR networks on PS5.



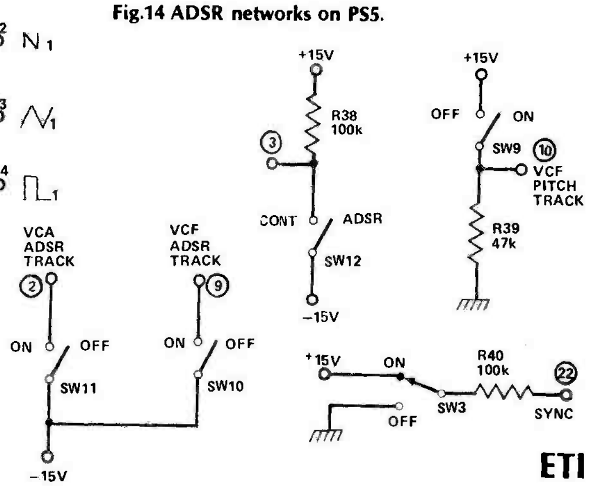


Fig.15 Waveform select networks for VCO1,2.

Next month: The Polysynth continues with constructional details of the voice boards.

ETI

SLR ELECTRONICS

The humble 35 mm SLR camera has changed a great deal in recent years. Ian Graham investigates one aspect of electronics in photography, the development of camera electronics.

The point and shoot' phenomenon was for many years associated with cheaper non-reflex cameras, designed to be idiotproof, with ease of film loading and exposure in mind. Now, however, most manufacturers have at least one automatic SLR (single lens reflex) model in their range.

The 35 mm SLR is the most popular and versatile camera type in use today. It's versatile, because a typical SLR offers a range of interchangeable lenses and matched add-ons — motor-drive, power winder, electronic flash, bulk film pack, databack, etc. Further, because the viewfinder shows the image seen through the lens, the effect of any lens can be seen immediately — the photographer sees what the film 'sees'.

Meter Manual

In a manual TTL (through the lens) meter, light passes through the lens and is reflected by a mirror up to a prism at the top of the camera and out through the viewfinder eyepiece. Photocells mounted on the prism measure the brightness of the incoming light. Film speed and, typically, shutter speed are preset by the photographer. Adjusting the aperture of the lens causes a needle visible in the viewfinder to move towards a + (over exposure) or a − (under exposure). When the needle is central, the film will be exposed correctly when the shutter release is pressed.

However, this system cannot be used to operate an automatic system. It's easy to see why. You switch on the meter and compose your picture. The automatic meter selects the appropriate shutter speed (in an aperture priority system). When you press the shutter release, the mirror up, it is not seeing the view through the lens any more. The end result is a wrongly exposed film. The answer is to provide some means of storing or remembering the meter measurement during the exposure. One method involves the use of a capacitor to store the meter control voltage.

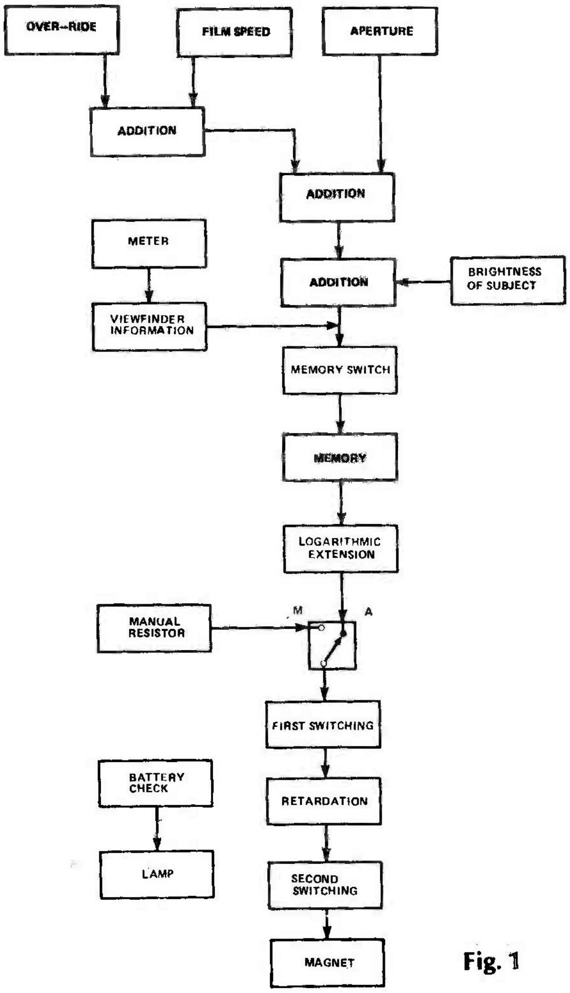


Fig. 1

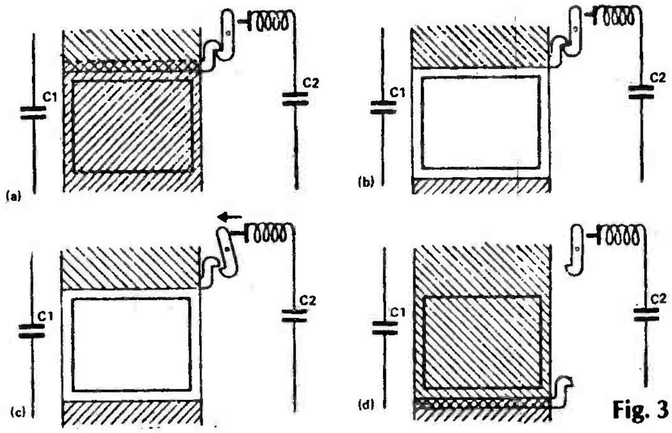


Fig. 3

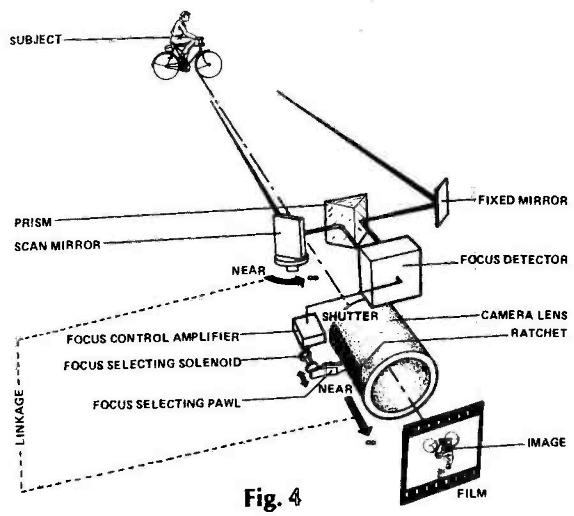


Fig. 4

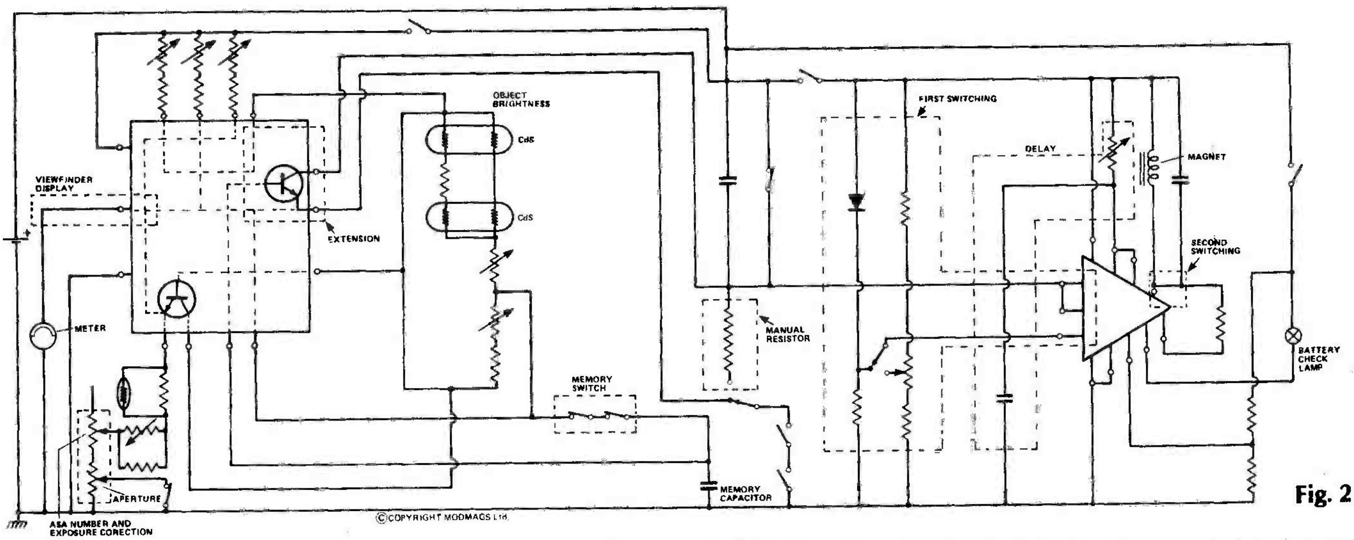


Fig. 2

Fig. 1 Block diagram of the manual/automatic exposure control employed by the Minolta XE-1.

Fig. 2 Circuit diagram of the exposure control system used by the Minolta XE-1.

Fig. 3 Mamiya's moving coil electronic shutter consumes a tenth the power of electromagnetic systems. In addition, the consumption remains constant whatever the shutter speed. Up to 100,000 exposures can be made with one 6 V silver oxide cell. (a) The shutter is closed. The moving coil energising capacitor (C2) is normally charged. Current is not flowing. (b) The first blind moves, opening the shutter when the shutter release button is pressed. The exposure time control capacitor (C1) begins to charge. The latch holds back the second blind. The charge time of C1 is determined by the shutter speed. (c) The instant of exposure. When C1 reaches a preset voltage, C2 discharges, energising the moving coil. This releases the second blind. (d) The second shutter blind moves, closing the shutter. C2 charges in a very short time, consuming very little power — ready for the next exposure.

Fig. 4 Konica developed the first self-focusing camera — the C35 AF. Light from the subject passes through two windows on the front of the camera on to two mirrors, one fixed and one moveable. When the shutter release is pressed, the moveable mirror turns until the two images coincide on the focus detector. A focusing control signal is then used to focus the lens correctly — all within 80 mS.

Direct Measurement

The Olympus OM-2 uses TTL metering, but its SBC (Silicon Blue Cell) sensors face the film, and so they measure the light actually reaching the film emulsion during the exposure. This makes the memory device used in other cameras obsolete. The OM-2's system doesn't have to remember its light reading, because the reading is taken during the exposure itself. Its advantage is that it can compensate for changes in light levels after the beginning of the exposure. By eliminating a memory device power consumption is reduced.

Also, in flash photography, the sensors can follow the flash intensity as it increases in fractions of 1/10,000 S and cut off the camera's flash unit when the correct exposure is reached. Of course, a dedicated flash system is needed.

The OM-2 manages to combine centre and average exposure weighting. At high shutter speeds (over 1/60 S) the light level reading is taken from the shutter curtain. Its reflective coating pattern produces a centre-weighted reading. At lower speeds (below 1/15 S) the measurement is made directly from the whole film surface.

Logarithms

The shutter speed settings follow the simple geometric progression 1 S, ½ S, ¼ S, . . . 1/250 S, 1/500S, 1/1000 S. If, for ease of calculation, we start with a meter circuit output of 0V1 and double it for each successive stop on the shutter speed dial, by the time we reach the last speed setting, the output voltage would be:

$$0V1 \times 2^{10} = 102V4$$

Because of the size, weight and expense of batteries, no camera can use a 100 V supply.

The answer is logarithmic compression of the voltage steps, so that the maximum power requirement is given by:

$$0V1 \times 10 = 1\ V$$

In practice, most of the cameras available now derive their supply requirements from a single 6 V silver oxide cell or two 1V5 silver oxide cells.

Metering

One exception is the Konica FS-1, powered by four alkaline-manganese penlight cells. However, the FS-1 is no ordinary camera. It looks much the same as any other, except for the lack of a wind-on lever. It doesn't need one — it has its own built-in power winder, yet the combination is smaller and much lighter than a conventional SLR plus add-on winder.

The four size AA cells power the winder *and* camera electronics. The obvious advantage is that the photographer need carry only one spare set of batteries. Normally camera and winder batteries are not interchangeable.

Processing

The FS-1 employs a digital CPU (Central Processing Unit) together with support ICs to take care of light measurement, exposure calculation and motor control to provide total electronic control. The tiny CPU manages to pack in more than 1100 gates and 250 transistors, impossible to fit inside a camera just a few years ago.

Information from the Gallium Arsenide Phosphide photocell about the light level is compared with preset values for film speed and shutter speed to compute the appropriate aperture (f/stop). This analogue value is converted to a digital input for the f/stop register. The aperture information is also displayed in the viewfinder.

The Pentax ME Super *has* a wind-on lever, but no shutter

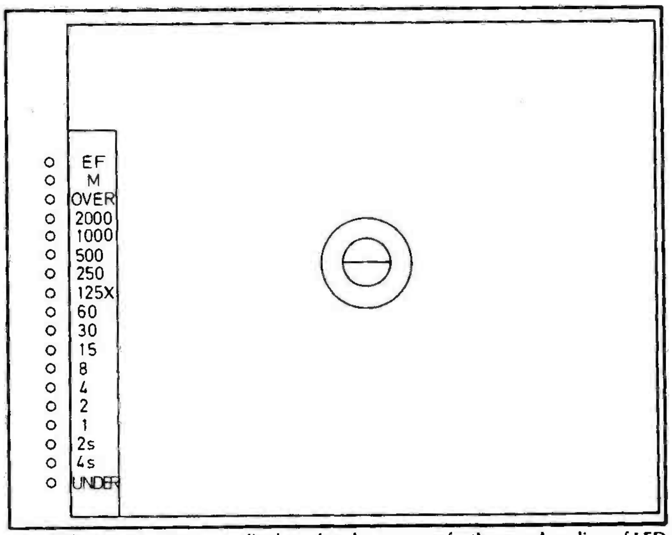


Fig. 5 The Pentax ME Super displays data by means of a three-colour line of LEDs. At 1/60 S and above, the speed selected by the camera will turn on the appropriate green LED. If you see green, it's OK to shoot. If the camera selects 1/30 S or below, the LED lit is yellow, warning you that, although the exposure is correct, there is a danger of blur due to camera shake. At each end of the scale there is a red LED to indicate under or over exposure. If exposure compensation is being used, a red EF LED comes on. Manual operation is similarly shown (green LED).

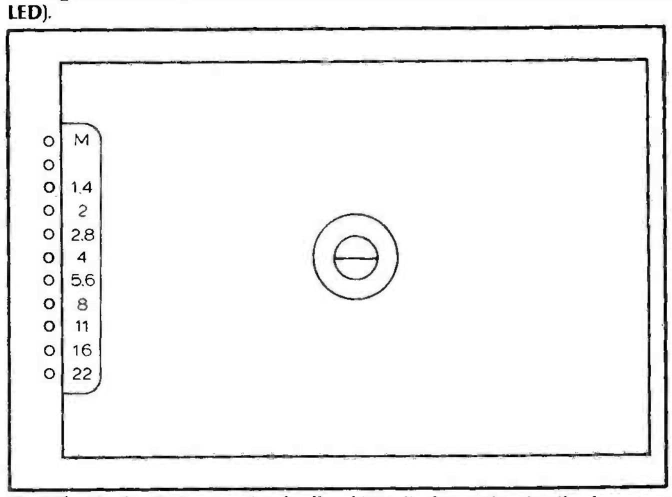


Fig. 6 The Konica FS-1 uses a simple all-red LED display to give details of aperture selected, under/over exposure, battery check, flash ready and manual mode.

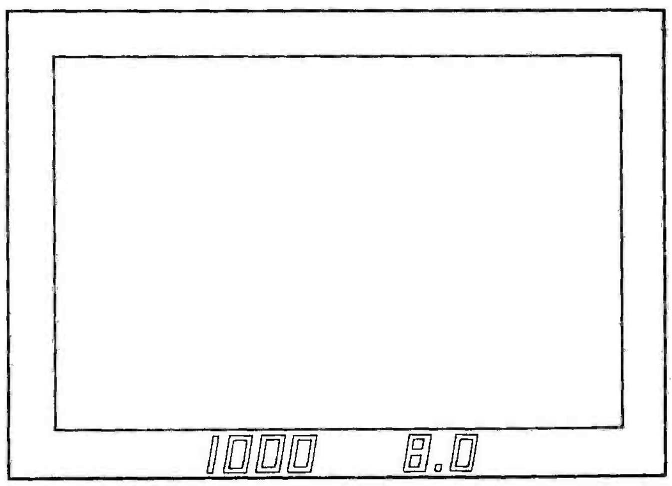


Fig. 7 The Canon A-1's alphanumeric LED display gives the photographer data on just about all the camera's functions — aperture, shutter speed, under/over exposure, flash ready, manual mode, B setting, out of range and operating error. There's even an automatic brightness control to match the display brightness to that of the image in the viewfinder.

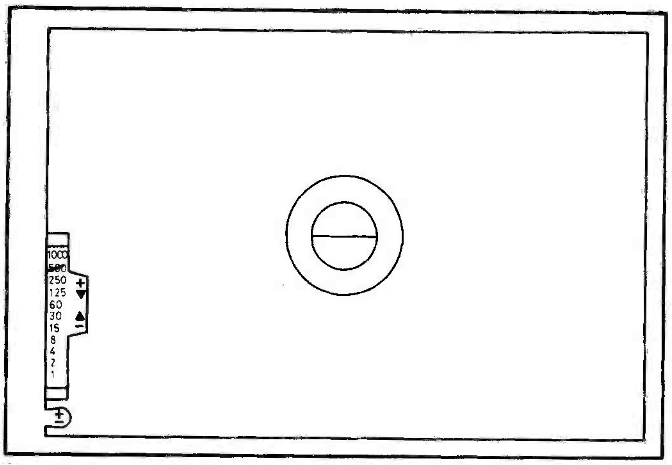


Fig. 8 The Olympus OM-2's bright viewfinder display shows the shutter speed by means of a needle on a scale. Information about under/over exposure, flash ready, exposure compensation, etc is also shown. When you switch to manual, the shutter speed scale disappears and you are left with the conventional needle display described earlier. When the camera is switched off, the viewfinder display disappears completely.

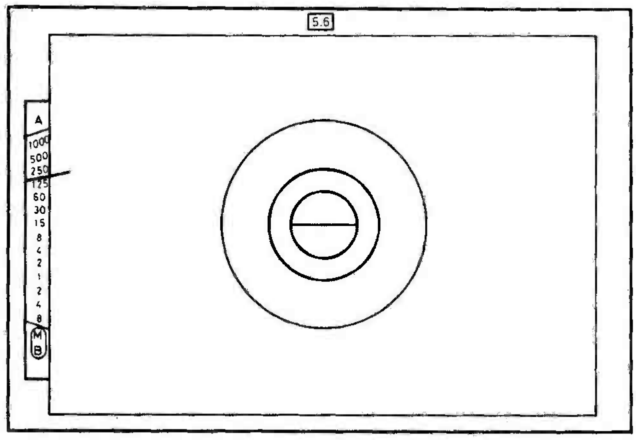


Fig.9 Like the OM-2, the Nikon FE's display of shutter speed is a needle-on-scale type. The Silicon Photodiodes used in the FE are filtered to match the spectral response of the human eye.

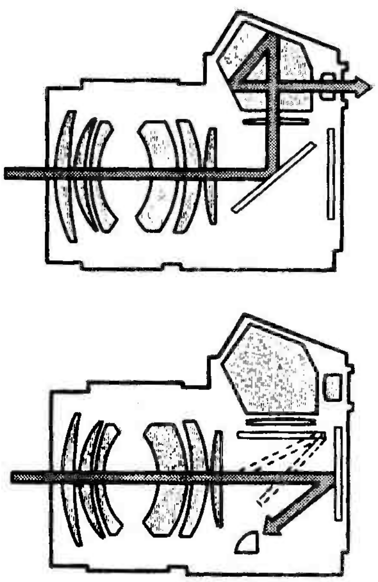


Fig.10 With the mirror in the down position (top), the Nikon FE looks much the same as any other camera, but when the mirror flips up (above) a light reading is taken directly from the film plane.

speed dial. In manual mode, shutter speeds are selected by pressing one of two buttons on the top of the camera — one causes the shutter speed selected to increase one LED at a time, the other causes it to decrease, until the desired speed is reached.

Multi-mode

Up to now I have been describing cameras using either shutter speed priroity or aperture priority. But, it *is* possible to have both. In fact, the Canon A-1 has no less than five automatic programmes:

1. Shutter speed priority — useful for action photography.
2. Aperture priority — useful if you know that your subject is not going to get up and run away.
3. Stopped down — with the meter reading the light entering the lens, accessories which don't couple directly to the camera electronics can be used.
4. Programmed — the camera decides the shutter speed *and* aperture.
5. Flash — using a flashgun which couples directly to the camera electronics, automatic flash photography is possible.

The viewfinder alphanumeric LED display gives a complete run-down on just about everything. The A-1's self-timer allows selection of a 2 S or 10 S delay. As the timer is completely electronic, it can be cancelled at the touch of a button, unlike most mechanical self-timers.

The A-1 and the Nikon FE (an aperture priority model) both have a memory lock facility. Suppose you are photographing your loved one (or wife) against a bright window. Click — and there you have an interesting silhouette. The meter has exposed the film for the bright window, not for the subject.

With the A-1 and FE, you can take a correct exposure reading from the subject's face, turn on the memory lock and take the picture. The meter will 'remember' the correct exposure until the lock is turned off.

Screen Data

The information displayed in the viewfinder and the method of display varies enormously from camera to camera. Some give full alphanumeric data on everything. Others rely on a very simple three-LED system — red, green, red meaning under-exposed, correct and over-exposed (manual TTL system).

Typically, slight pressure on the shutter release button switches the meter on. Some cameras still use an on/off switch mounted on the camera body. If yours does, remember to switch it off! The first-pressure type is foolproof, even with an absent-minded photographer to contend with. Table 1 is a quick guide to a few popular automatic mode 35 mm SLRs, giving details of the camera's electronic systems. It is by no means exhaustive and is not intended to be used as a buyers' guide.

The space available for components and PCBs inside the camera is severely limited. Nowadays the circuitry is commonly mounted on and in flexible, paper-thin, plastic film PCBs, which can be wrapped round the familiar shape of the major features of the camera under the thin metal skin. The flexible tracks greatly reduce the number of flying leads and solder joints necessary. The fewer connections, the less chance there is of a broken wire or a dry joint.

Finally . . .

The microprocessor is only now beginning to make an impression on amateur photography, so the camera is probably at the simple four-function pocket calculator stage. Look what has happened to calculators in a very few years — LCD displays, programmable, sound effects, talking displays, etc. It will be interesting to watch how the designers transfer this kind of technology to cameras. ➡

Table. 1 A comparison of the electronic systems used by some popular 35 mm SLRs with automatic programmes.

Camera	Model	Viewfinder Information	Shutter	Auto Exposure	Meter	Power
Canon	A-1	A-LED Aperture Shutter Speed Manual Override Flash Ready B Setting Over/Under Exposure Out of Range Operating Error	EHC	Aperture Priority Shutter priority Pre-Programmed Stopped Down Flash	TTL SPD Centre-Weighted Full aperture	6 V Silver Oxide Cell
Fujica	AX-5	LED Aperture Exposure Mode Over/Under Exposure Battery Check	EHC	Aperture Priority Shutter Priority Pre-Programmed Stopped Down Flash	TTL SPD Centre-Weighted Full Aperture	6 V Silver Oxide Cell
Konica	FS-1	LED Aperture Flash Ready Over/Under Exposure Manual Override Automatic Mode Battery Check	EVM	Shutter Priority	TTL GaAsP Centre-Weighted Full Aperture	Four Alkaline-Manganese Cells
Minolta	XG9	Exposure LEDs Shutter Speeds	EHC	Aperture Priority	TTL CdS Centre-Weighted Full Aperture	Two 1V5 Silver Oxide Cells
Nikon	FE	Shutter Speed Scale Aperture/Meter Needle	EVM	Aperture Priority	TTL SPD Centre-Weighted Full Aperture	Two 1V5 Silver Oxide Cells
Olympus	OM-2N	Exposure Index (Manual) Shutter Speed (Auto)	EHC	Aperture Priority	TTL SPD + CdS Centre-Weighted Full Aperture	Two 1V5 Silver Oxide Cells
Pentax	ME Super	Aperture Shutter Speeds Exposure LEDs Over/Under Exposure Flash Ready	EVM	Aperture Priority	TTL GPD Centre-Weighted Full Aperture	Two 1V5 Silver Oxide Cells

KEY:

Viewfinder Information	A-LED — alphanumeric LED
Shutter	E — electronic H — horizontal V — vertical C — cloth M — metal
Meter	TTL — Through The Lens SPD — Silicon Photodiode GaAsP — Gallium Arsenide Phosphide CdS — Cadmium Sulphide GPD — Gallium Photodiode

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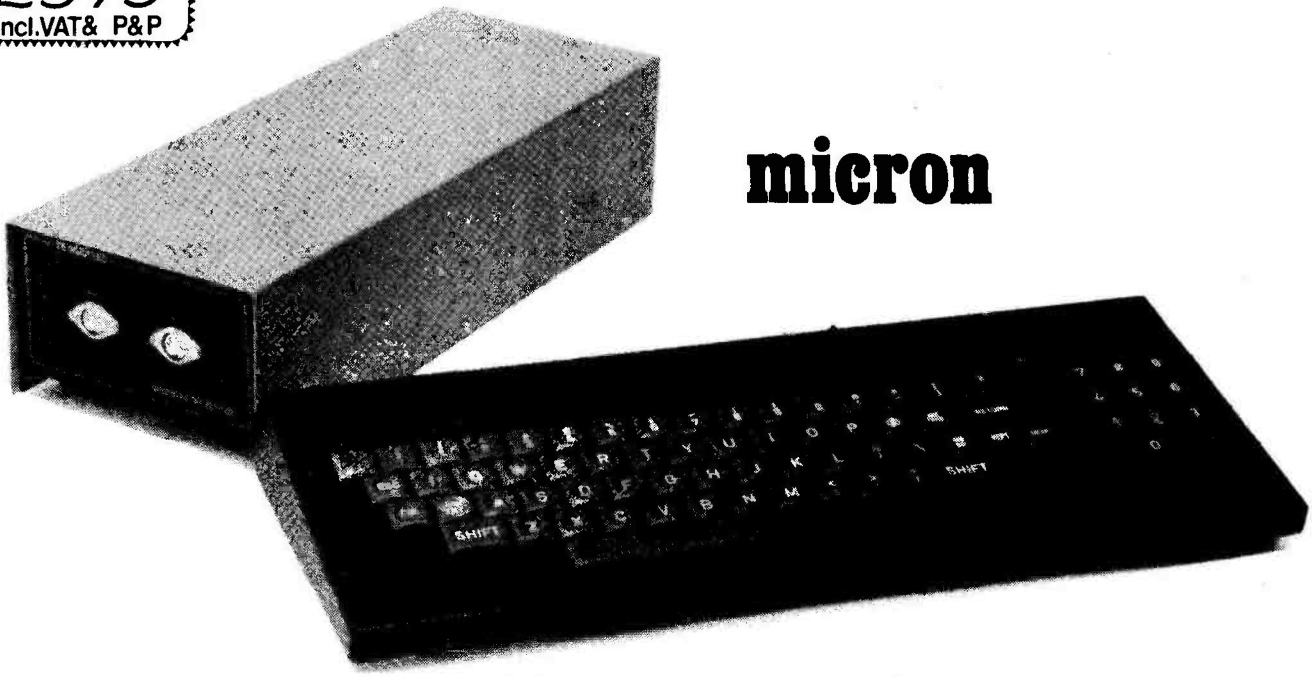

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TECH TIPS

Click Eliminator Auto Threshold

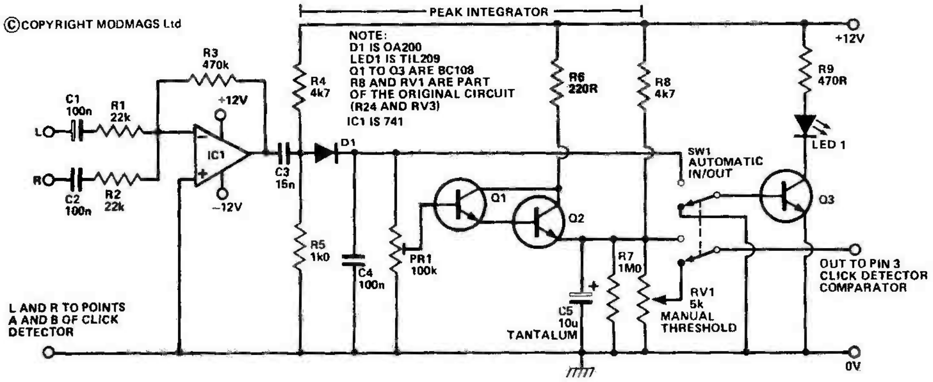
S.P. Cobbold, Cambridge

This circuit is designed to increase the versatility of the 'ETI Click Eliminator'. It automatically adjusts the threshold level for greater sensitivity during extended quiet passages, while reducing the sensitivity during peak transient levels.

The left and right channels are added and amplified by the operational amplifier IC1, which largely cancels the antiphase signals of the click. C1 and C2 decouple any DC offset voltage from the input amplifiers. D1 and C4 hold the peak level of the higher frequency audio signals and pass this to C5 through Q1 and Q2, giving a rise time of approximately 3 mS and a hold time of the order of 5 S. No buffer is required for C5 as the comparator of the click detection circuit has a JFET input. R4 and R5 bias the peak integrating section to give a minimum of approximately 0V5 on C5 when the preset PR1 is adjusted for optimum click detection. This adjustment is best performed using a badly scratched record (borrow a friend's if necessary) and setting PR1 to the point where the loudest click is just removed from a section of loud music.

Q3 and LED1 give a visual indication of operation by changing from dull to bright with the music signal when switched to automatic.

It can be seen from the rise and hold times of the peak integrator that large transients in the middle of a quiet passage (eg a cymbal crash) may cause a single inappropriate click detection before the integrator charges up. Conversely, a series of clicks in very rapid sucession may be ignored. However, I have found these two faults far more acceptable than the severe distortion caused by repeated spurious click detection when unexpectedly high transient levels pass the manually set threshold.



Shop Doorbell

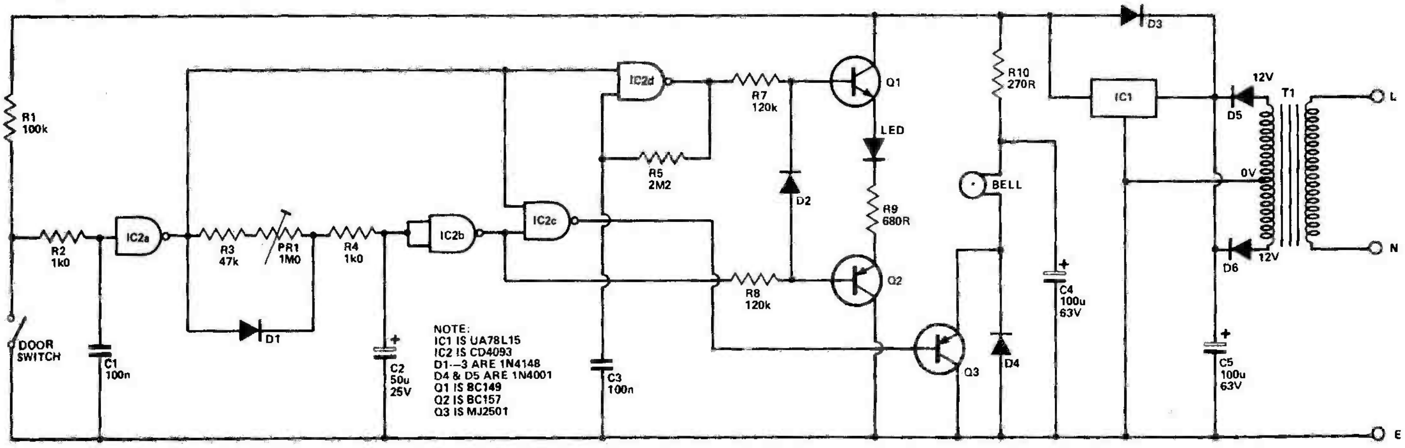
R. Gamester, Chesham

This unit was designed to give a remote indication of a shop door opening. The bell rings once as the door opens and a flashing LED indicates that the door is open. To prevent the unit being repeatedly triggered, a time delay operates from the closing of the door for a period of 20-30 S, during which time the LED is constantly illuminated.

When the door opens, C2 charges quickly through D1 and IC2b turns Q2 on. The oscillator (IC2d) is running and interrupts the LED by switching Q1 on and off.

When the door is closed the oscillator is stopped, leaving Q1 on. This gives a constant indication until C2 discharges through R3, PR1 and R4.

The bell is a standard 3 V vibrator type and is powered by C4, this being discharged through the armature by Q3. IC2c generates the drive pulse, its duration being the charge time of C2.



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Simple Combination Lock

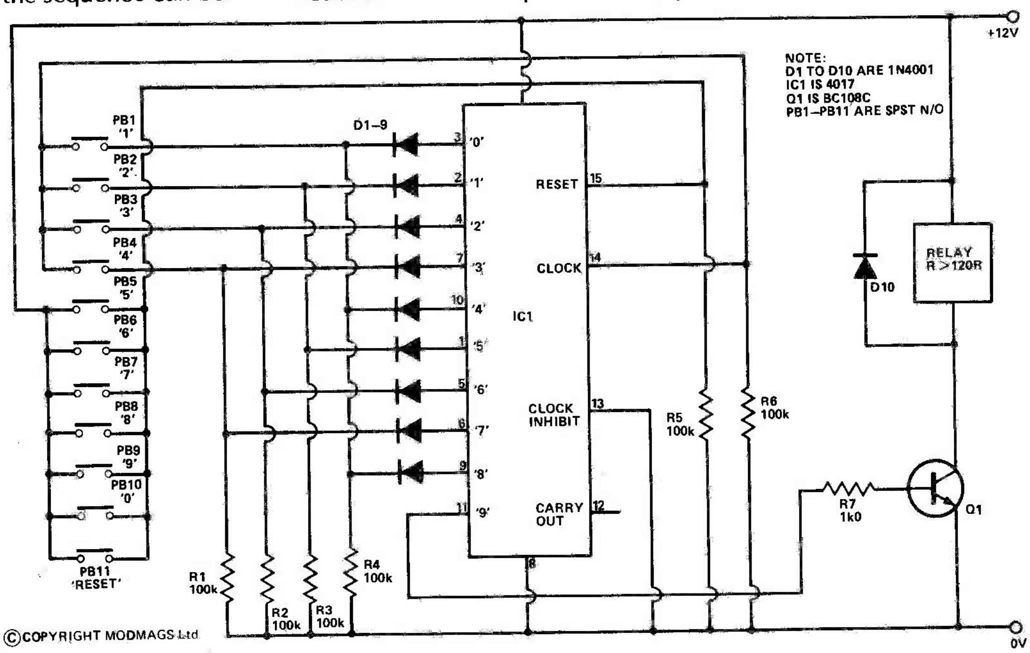
M.D. Chapman, Sale

Although this circuit uses surprisingly few components, the unit provides up to nine code elements and a billion-to-one chance of random operation.

The first nine outputs of the decade counter (IC1) are fed via the diode OR gates (one for every different number used in the code) to the selected switches. As shown on the circuit diagram the combination sequence is 123412341. However, both the numbers and the sequence can be modified by rewiring the output diodes (D1-9) to different switches. To change the number of active code switches (ie. numbers 1234 in this case), you will have to either remove or add to the number of diode OR gates.

Operation is very simple. As the counter sequences through its outputs 0-9 it provides a logic 1 to one of the four diode OR gates, thereby making one of the active switches live. When this live switch is pressed it provides the clock pulse to increment the counter one step. This, then, provides a logic 1 to the next OR gate, making the next digit in the code live, which in turn, when pressed, provides the next clock pulse and so on until the counter reaches its tenth output. Once output nine goes high it turns on Q1, thereby switching the relay and desired load. Since only one of the outputs is high at any one time, only one of the keys will move the counter and, should any dud key (ie. keys 567890 in this case) be pressed, this will reset the counter to zero, making guesswork ineffectual.

When selecting the code sequence, it is worth remembering that in order to maintain a nine element code the effect of switch bounce should be minimised by avoiding the use of any number consecutively, ie. codes such 123343222. However, if necessary, the clock input can be debounced to allow such a sequence.

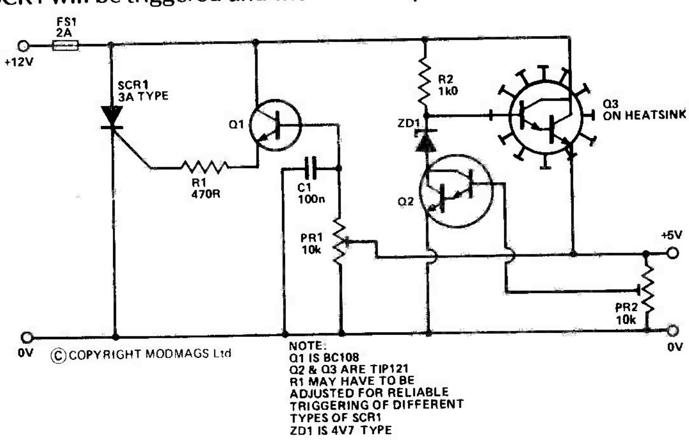


5 V TTL Supply

D. McIntyre, Camberley

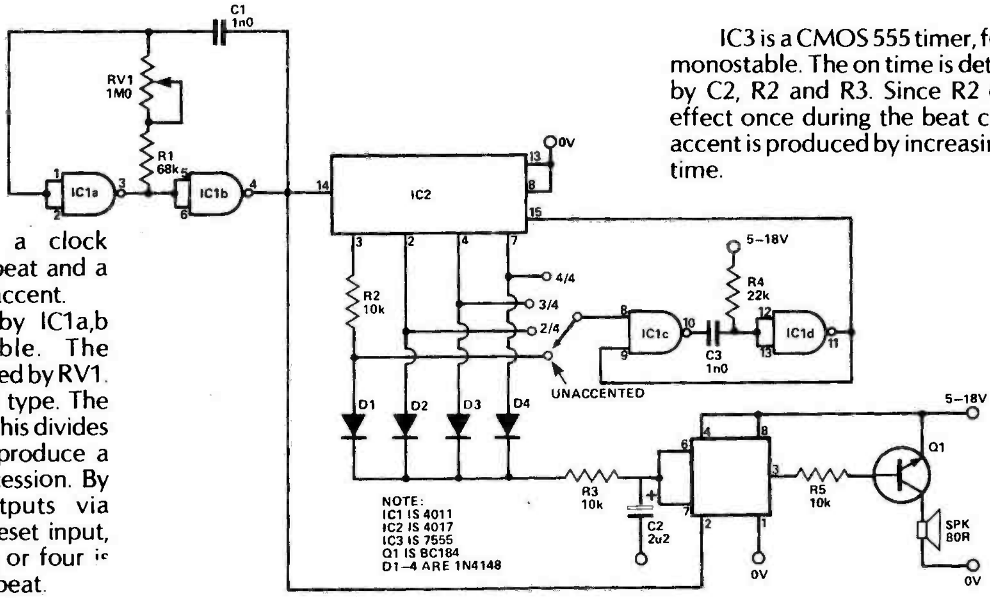
The circuit shown was designed to eliminate expensive accidents with TTL caused by inadvertently turning up the knob on the (heavily smoothed) train controller normally used as a bench PSU. It is provided with crowbar protection just in case, though.

Power Darlington Q3 is biased to just over 5 V by ZD1 and Q2 (this does not have to be a Darlington, although the output will not be as stable if it is not). Any change in output voltage is sensed by Q2 and it adjusts ZD1's reference level accordingly. Any change in input voltage is adjusted by normal zener operation. The output level may be set using PR2 and it will remain fairly stable (±0V5) for a change in input from 8 V to 12 V. If, for some reason, the output voltage should rise above the preset level to, say, 6 V, SCR1 will be triggered and the fuse will blow. This trigger level may be set by PR1. C1 reduces the (extreme) sensitivity to noise. SCR1 is not critical, but it should be capable of sinking the required current.



Accenting Metronome

P. Hill, London



The circuit consists of a clock generator determining the beat and a monostable producing the accent.

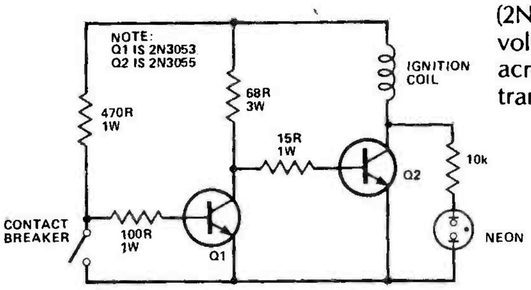
The clock is formed by IC1a,b configured as an astable. The frequency or tempo is adjusted by RV1. C1 must be a non-polarised type. The clock pulses are fed to IC2. This divides and decodes the clock to produce a high at each output in succession. By feeding one of the outputs via monostable IC1c,d to the reset input, division by one, two, three or four is possible, thus selecting the beat.

IC3 is a CMOS 555 timer, forming a monostable. The on time is determined by C2, R2 and R3. Since R2 only has effect once during the beat cycle, the accent is produced by increasing the on time.

Contact Breaker

E. P. Young, Plymouth

The contact breaker carries a mere 25mA when the ignition coil is charging up for the induction of high voltage to produce a spark in the spark plug. Further, without the induced EMF across the CB from the primary winding of the ignition coil, the life of the CB will be greatly increased.



A cheaper power transistor (2N3055) is chosen instead of the high voltage type. A neon bulb is used across collector-emitter to protect the transistor from a high induced EMF.

Simple VCR

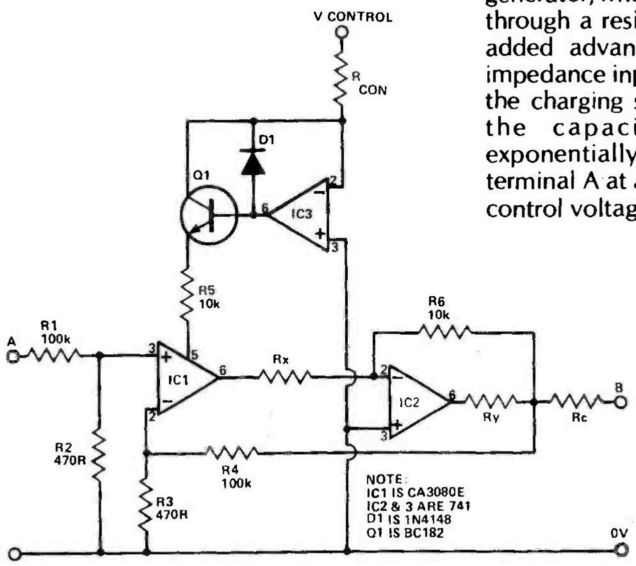
S. Draper, Sudbrooke

This circuit is a simple voltage-controlled resistor, which may be used in a variety of applications (it was originally designed as a portion of a voltage-controlled envelope generator). It has two big advantages over the often-used FET type circuit — a large control range (10,000:1) and a predictable voltage-current characteristic.

The voltage differential between terminals A and B is amplified and converted to a current by OTA IC1, the gain of which is controlled by the current flowing into it at pin 5. The resulting current is fed to current multiplier IC2, which multiplies it by a factor of R_X/R_Y and feeds it to terminal B. This means that the current flowing into or out of terminal B is proportional to the voltage difference between terminals A and B and to the control current generated by voltage-current converter IC3.

The formula for the circuit resistance is as follows:

$$R = \frac{200 R_{CON} R_Y}{19.2 V_{CON} R_X} + R_C$$



This means that with a constant applied voltage, the output current will be proportional to the control voltage and the effective resistance is inversly proportional to same.

In circuits such as an envelope generator, where a capacitor is charged through a resistor, this circuit has the added advantage of having a high impedance input and so does not load the charging source. In this example, the capacitor would charge exponentially to the voltage on terminal A at a rate determined by the control voltage.