electronics today INTERNATIONAL

NOVEMBER 1978

Presenting the ETI TRITON Home Computer

·Single PCB ·Resident BASIC

Inside: computing today no1

THE FIRST ISSUE OF OUR NEW MAGAZINE FOR SMALL SYSTEMS!

Autochord

Venus Probe

Crimson Pre-amp

LCD DFM/Oscillator

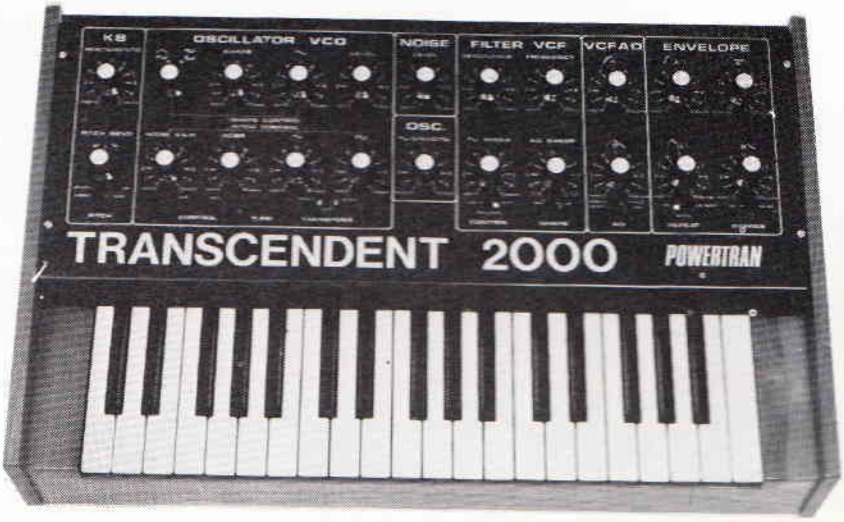
...NEWS.....PROJECTS....MICROPROCESSORS....AUDIO...

TRANSCENDENT 2000
SINGLE BOARD SYNTHESIZER

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

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

The kit includes fully finished metalwork, solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or 1% 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 fibre glass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready built units selling for between £500 and £700!



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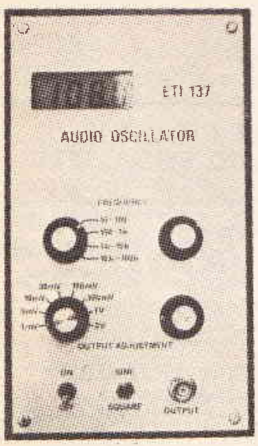
electronics today INTERNATIONAL

NOVEMBER 1978 VOL 7 NO 11

what a display p.16



sine of the times p. 71

FEATURES

PROJECTS

INFORMATION

COMPUTING TODAY: NEW MAGAZINE FOR SMALL SYSTEMS. FIRST ISSUE INSIDE.

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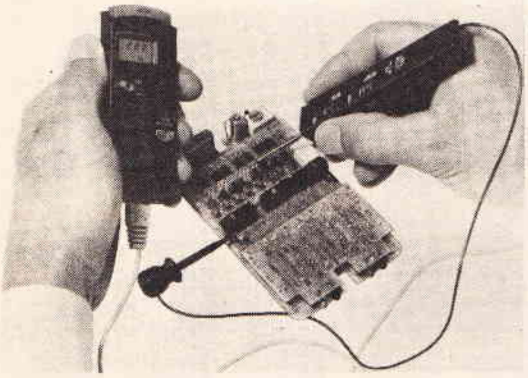
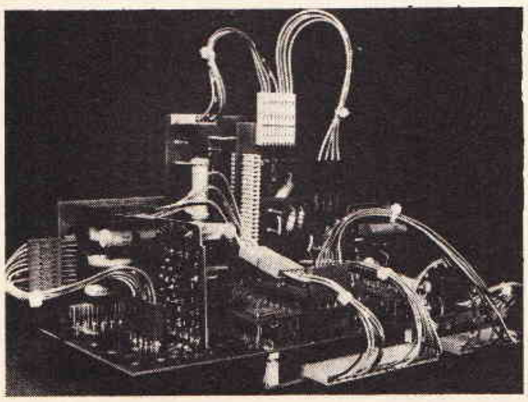
news digest

dmm(digital midget meter?)



Guinness take note – the world's smallest DMM it seems. Made by Heuer Time Ltd it measures just 4" x 1.6" x 0.5" (100 x 40 x 20mm to you Euro-people) with a probe which is 4" x 0.8" x 0.5" (you mm lot can work that out yourselves). Volts Ohms and Amps either DC or AC can be accommodated between 2V-1kV, 2mA-2A and 2k-20M although not necessarily in that order. AC measurement is true RMS. Display is 3½ digit LCD. Input 7 10M + Price around £240. Address: Heuer Ltd, Argyle House, 29/31 Euston Road, London.

the dalek connection



This lot looks like it could give Dr Who a few sleepless nights does it not? It's easy to imagine it lumbering across a smoke-circled hill and intoning "Take me to your leader. . . ."

Perhaps fortunately for the human race it is simply a noteworthy new connection system from Pressac Ltd. The PCB mounting plugs and sockets can be got at from either direction, and cable and chassis mounting assemblies are also available. Spacing can be either 2.5mm or 5.0mm and up to 40 ways are possible.

Pressac Ltd, Acton Grove, Long Easton, Nottingham NG10 1FW.

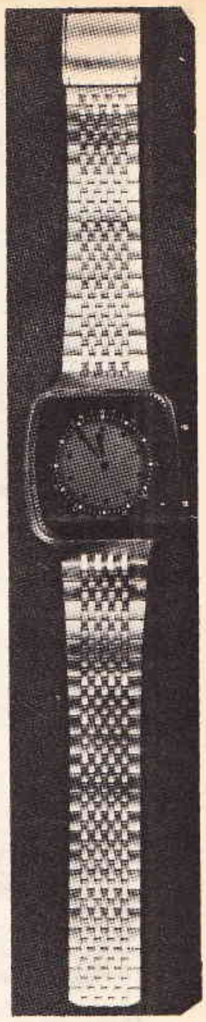
eye of the tornado?

Britain and NATO's new aircraft the MRCA Tornado is to be fitted — in its inceptor role — with a Visual Augmentation System developed by Marconi. The system presents the crew with a television picture of what lies ahead of their machine using a newly-developed low-light TV camera system.

Based on an existing Marconi design for a low light camera, the equipment produces an image at ranges far in excess of what the unaided eye can manage, and in light conditions anywhere from daylight to starlight.

Every little helps. . . .

on the face of it



It had to come. Someone somewhere had to go produce an ANALOGUE digital watch. And here we have it. Must confess it looks very nice too. Texas get the credit/blame or whatever.

The display is beautiful. 120 segments are used to produce the illusion of the dial. On normal LCD's up to half the area is used for contacts to the segments, which would mean that with 121 contacts to provide the display would have to be pretty big – a clock yes, but no watch. Texas have gotten this by multiplexing the drive to the segments, which allows 90% of the area to be freed for usage.

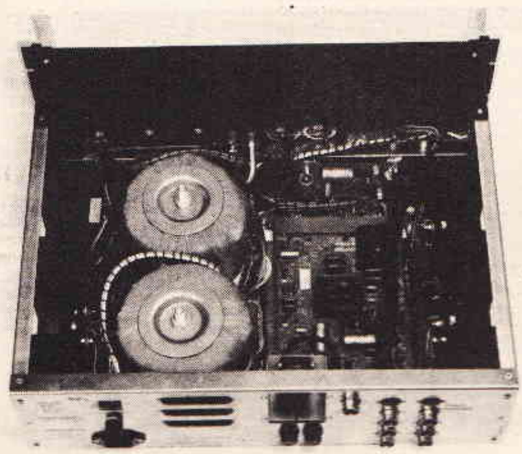
The chip is I^2L — and this is unusual. I^2L is not normally employed in LCD units because of the problem of driving the highly capacitive elements. Bipolar drivers are used to avoid this, and are designed to drive the large capacitance with a (relatively) large $150\mu A$ initial current for about 100 μS and to provide the 100 nA 'sustan' current thereafter.

Another interesting point is that the material used for the display, a low voltage ester material would not usually be employed in watches because of its negative temp. Coeff. — higher the temp. the lower the drive required — which can lead to 'ghosting' and confusion of the display. The I^2L however can compensate for this.

Naturally, since this is the first of its kind, the price of all this invention will be high initially — but the watch will function as a chronograph too and the Jones's will NEVER be able to keep up with this.

In the shops soon we hear.

watt batteries



Here is an amp to really annoy the neighbours with. If they complain about the hi-fi again, pack up the battery cassette recorder, speakers and this PAC 250 MB, drive around the back of the house and when they're least expecting it give 'em 250W a channel straight in the back door. An outflanking move to warm Napoleon's heart.

The PAC 250 you see will run quite happily from 24V DC or 250V AC. Very handy for PA as well as neighbour baiting.

Details from: Millbank Electronics Ltd, Uckfield, Sussex TB22 1PS.

Sound of safety?

A car alarm which operates on the ultrasonic area protection principle usually employed in houses is now being imported from the land of pasta and pinched bottoms.

Called the 'Break' it uses four sensors to cover the interior of any vehicle, and has adjustable sensitivity so that spurious triggering can be avoided. Once activated you have 40 secs to clear out before it goes off — so don't get stuck in the seat belt — and coming back in 10 secs to swtich it off.

Once the alarm is in mid sing-song, the removal of the felon will lead to a shutdown 15 secs later. If he persists so will the alarm. Price around £50 — not including ear plugs — from:
Sofare Ltd, Stoke Heath, Market Drayton, Shropshire.

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POLYESTER CAPACITORS: Axial lead type. (Values are in µF). **400V:** 0.001, 0.0015, 0.0022, 0.0033 **7p;** 0.0047, 0.0068, 0.01, 0.015, 0.018 **9p;** 0.022, 0.033, **10p;** 0.047, 0.068 **14p;** 0.1, **15p;** 0.15, 0.22, **22p;** 0.33, 0.47 **39p;** 0.68 **45p.** **160V:** 0.039, 0.15, 0.22 **11p;** 0.33, 0.47 **19p;** 0.68, 1.0 **22p;** 1.5 **29p;** 2.2 **32p;** 4.7 **36p.** **DUBILIER: 1000V:** 0.01, 0.015 **20p;** 0.022 **22p;** 0.047 **26p;** 0.1 **38p;** 0.47 **48p.**

POLYESTER RADIAL LEAD (Values in µF) **250V:** 0.01, 0.015, 0.022, 0.027 **5p;** 0.033, 0.047, 0.068, 0.1 **7p;** 0.15 **11p;** 0.22, 0.33 **13p;** 0.47 **15p;** 0.68 **18p;** 1.0 **24p;** 1.5 **27p;** 2.2 **31p.**

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

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF). **63V:** 0.47, 1.0, 1.5, 2.2, 2.5, 3.3, 4.7, 6.8, 8, 10, 15, 22, **8p;** 47, 32, 50, **11p;** 63, 100, **27p; 50V:** 100, **7p;** 50, 100, 220, **25p;** 470, **50p;** 1000, 2200, **68p; 40V:** 22, 33, **7p;** 100, **11p;** 3300, **62p;** 4700, **64p; 35V:** 10, 33, **7p;** 330, 470, **32p;** 1000, **49p; 25V:** 10, 22, 47, **6p;** 80, 100, 160, **8p;** 220, 250, **13p;** 470, 640, **25p;** 1000, **27p;** 1500, **30p;** 2000, **34p;** 3300, **58p;** 4700, **64p; 16V:** 10, 40, 47, 68, **7p;** 100, 125, **8p;** 470, **16p;** 1000, 1500, **20p;** 2200, **34p; 10V:** 4, 100, **6p;** 640, **10p;** 1000, **14p.** **TAG-END TYPE: 70V:** 2000, **98p;** 4700, **121p; 50V:** 10,000, **255p;** 3000, **75p; 40V:** 4000 **70p;** 2500, **65p; 25V:** 4700, **48p;** 2000, **37p; 40V:** 15,000 **450p. 325V:** 200+100+50+100 **190p.**

TANTALUM BEAD CAPACITORS
35V: 0.1µF, 0.22, 0.33, 0.47, 0.68, 1.0, 2.2µF, 3.3, 4.7, 6.8 **25V:** 1.5, 10 **20V:** 1.5 **16V:** 10µF **13p** each, 22 **25p.** 47µF, 100 **40p.**
10V: 22µF, 33, 47 **6V:** 47, 68, 100. **3V:** 68, 100µF **20p** each.

MYLAR FILM CAPACITORS
100V: 0.001, 0.002, 0.005, 0.01µF **5p**
0.015, 0.02, 0.04, 0.05, 0.056µF **7p**
0.1µF, 0.15, 0.2 **9p. 50V:** 0.47µF **11p**

CERAMIC CAPACITORS 50V
Range: 0.5pF to 10,000pF **3p**
0.015µF, 0.022µF, 0.033µF **4p**
0.047µF **4p.** 0.1µF **6p.**

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 **9p** each
250, 300, 330, 360, 390, 600, 820 **16p** each
1000, 1800, 2000, 2200 **20p** each

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

CERAMIC TRIMMER CAPACITORS
2-7pF; 4-15pF; 6-25pF, 8-30pF **20p**

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

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0.25W log and linear values 60mm
5KΩ-500KΩ single gang **70p**
10KΩ-500KΩ dual gang **80p**
Self Stick Graduated Bezels **22p**

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½W	2.2Ω-4.7M	E12	2p	1.5p
1W	2.2Ω-10M	E12	5p	4p
2% Metal Film	10Ω-1MΩ		6p	4p
1% 0.5W	51Ω-1M	E24	10p	7p

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	p
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AA15	15
CRO33	157
BY100	24
BY126	14
BY127	14
OA9	75
OA47	12
OA70	12
OA79	12
OA81	15
OA85	12
OA90	6
OA91	6
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
IN4001/2★	5
IN4003★	6
IN4004/5★	6
IN4006/7★	7
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3A/400V★	20
3A/600V★	27
3A/1000V★	30
6A/600V	50

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BB104 **40**
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BB106 **40**

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3A400V **55**
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6A500V **85**
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8A400V **75**
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15A400V **165**
16A400V **185**
16A500V **210**
40669 **95**

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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/200V	75
4A/400V	79
4A/600V	105
4A/800V	120
6A/100V	73
6A/200V	75
6A/400V	85
BY164	56
VM18 DIL	40

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Range 2V7 to 39V 400mW **9p each**
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1A100V	42
1A200V	47
1A400V	52
1A600V	70
3A50V	38
3A100V	43
3A200V	60
3A400V	110
3A600V	120
5A400V	120
7A400V	125
8A400V	150
BT106	150
C106D	55
TIC44	25
TIC45	45
2N4444	140

DIAC★
ST2 **25**

TRANSISTORS

Type	p
AC107★	23
AC117★	35
AC125★	19
AC126★	19
AC127★	19
AC128★	18
AC141★	24
AC141K★	38
AC142★	24
AC142K★	38
AC176★	18
AC187★	20
AC188★	20
ACY17	35
ACY18	40
ACY19	40
ACY20	40
ACY21	35
ACY22	40
ACY28	40
ACY39	78
ACY41	39
ACY44	39
AD149★	60
AD161★	42
AD162★	42
AF106★	70
AF114★	25
AF115★	25
AF116★	25
AF117★	25
AF118★	55
AF121★	48
AF124★	55
AF125★	35
AF126	55
AF127★	35
AF139★	35
AF178★	70
AF180★	70
AF186★	50
AF239★	42
AFZ11	128
ASY26★	40
ASY27★	45
ASY50★	95
ASY76★	95
ASZ21	60
BC107★	9
BC107B★	10
BC108★	9
BC108B★	12
BC108C★	12
BC109★	9
BC109B★	12
BC109C★	12
BC113	17
BC114	19
BC115	19
BC116	19
BC117	15
BC118	19
BC119★	26
BC134	19
BC135	20
BC136	18
BC137	20
BC140★	28
BC142★	25
BC143★	25
BC147	7
BC147B	10
BC148	7
BC148B	10
BC148C	10
BC149	8
BC149C	10
BC153	14
BC154	14
BC157	10
BC158	11
BC159	11
BC160★	27
BC167A	11
BC168C	12
BC169C	10
BC170	17
BC171	11
BC172	10
BC177★	15
BC178★	14
BC179★	14
BC182	9
BC183	9
BC184	9
BC182L	10
BC183L	10
BC184L	10
BC186	21
BC187★	28
BC212	9
BC212L	10
BC213	9
BC213L	10
BC214	9
BC214K	14
BC214L	10
BC307B	14
BC308	13
BC327	15
BC328	13
BC338	12
BC441★	30
BC461★	30
BC477★	18
BC547	11
BC548	11
BC549C	13
BC557	13
BC558	12
BC559	20
BCY30★	57
BCY34★	75
BCY39★	180
BCY40★	78
BCY42	48
BCY43	75
BCY58	22
BCY59★	22
BCY70★	15
BCY71★	15
BCY72★	16
BCY78★	20
BCZ11	145
BD112	95
BD115★	62
BD121	95
BD123	98
BD124★	115
BD131★	38
BD132★	38
BD133★	43
BD135★	36
BD136★	37
BD137★	36
BD138★	36
BD139★	45
BD140★	50
BD142★	59
BD144★	198
BD145★	198
BD181★	85
BD205★	110
BD378★	65
BD434	42
BD517★	65
BD695A★	75
BD696A★	75
BDY11	220
BDY17★	195
BDY60★	110
BDY61★	165
BF115★	22
BF154★	25
BF158★	29
BF160	30
BF161	60
BF167	25
BF173★	25
BF177★	24
BF178★	25
BF179★	30
BF180★	20
BF181★	30
BF182★	30
BF183★	30
BF184★	30
BF194	10
BF195	10
BF196	10
BF197	10
BF198	18
BF199	18
BF200★	32
BF224A	18
BF244	24
BF244B	30
BF256★	50
BF257★	26
BF258★	30
BF259★	37
BF336	30
BF394	22
BF594	40
BF595	38
BFR39	25
BFR40	25
BFR41	28
BFR79	28
BFR80	28
BFR81	28
BFR98	105
BFX29★	26
BFX81★	130
BFX84★	24
BFX85★	24
BFX86★	28
BFX87★	23
BFX88★	24
BFY18★	50
BFY50★	20
BFY51★	20
BFY52★	20
BFY53★	28
BFY55★	40
BFY64★	40
BFY71★	20
BSX20★	18
BSX26★	75
BSX29★	45
BSX78★	55
BSY95A★	25
BU105★	140
BU205	190
BU208	228
E421	96
E5567	65
MD8001★	158
ME1120	25
ME4102	10
ME6002	14
MJ400★	90
MJ491★	190
MJ2955★	99
MJE340★	45
MJE370★	55
MJE371★	60
MJE520★	45
MJE521★	65
MJE2955★	115
MJE3055★	80
MPF102	30
MPF103	36
MPF104	36
MPF105	36
MPF106	50
MPF107	50
MPS3904	40
MPSA05	24
MPSA06	24
MPSA12	42
MPSA55	24
MPSA56	24
MPSA70	34
MPSU02	58
MPSU05	48
MPSU06	54
MPSU52	65
MPSU55	53
MPSU56	56
MPU131★	39
OC23★	150
OC25★	120
OC26★	150
OC28★	99
OC29★	160
OC35★	80
OC36★	99
OC41★	48
OC42★	32
OC43★	55
OC44★	31
OC45★	20
OC46★	28
OC70★	19
OC71★	25
OC72★	30
OC74★	45
OC75★	45
OC76★	36
OC77★	76
OC79★	76
OC81D★	28
OC82D★	48
OC83★	48
OC84★	44
OC122★	48
OC123★	48
OC139★	85
OC140★	85
OC141★	85
OC170★	40
OC171★	40
OC200★	48
OC201★	75
OC203★	85
OC204★	85
SJE5039★	95
TIP29	43
TIP29A	44
TIP29B	56
TIP29C	60
TIP30	47
TIP30A	47
TIP30B	64
TIP30C	65
TIP31★	40
TIP31A★	40
TIP31B★	40
TIP31C★	66
TIP32★	49
TIP32A★	70
TIP32B★	70
TIP32C★	70
TIP33★	80
TIP33A★	80
TIP33B★	100
TIP33C★	105
TIP34★	85
TIP34A★	85
TIP34B★	110
TIP34C★	110
TIP35★	219
TIP35A	225
TIP35B★	240
TIP35C★	270
TIP36★	260
TIP36A★	265
TIP36B★	300
TIP36C★	325
TIP41A★	63
TIP41B★	73
TIP42A★	64
TIP42B★	82
TIP2955★	63
TIP3055★	51
TIS43	36
TIS44	45
TIS45	45
TIS46	45
TIS47	50
TIS48	50
TIS49	50
TIS50	47
TIS74	47
TIS90	18
TIS91	22
ZTX107	11
ZTX108	11
ZTX109	11
ZTX212	28
ZTX300	13
ZTX301	16
ZTX302	18
ZTX303	21
ZTX304	24
ZTX311	17
ZTX314	24
ZTX320	30
ZTX326	40
ZTX341	20
ZTX500	13
ZTX501	14
ZTX502	19
ZTX503	15
ZTX504	25
ZTX531	25
ZTX550	25
40250★	85
40251★	97
40311★	50
40313★	125
40315	55
40316★	85
40317★	52
40319★	71
40320★	56
40323★	60
40324★	85
40326★	52
40327★	62
40347★	80
40348★	101
40360★	43
40361★	45
40362★	48
40406★	65
40407★	50
40408★	75
40411★	285
40412★	63
40467★	95
40594★	80
40495★	90
40603★	65
40636★	125
40673★	68
2N697★	21
2N698★	39
2N699★	39
2N706A★	19
2N707★	50
2N708★	19
2N914★	19
2N916★	27
2N918★	30
2N920★	51
2N930★	18
2N1131★	22
2N1132★	22
2N1303★	50
2N1304★	50
2N1305★	28
2N1306★	35
2N1307★	50
2N1308★	46
2N1613★	23
2N1670★	150
2N1671B★	195
2N2160★	105
2N2217★	48
2N2218A★	31
2N2219A★	22
2N2220A★	26
2N2221A★	23
2N2222A★	20
2N2303★	45
2N2368★	21
2N2369A★	15
2N2483★	28
2N2484★	30
2N2646★	48
2N2784	55
2N2904★	22
2N2905A★	20
2N2906★	18
2N2907★	20
2N2907A★	22
2N2926G	10
2N3011★	24
2N3053★	20
2N3054★	49
2N3055★	55
2N3108	39
2N3442★	131
2N3563	20
2N3614★	169
2N3615★	135
2N3663★	24
2N3702	10
2N3703	11
2N3704	10
2N3705	11
2N3706	10
2N3707	10
2N3708	10
2N3709	10
2N3710	16
2N3711	10
2N3772★	170
2N3773★	288
2N3819	22
2N3820	32
2N3823★	65
2N3824★	70
2N3866★	90
2N3903	18
2N3904	18
2N3905	18
2N3906	17
2N4037★	52
2N4041★	80
2N4058★	17
2N4061	17
2N4062	13
2N4064★	120
2N4069	45
2N4236	145
2N4286	20
2N4289	20
2N4859	65
2N4922★	55
2N5135	42
2N5136	42
2N5138	20
2N5172	24
2N5179★	60
2N5180★	60
2N5191★	65
2N5305★	24
2N5457	32
2N5458	32
2N5459	32
2N5485	32
2N5777★	45
2N6027	40
2N6109	45
2SD234★	50
3N128★	85
3N140★	85

Matched Pair 10p extra

LINEAR ICs

702	75
709C 8 pin	35
709C 14 pin	49
709C TO5	35
723★ 14 pin	45
741★ 8 pin	22
741★ 14 pin	32
747C★ 14 pin	79
748C★ 8 pin	36
753 8 pin	150
810	159
AY-1-0212	580
AY-1-1313A	660
AY-1-1320	305
AY-1-5050	241
AY-1-5051	145
AY-1-6721/6	195
AY-3-1015★	560
AY-3-8500★	390
AY-3-8550★	450
AY-3-8710★	850
AY-5-1013★	450
AY-5-1224A★	260
AY-5-1230★	490
AY-5-1315	560
AY-5-1317A	630
AY-5-3500★	510
AY-5-3507★	415
AY-5-4007	650
CA3011★	82
CA3014★	137
CA3018★	68
CA3020	170
CA3023	170
CA3028A★	80
CA3035	240
CA3036	110
CA3043	190
CA3046	71
CA3048	200
CA3075	175
CA3080E★	70
CA3081	190
CA3089E	210
CA3090AQ	375
CA3123E	200
CA3130★	85
CA3140★	70
ICL7106★	722
ICL7107★	975
ICM7205★	1150
ICL8038CC★	335
LM300H	170
LM301AP★	30
LM304	240
LM308T	110
LM318H★	205
LM319S★	195
LM324A	79
LM339★	80
LM348★	95
LM379★	375
LM380	95
LM381N	145
LM381AN	248
LM382	125
LM1458★	50
LM3900★	60
LM3909N★	70
LM3911★	125
MC3242A★	750
MC3246A★	795
MC663	275
MC724★	175
MC1303	88
MC1304P	260
MC1310P	149
MC1312PQ	195
MC1488	85
MC1489★	90
LD130★	452
MC14433L	1250
MC1458★	50
MC1495★	395
MC1496L	92
MC1710CG	79
MC3340P	150
MC3360P	120
MC3401	70
MEM780	205
MFC4000B	85
MFC6040★	97
MK50253★	650
MK50362★	650
MK50398★	635
MM2112★	110
MM57160★	620
NE350	160
NE515	80
NE543K	210
NE544	185
NE555★	29
NE556DB★	60
NE560★	325
NE561★	395
NE562B★	410
NE565A★	120
NE566★	160
NE567V	170
NE571	450
RAM2102-2★	170
RC4136D	120
ROM2513★	700
SAS560	240
SAS570	240
SG3402★	295
SL437A	560
SN72710★	43
SN72733★	99
SN75450★	84
SN75454B★	46
SN76003N	175
SN76013	140
SN76018★	148
SN76023	140
SN76033N	175
SN76115N	215
SN76131★	110
SN76227N	115
SN76477★	225
SN76810★	150
TAA550	50
TAA621AX1	228
TAA661A	155
TAA700	353
TAA960	300
TAD100	150
TBA120S	70
TBA540	215
TBA540Q	220
TBA550Q	330
TBA641-A12 BX or BX11	250
TBA651	180
TBA800	90
TBA810S	99
TBA820	70
TBA920Q	260
TCA270Q	220
TCA270SQ	220
TDA1022	575
TDA2020	320
TLO81CP★	52
TLO82CP★	96
TLO84CP★	130
UAA170	198
ZN414	90
ZN424E	130
ZN425E★	375

TTL 74★ (TEXAS)

7400	13
7401	13
7402	14
7403	14
7404	14
7405	18
7406	38
7407	38
7408	17
7409	17
7410	15
7411	20
7412	17
7413	30
7414	51
7416	30
7417	30
7420	16
7421	29
7422	24
7423	27
7425	27
7426	36
7427	27
7428	35
7430	17
7432	25
7433	40
7437	30
7438	33
7440	17
7441	74
7442	68
7443	115
7444	112
7445	94
7446	94
7447	82
7448	56
7450	17
7451	17
7453	17
7454	17
7460	17
7470	28
7472	25
7473	32
7474	27
7475	38
7476	36
7480	48
7481	86
7482	69
7483	72
7484	95
7485	106
7486	31
7489	210
7490	33
7491	75
7492	38
7493	32
7494	78
7495	65
7496	57
7497	189
74100	119
74104	62
74105	62
74107	29
74109	54
74110	54
74111	68
74116	198
74118	83
74120	115
74121	25
74122	46
74123	48
74125	38
74126	57
74128	74
74132	73
74141	56
74142	269
74143	314
74144	314
74145	65
74147	175
74148	109
74150	99
74151	64
74153	64
74154	96
74155	53
74156	80
74159	210
74160	82
74161	92
74163	92
74164	105
74165	105
74166	161
74167	20
74172	625
74173	170
74174	87
74175	87
74176	75
74177	78
74180	85
74181	165
74182	160
74184	135
74185	135
74188	275
74190	115
74192	105
74193	105
74194	105
74195	95
74196	99
74197	85
74198	150

CMOS★

4000	15
4001	17
4002	17
4006	105
4007	18
4008	87
4009	50
4010	50
4011	18
4012	18
4013	42
4014	86
4015	89
4016	45
4017	89
4018	89
4019	48
4020	99
4021	91
4022	88
4023	20
4024	66
4025	19
4026	180
4027	45
4028	81
4029	99
4030	58
4031	205
4032	100
4033	145
4034	196
4035	111
4036	325
4037	100
4038	108
4039	320
4040	105
4041	80
4042	75
4043	94
4044	95
4045	145
4046	128
4047	87
4048	58
4049	48
4050	48
4051	72
4052	72
4053	72
4054	110
4055	128
4057	2570
4059	480
4060	115
4063	110
4066	58
4067	380
4068	22
4069	20
4070	32
4071	21
4072	21
4073	21
4075	23
4076	85
4077	40
4078	21
4081	20
4082	21
4085	74
4086	73
4089	150
4093	85
4094	190
4096	105
4097	372
4098	110
4099	145
4160	109
4161	109
4162	109
4163	109
4174	110
4175	99
4194	108
4408	720
4409	720
4410	720
4412F	1650
4412V	1380
4415F	795
4415V	795
4419	280
4422	545
4433	1225
4435	825
4440	1275
4450	295
4451	295
4452	
4490F	695
4490V	525
4501	17
4502	120
4503	69
4506	51
4507	55
4508	298
4510	99
4511	150
4512	98
4513	206
4514	265
4515	299
4516	120
4517	382
4518	102
4519	55
4520	108
4521	268
4522	199
4527	152
4528	99
4529	165
4530	85

74LS★

00	18
01	18
02	20
03	20
04	20
05	23
08	22
09	22
10	20
11	22
12	23
13	38
14	75
15	30
20	20
21	22

74LS Section completed on next page

news digest

all change

This is the month when the BBC plays hide and seek with the four stations. They are gonna move 'em — you've gotta find 'em again. Fun eh? Radio One goes to 275m and 285m; Radio 2 goes to 433m and 330m: Radio 3 goes to 247m; and Radio 4 vanishes onto long wave at 1500m. VHF is unchaged thank God.

The Beebs purpose in shuffling dials is to reduce interference from overseas stations. New transmitters are being fitted in some areas, so how it behaves now is *no* indication of how well you'll get the station once they change it around. Radio 2 will now be better in the day, but worse at night, with Radio 3 generally better.

The movement is to fit in with new European agreements which will allow more stations with better coverage to use the MW and LW bands, so we shouldn't complain.

Oh yes there is one more thing. Up to the switch – November 23 will dawn with the new frequencies operating – unscheduled breaks in transmission will occur in MW and LW programmes lasting between a blink and several minutes. Don't smash your set it's the BBC's fault. They're working on the transmitters and aerials now to ready them for the big switch over, and well you never know who might drop a spanner or two. . . .

Details will be plastered all over radio, TV and Radio Times between now and then so don't worry about not hearing what's going on. It's most unlikely.

short stuff

● GI has released an appliance timer — the AY-3-1251-MPU-based it is, and can be used in such things as cookers to replace nasty mechanical things like clocks. Two versions are available and facilities include keyboard entry, direct display drive, four outputs et al.

● A new digital logic family called FAST (Fairchild Advanced Schottky TTL) is to be released soon. Power consumption is much lower than normal types — about 25% in fact. Typical delays are about 3 nS — hence the name. 66 circuits will be released by the year's end. Price? Competitive apparently, whatever that means.

● Prom programming overnight is offered by Memec Ltd of Thame Park Industrial Estate, Thame, Oxon. A 24hr turnaround is quoted and all types of PROM can be handled.

● RCA have a new chip out which a smoke detector unto itself. It requires only an ionisation chamber and horn alarm to begin detecting and alarming. The number is T-A 10451 and it will operate on either battery or line.

● Britain has produced a new design of terminal to operate with the European OTS test sattelite. The idea is a joint venture between Marconi, the Post Office and the Department of Industry.

● Compe 78 will be held at Olympic this year to allow for more exhibitors. The exhibition deals with small systems, minis and micros, software and hardware and Uncle Tom Cobley and all. . . .

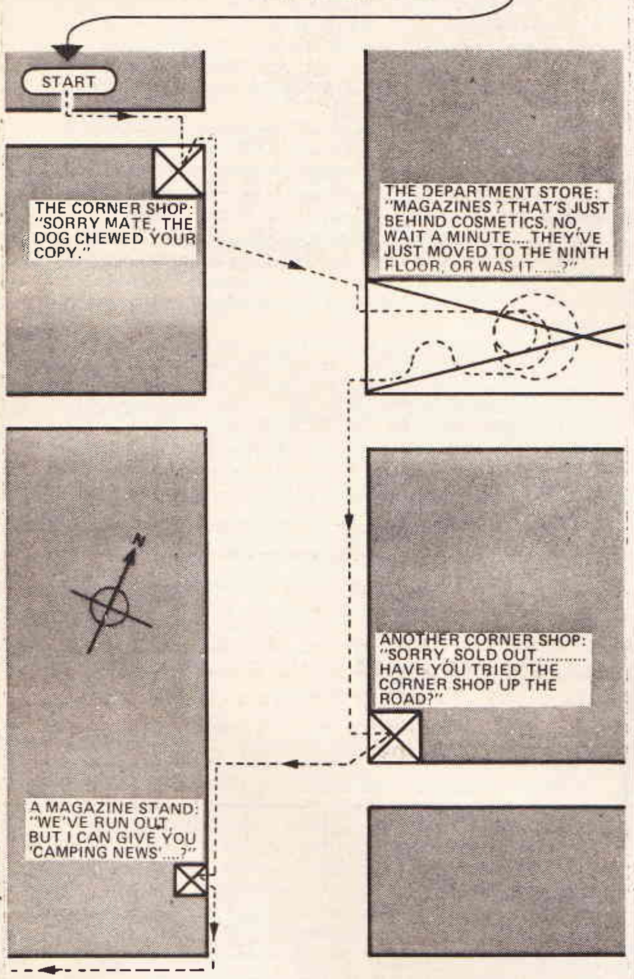
● Supervisor is a remote controlled helicopter for use on the modern battlefield. It has been developed by Marconi and Westland. The machine stands about as high as a man and contains cameras and other surveillance equipment. It has just passed its first flight tests successfully and could be of great use to NATO when in service.

● Two books from GI to full up the bookshelves usefully are the 600p Catalogue and the 300p Applications Handbook. Both will be of great use indeed to both engineers and serious home dabblers. They cost £3.00 and £1.80 respectively from any GI distributors.

● Toshiba and Rank have completed an agreement to produce TV sets and audio equipment in Plymouth and Cornwall.

● Texas Instruments new 64K RAM is at last released. Automation in production means that by 1980 each unit will require only 5 man MINUTES to produce from start to finish, and that a mere 1000 staff will be able to service entire world demand!

NON-SUBSCRIBERS START HERE



GIVE UP, GO HOME:
......AND TAKE OUT A POSTAL SUBSCRIPTION TO ETI.

It can be a nuisance can't it, going from newsagent to newsagent? "Sorry squire, don't have it — next one should be out soon."

Although ETI is monthly, it's very rare to find it available after the first week. If it is available, the newsagent's going to be sure to cut his order for the next issue — but we're glad to say it doesn't happen very often.

Do yourself, your newsagent and us a favour. Place a regular order for ETI; your newsagent will almost certainly be delighted. If not, you can take out a postal subscription so there's nothing for you to remember — we'll do it for you.

For a subscription, send us £7.00 (£8.00 overseas) and tell us which issue you want to start with. Please make your payment (in sterling please for overseas readers) to ETI Subscriptions and keep it separate from any other services you want at the same time.

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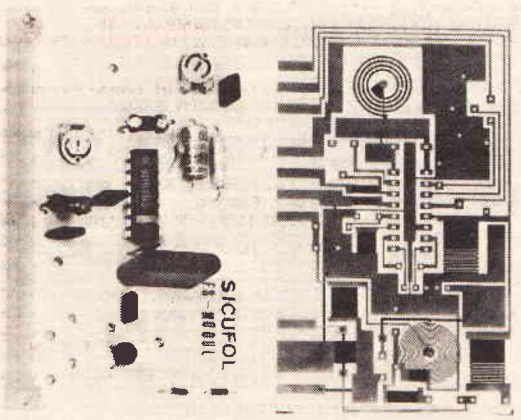
foiled again

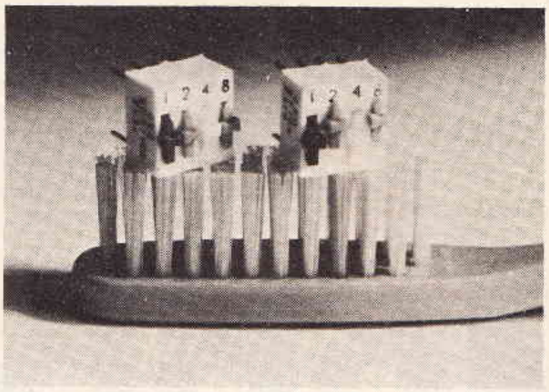


These structures made of chrome-nickel and copper represent an integrated passive circuit with capacitors, coils and resistors, the carrier being a plastic foil. The rectangular, spiral and meandrous shapes largely determine the capacitances, inductances and resistances. Using the name "Sicufol" (Siemens copper foil) Siemens is now offering modules for television sets as the first wares in this new technology.

Resistances up to 300R can be fabricated directly, capacitance to 150pf/cm² and inductances up to 10μH. By meandering the track back and forth, an increase of up to 3800 per given area is possible.

The carrier foil is a kind of Teflon so you shouldn't be *stuck* for ideas. . . .

eat your heart out colgate

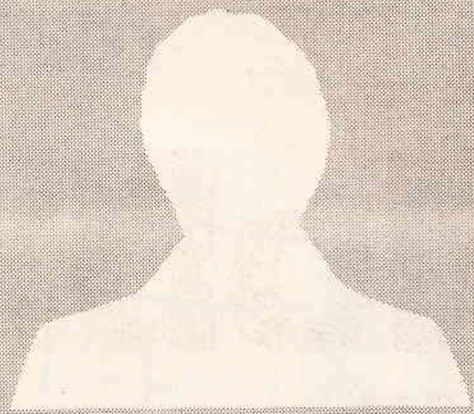


One might question the wisdom of a picture like this, bristling as it is with cunning. At least it's an excuse to brush up on DIL switches. These are made by ERG Components and can switch at up to 10 VA. Fitting a normal DIL format they are numbered in a standard BCD format, and can be very useful in any digital circuitry. Home constructors never seem to make much use of these components for reasons best known to themselves. ERG Components, Luton Road, Dunstable, Bedfordshire.

ooops

Please note that the prices shown on the Gould Advance Ad on Page 14 of the October issue were incorrect. The correct prices are shown on page 14 of this issue. We apologise to Gould Advance and our readers for any inconvenience caused.

WANTED



Editorial Assistant for ETI and Hobby Electronics

If YOU have a genuine interest in electronics and project building and an above-average ability to express yourself in writing, you could be the person we're looking for. We are being serious.

We are looking for someone to join the editorial team and reckon that an enthusiastic reader is likely to be the type to join us. Not an uncritical reader — we want to continue to improve. The work will entail dealing with articles and news — licking them into shape — and making them better than anyone else's articles and news. The applicant will work on both ETI and our new sister publication Hobby Electronics. Readers employed in journalism at the moment will be considered but we are not primarily looking for someone with magazine experience.

We are flexible about age and experience but imagine that the person who gets the job will be between 21 and 28.

Salary will depend upon age and experience but will be in the range £3,700 to £4,100, possibly more for someone with exceptional qualifications.

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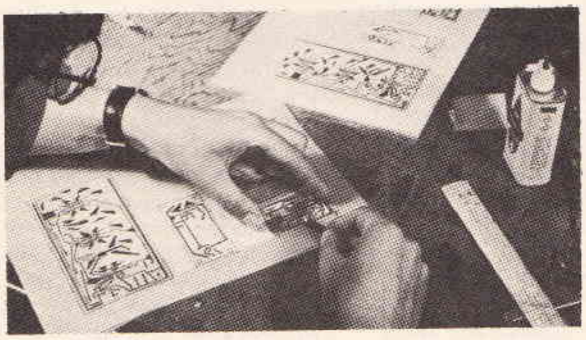

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ONE BOARD HOME COMPUTER

ETI, Transam and Mike Hughes, who designed the system, present the Triton — a one board computer that includes all the features expected in a machine providing the basis of a really powerful home system.

ADD A STANDARD domestic TV set and a cassette recorder to the TRITON and you have a complete home computing system that is equal to, indeed in some areas superior to, many of the commercial ready built systems now on the market.

The TRITON has been designed on a single board, which means that construction should not pose any problems providing an adequate standard of soldering is maintained throughout. The case, designed specifically for the TRITON, means that the finished unit can safely and attractively be housed. In use, with the TV set on top of the case, the TRITON will be easy and convenient to operate.

The TRITON is based on the 8080 MPU, a device which has proven itself over a number of years. This MPU has a vast amount of software available for it and the TRITON's 1K monitor system allows for easy entry and subsequent modification of such material.

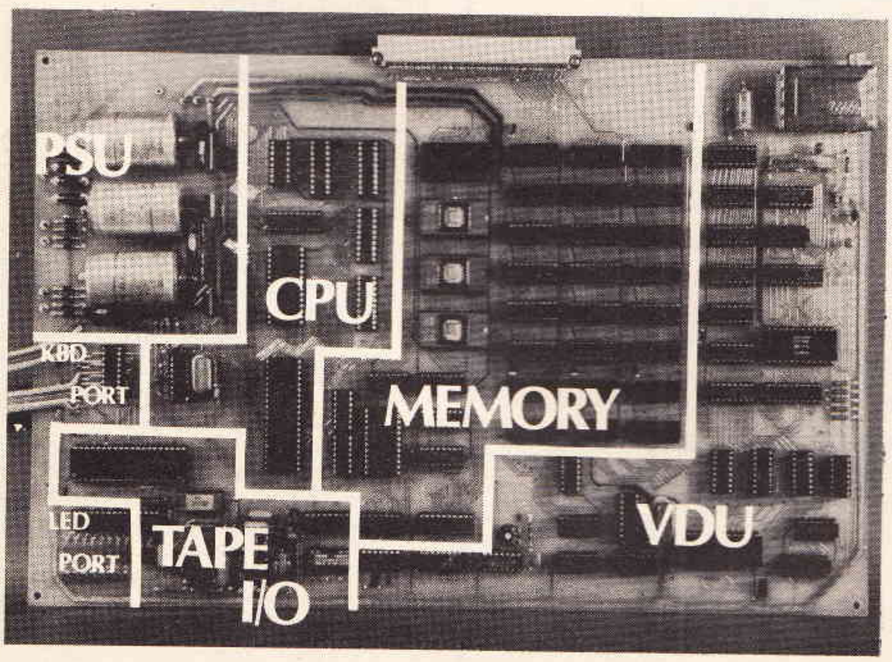
The 2K TINY BASIC that is also resident in the TRITON, allows this popular, easy to learn, language to be used in conjunction with the TRITON's versatile graphic character set and unique VDU function to develop everything from games to education programs quickly and easily.

The TRITON has space for 3K of user RAM on board but the machine has been designed in order to make expansion a simple matter. All the signals necessary to add further memory, I/O devices etc. are brought out to an edge connector at the back of the board.

It is essential to use a top quality double sided plated through board for the project. Unlike many projects the PCB is likely to be the most expensive single item you have to invest in but it is this component which brings the whole project into scope for the average constructor with no significant theoretical knowledge.

The board has been designed to keep all the most intricate wiring on the top side — in particular the connections that run between IC pins. The latter are the most vulnerable to a heavy hand on the soldering iron but this is not saying that you can afford any carelessness underneath! Use the smallest soldering iron you can lay your hands on and the bit must, certainly, be no greater than 3/32in diameter. As stated, **all** soldering operations should be carried out on the underside of the board; the through hole plating will route all necessary connections to the topside.

Wherever possible it is worth trying to re-inforce the through hole plating by getting molten solder to creep through the hole by capilliary action, therefore hold the soldering iron in place long enough for the heat to flow through the hole and take the solder with it. A couple of seconds longer than your usual soldering time should suffice. You will notice that on the underside of the board there are hundreds of IC pin lands that do not appear to be connected to anything. These lands **must** be soldered in **all** positions because nearly all of them go somewhere on the top side!



The single board that carries all of the Triton's circuitry with the areas concerned with various parts of the system indicated.

See John Coll's comments on the Triton in Computing Today

Transam Components Ltd of 12 Chapel St, will be sole suppliers of the Triton and will also supply individual parts for the computer.

Construction Commences

Take your time with the soldering — even at a slow pace you can complete this project in a couple of days — because it is very easy to miss a connection or produce a dry joint. We recommend that you insert one component at a time and solder it in completely before moving on to the next; a visual check of each joint is essential and if you have any doubt don't be afraid to use a magnifying glass. A few seconds wasted doing this can save hours — if not days — trying to find a single missed connection!

All the holes on the board have been pre-drilled to the correct diameters but in the event of you having a device which will not quite go through the hole do not UNDER ANY CIRCUMSTANCES attempt to drill out to size — you will ruin the through hole plating! The ONLY holes you may drill out are the fixing holes for the board and the mounting holes for the extender socket. If you have a stubbern component try scraping down the diameter of its lead with a sharp knife or use a needle file to reduce its dimensions slightly. Probably the only offender you will find in this respect is the modulator which has rather large fixing lugs that sport a taper. These might vary a little from device to device.

We recommend the use of sockets for all the integrated circuits as it is virtually impossible to remove ICs from a double sided THP board.

Start construction by soldering in all the DIL sockets while the board is flat — it makes life much easier — and then insert all resistors and diodes. Next insert the nine board pins which connect to the transformer and IC1 (the off board voltage regulator). Proceed to solder in the in line strip sockets and the extender socket. When the latter is firmly soldered you should carefully drill out the board mounting holes with a drill using the connector's holes as a guide and then bolt it firmly into place.

Switched On System

Insert the three transistors for the tape I/O. Procede then to the capacitors and LEDs. Leave the three large smoothing capacitors till last and be very careful that you insert the LEDs the right way round. You will have to look very careful at the solid tantalum capacitors to find their polarity. You should then insert, and solder in the three preset potentiometers.

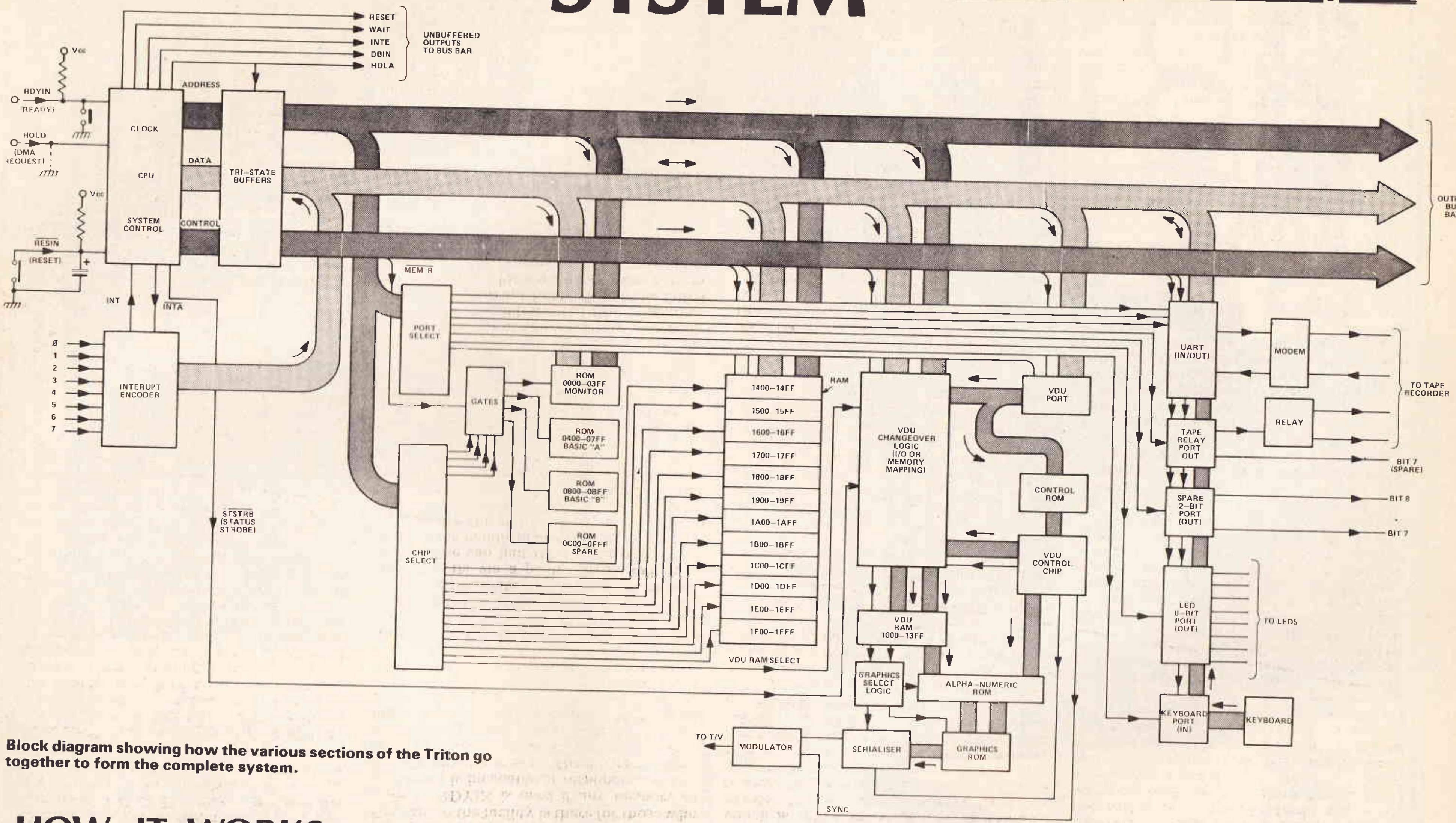
Before progressing further check the polarity of all the diodes and electrolytic capacitors you have inserted.

You can now insert, and solder in the three crystals making sure you have them in the correct positions. The crystals have their frequencies stamped on them (usually in kilohertz).

Continue with construction by putting in the modulator and the two on board regulators. Make sure you have the regulators in the right position. Ensure that you insert them the right way round. The metal fin should be on the face of them furthest away from the main smoothing capacitors.

Temporarily mount IC1 on its heatsink and run flying leads to the three pins allocated to it.

The great moment is close at hand but before inserting any integrated circuits give the power supply a dry run. Connect up the remaining six board pins to their corresponding terminals of the transformer and apply power. Use a voltmeter to see that you have the correct voltage rails present. You should get +5 V and +12 V at the output pins of ICs 1 and 2 respectively and —12 V at the output of IC3. You should read —5 V



Block diagram showing how the various sections of the Triton go together to form the complete system.

HOW IT WORKS

The heart of the system is the microprocessor (MPU) itself — the faithful old 8080A. This MPU has a very simple to understand instruction set which is remarkably versatile for those who like to dabble in work at machine code level and because of its years of experience there is a great variety of software freely available to use with it. In addition it is one of the cheapest MPUs on the market.

The MPU will sequence through a list of

These eight lines are decoded to activate any one of 256 possible external devices through what are called PORTS.

Before moving on from the heart of the system it is worth mentioning some of the single lines depicted on the illustration. When the computer is initially switched on it is necessary to give it the right instruction to start with so that it can sequence on from there to complete the program in a sane manner. For this reason it is usual to have the

operation on the VDU screen and to do a re-initialisation without clearing all the memory (which would otherwise happen if one pressed the reset button). There are five remaining lines one of which is brought out to a spare push button on the front panel and the rest are piped down the multiway socket along with the busbars. The interrupt request lines have to be encoded and formatted into an eight bit data byte. When this is done the interrupt encoder tells the CPU with the INT

decoding the least significant eight bits of the address bus) through the Port Select logic and issues a I/OR control signal will data from the keyboard be placed on the data busbar. Working in the opposite direction, the Output Port driving a bank of eight on board LEDs is a set of eight latches which catch and hold whatever data is on the busbar when they receive a coincident pair of signals from the port selector and the I/OW line of the control bus. These onboard LEDs instructions held in memory as 8 bit bytes and on receipt of each instruction will carry out an operation which ranges from getting another byte of data from somewhere else in memory to carrying out simple logical or arithmetical operations on that data. It is not within the scope of this article to cover the inner workings of the MPU itself or, for that matter, to explain every operation that the 8080 can offer.

As it operates sequentially the MPU needs clock. In this case the master frequency is 7.20MHz which is divided down to clock the MPU every 1.25uS. This time is the duration of a microcycle and it takes from 4 to 11 microcycles for the MPU to complete an instruction.

The MPU itself has quite a large number of lines leading to it. The 8 data lines are in the form of a bi-directional busbar (i.e. can carry data to or from the MPU). To cut down on the number of wires coming from the MPU the data busbar serves a secondary purpose. It carries what is called "STATUS" information at a certain point in time within an instruction cycle. This status information is in the form of an 8 bit byte and is decoded by the System Controller. When decoded the Status byte feeds one of 5 lines with a locigal "o" which tells the rest of the system what sort of instruction the MPU is executing during that cycle. These lines are grouped together to form the CONTROL BUSBAR and are designated INTA (meaning that the computer has just been interrupted by an external "Interrupt Request"), MEMR (reading data from a memory location), MEMW (writing — or storing — data into an internal memory location), I70R (inputting data from an external source — such as a keyboard or a tape system) and I/OW (outputting-data to an external destination such as a VDU or a tape system).

The 16 lines which carry a 2 byte WORD which is used to ADDRESS a specific byte of memory form the uni-directional ADDRESS BUSBAR. Using 16 binary lines one can therefore address up to 65,536 (decimal) memory locations. We have limited the capacity of the TRITON to 8K of memory but the address busbar (in common with the data and control busses) are buffered and can be fed to the outside world through a multiway connector thus allowing easy expansion to maximum capacity with add on boards.

The address bus also serves a duplicity of roles depending on whether the instruction cycle is a memory addressing or an I/O addressing cycle. As already stated all sixteen lines are used to address memory locations but during an I/O read or write cycle the CPU is limited to providing address data on the eight least significant address lines. first instruction at address location zero. We can reset the MPU by depressing a push button or at switch on by the POWER ON RESET.

Those that want to can use the line marked HOLD for applications involving DMA (Direct Memory Access). Basically this means that by making this line go to logic "l" one can isolate the internal CPU from all three busbars (using the tristate facility of the buffers) and allow an external device to do what it will with the internal memory. We have strapped this line to "O" with a removable link so the facility is there for those who want it. RDYIN is used if any memory of peripheral is incapable of responding as fast as the computer desires. The external device can make this line go to "O" for any period of time (usually set by a monostable) and when this happens the MPU goes into a WAIT state and it does just that. It simply stops operating as long as this line is low and when the RDYIN signal is removed it carries on as if nothing had happened. The only thing it does do during this time is issue a signal to the outside world called WAIT. You can see the WAIT line designated as one of the unbuffered outputs. In addition by connecting RDYIN via a push button switch to ground one can halt the computer momentarily in the middle of any operation. Facility for bringing this out to a push button is not made on the board but it is a simple matter to pick up the right point on the top side and take it via a single wire to the front panel — see the circuit diagram of this section.

The RESET output goes high momentarily when the rest button is pressed and can be used to carry a synchronous reset on external equipment; the HDLA output tells the outside world that the computer has gone into a HOLD (or DMA) state — if anyone takes the HOLD Line high; the INTE Line tells the outside world that the computer is permitting itself to be interrupted (the mnemonic stands for Interrupt Enabled) and the DBIN line indicates which way the computer expects data to be flowing on the bi-directional data bus. It goes high when the CPU is expecting data to flow INTO it.

We are using the STSTRB (STATUS STROBE) signal — to synchronise the memory mapping of the VDU — more is said about this in the relevant section.

As already implied the 8080 will allow itself to be interrupted in mid program provided that the program sets the Interrupt Enable flag. There is facility for eight possible interrupts but only seven can really be used on this machine (Interrupt 0 is redundant as it duplicates RESET). An interrupt is entered into the machine on a single interrupt request line. Of the seven usable lines we are using two within the machine to do a clearing signal that an interrupt has been received. When the CPU is ready to be interrupted it issues an Interrupt Acknowledge signal INTA which is used to place the encoded byte on to the data bus. This byte enters the MPU and directs the computer to operate the desired subroutine. At the end of the routine the computer reverts to the main program continuing at the point where it was interrupted.

The memory of TRITON is split into three types on the main board. There are locations for up to 4K of Read Only Memory (ROM) which is split between four 2708 Erasable ROMs. These occupy address locations OOOOH to OFFFH. The standard TRITON uses the first 1K to hold Monitor and Utility routines necessary to initialise the machine and re-vector interrupts. The next 2K holds a BASIC INTERPRETER and the fourth 1K block is left spare for future expansion.

There is 1K of Random Access Memory dedicated to the VDU. This starts immediately above the ROM area starting at 1000H. Normally this RAM is addressed in synchronism with the VDU line scan by the VDU control circuitry but the CPU can take over addressing under program control (in effect interrupting the VDU). The VDU RAM can only be written into by the computer.

The rest of memory is made up of RAM which is both read and write. This area is used to hold the stacks and tables of the MONITOR and BASIC INTERPRETER (512 bytes) and the main work area starts at 1600H for a further 2½K ending at 1FFFH. This represents the full capacity of the on board memory. There is no reason, however, why further read write memory should not be added externally starting from location 2000H.

The ROM and VDU RAM areas are blocked into units of 1K — to fall into line with the types of integrated circuits used. However, the stack and work area RAMs are laid out in blocks of 256 bytes.

The high order lines of the address busbar are used to decode which block is being addressed — this is done by the Chip Select decoder. Note that the ROM chip selects are gated with the MEMR signal from the Control Bus whereas this control signal and MEMW go straight to the RAM chips. This is because the 2111 Random Access Memory ICs used have internal chip select gating and output enables.

With the exception of the VDU which is "hybrid" the rest of the system is made up from a variety of I/O stages. The most important of the latter is the Keyboard Input. The keyboard data and strobe lines are fed on to the data busbar via tri-state buffers which form the keyboard input port. Only when the computer's software addresses this port (by help to make the TRITON system more versatile and can be used for test purposes or in specialised development applications. The LEDs themselves could be discarded and the eight lines brought to the outside world as a spare general purpose output port.

By making use of a couple of spare latches on the board it was possible to provide two spare output lines on one port and a spare line on the port which also feeds the tape recorder power control relay.

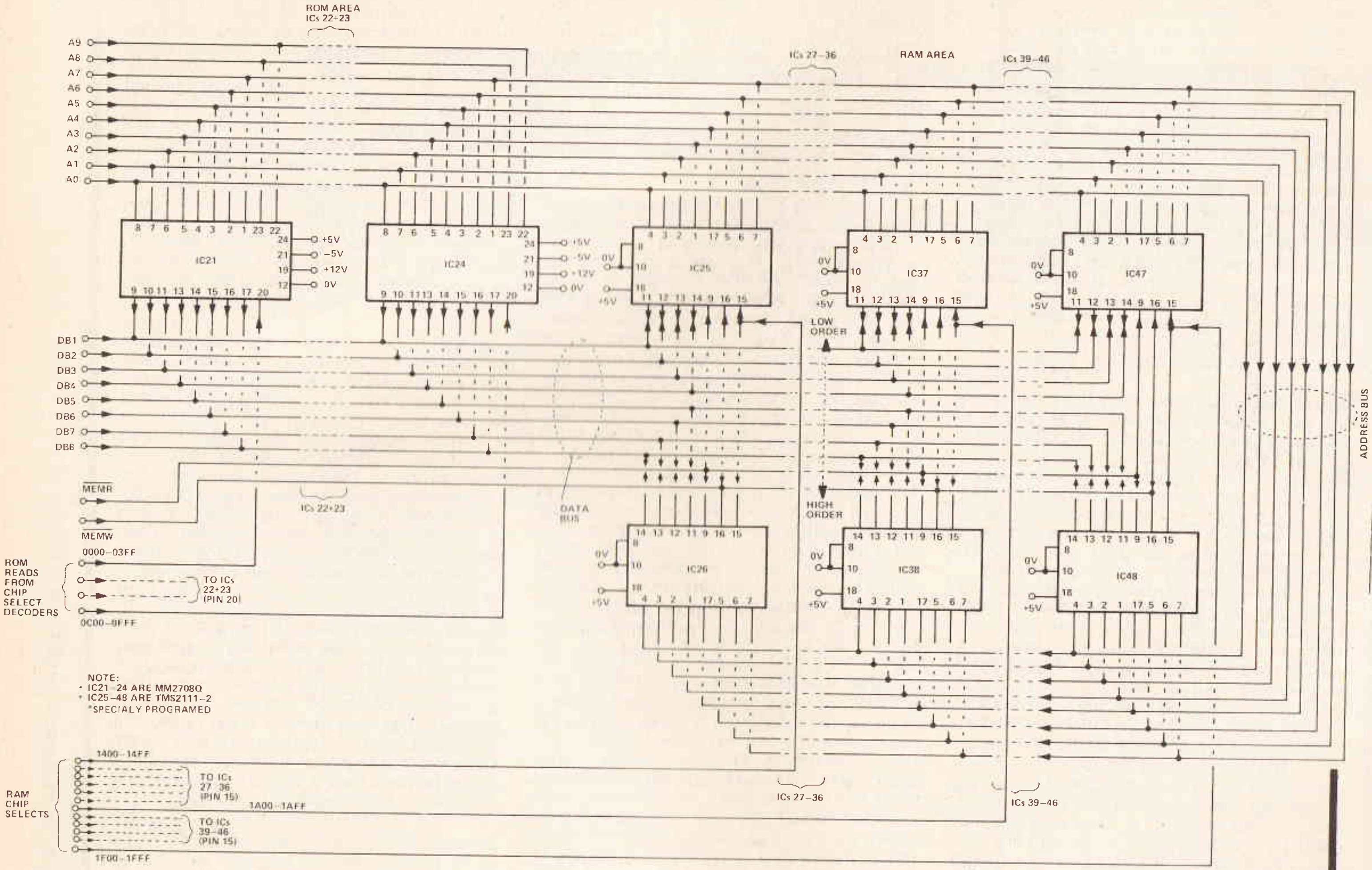
The UART (Universal Asynchronous Receiver/Transmitter) is the device which converts the eight bit wide parallel data on the busbar to a specially formatted serial stream to feed the tape recorder modulator. It also carries out the complementary function of converting a received serial stream into parallel data bytes. The device operates as if it were two input ports and one output port. One of each sort of port would be obvious for a device which receives and transmits but the requirement for a second innput port may not be so obvious. Because the device operates asynchronously from the main computer (it has its own clock operating at 300 baud) it is necessary to make the computer wait from time to time to allow the slower operating UART to complete a transmission cycle. This is indicated by the UART activating a flag which is regularly monitored by the second input port.

The VDU portion of the computer is based on the Thomson-CFS Control chip and operates in a unique manner for this integrated circuit. Not only can one output to the VDU through an output port (in similar manner to using a teletype) but one can use the computer to write data directly into the VDU's memory at extremely high speeds.

A further extension is the way the control chip has been used to handle Graphics. Instead of the usual six bit wide RAM seven bits are used in this VDU application. This way enables the use of the complete set of ASCII codes. 64 extra character codes are therefore available by using those normally associated with lower case "alpha" characters and all the control codes. Within the overal context of the computer some of the control codes serve dual purposes and the VDU control ROM inhibits printing a graphic when a control code is issued for genuine control purposes!

The graphic select logic looks at the two most significant bits of the ASCII code, determines whether or not the symbol is graphic or alpha-numeric, then proceeds to select the standard alpha-numeric ROM or the specially programmed graphics ROM. There is quite a lot of extra logic associated with this operation as well as the Memory Map/IO changeover but we shall reserve comment on this to the section describing the circuit in detail.

RAM & ROM



Circuit diagram of the ROM and RAM circuitry. Note that in the basic machine IC 24 is omitted as are ICs 33-48.

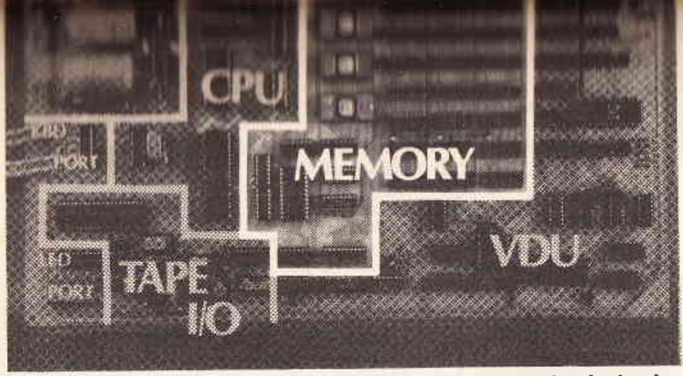
HOW IT WORKS

The circuit diagram of this section has been abbreviated as most of the memory circuitry is a repeat of the same theme. You can clearly see the difference between the ROMs and the Read/Write RAMS. There are four of the former – all 2708s but in the standard machine only three are used immediately. The 2708 is an ultra violet erasable ROM which contains 1,024 (decimal) bytes of memory each being 8 bits wide. To access a specific byte within it you need a 10 bit address and A0 through A9 are used for this purpose. The eight output pins are tri-state which are enabled by a "0" on pin 20 (the chip select input). The respective outputs from each of the ROMs can therefore be commoned together on the data bus. The "Programming Enable" pin (18) is only used when the devices are being programmed and therefore is left disconnected within the system. We use the block select signal gated with MEMR to provide the Chip Select strobe for the ROMs (this is described elsewhere).

The Monitor program is located within IC21 which starts at address location 0000H so that the computer will always go through a firmware initialisation routine when switched on. The Power On Reset ensures that the first instruction the CPU reads will be the one located at 000H. BASIC is located within ICs 22 and 23.

The RAM area of memory comprises TMS 2111-2 chips. These each contain 256 locations that are four bits wide. As we need to store eight bit bytes of data two chips are required for each 256 byte block of memory. The odd number designations IC25 to IC47 correspond to the low order nibble of the byte while the respective even numbers (IC26 to IC48) correspond to the high order. Only eight address lines (A0 through A7) are required to uniquely select a byte within this organisation of a chip pair but we need to specify which pair by means of the Chip Select lines (these have been decoded elsewhere in the system).

The 2111s have internal chip select and Read/Write gating so we are able to drive the MEMR and MEMW inputs direct from the control busbar.



at the junction between R1 and the zener diode. If all is well here; systematically check that you have the correct voltages at the sockets of **every** integrated circuit. Use the schematic diagrams to help you identify the pin numbers.

Finally check that you have inserted the single wire link to the right of the extender socket.

Insert all the integrated circuits making **absolutely sure** that you have them orientated correctly and have them in the correct locations. Use the dot on the UART to locate pin 1 (the notch can be misleading). Note that the orientation of ICs varies a lot on the board and you must check each one individually. Insert the 2708 EROM chip that is marked MONITOR V4.1 into the socket for IC21; the one marked BASIC L4.1 "A" into the socket for IC22 and BASIC L4.1 "B" into IC23. Insert eight TMS 2111-2 devices in IC locations 25 to 32 inclusive. The only gaps you should have on the board are the IC24 and ICs 33 to 48.

Do not bother with a keyboard at the moment but simply make up a coaxial lead to go from the modulator to the aerial socket of a standard 625 line television set. Switch the TV on and allow it to warm up checking that a raster is just visible and tune it to approximately channel 36.

Set the three on board potentiometers to their mid way positions and apply power to the TRITON. You should see some change on the television screen even though you may not be spot on tune. Try adjusting the tuning over the whole range until a strong signal is locked in. You should see the welcome message:

TRITON READY
FUNCTION: PGIOLWT

It may respond with INVALID as the keyboard is not fitted — do not worry this is still an indication that everything is working.

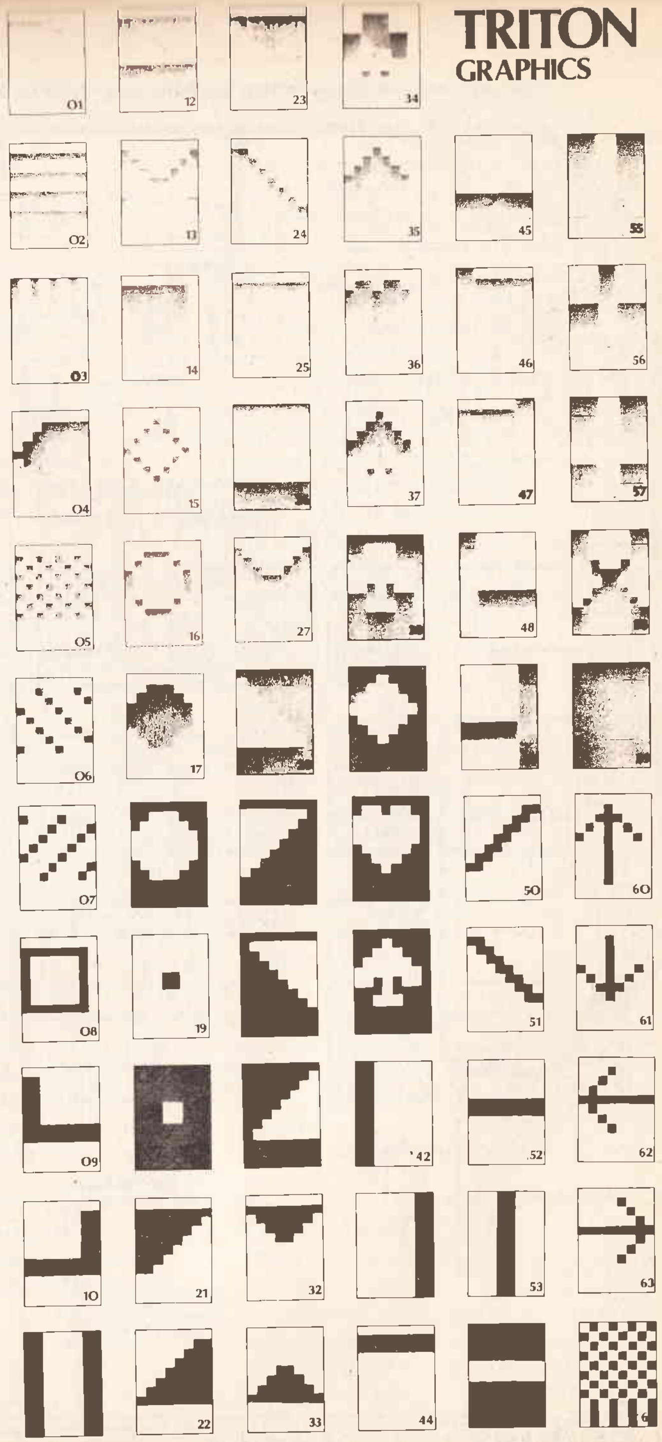
Hopefully this will be the case and you can rest assured that your computer is working! Switch the computer off; wait a few seconds and switch it on again. For a fraction of a second you will see a load of rubbish on the screen which will rapidly clear and the previous message will be repeated.

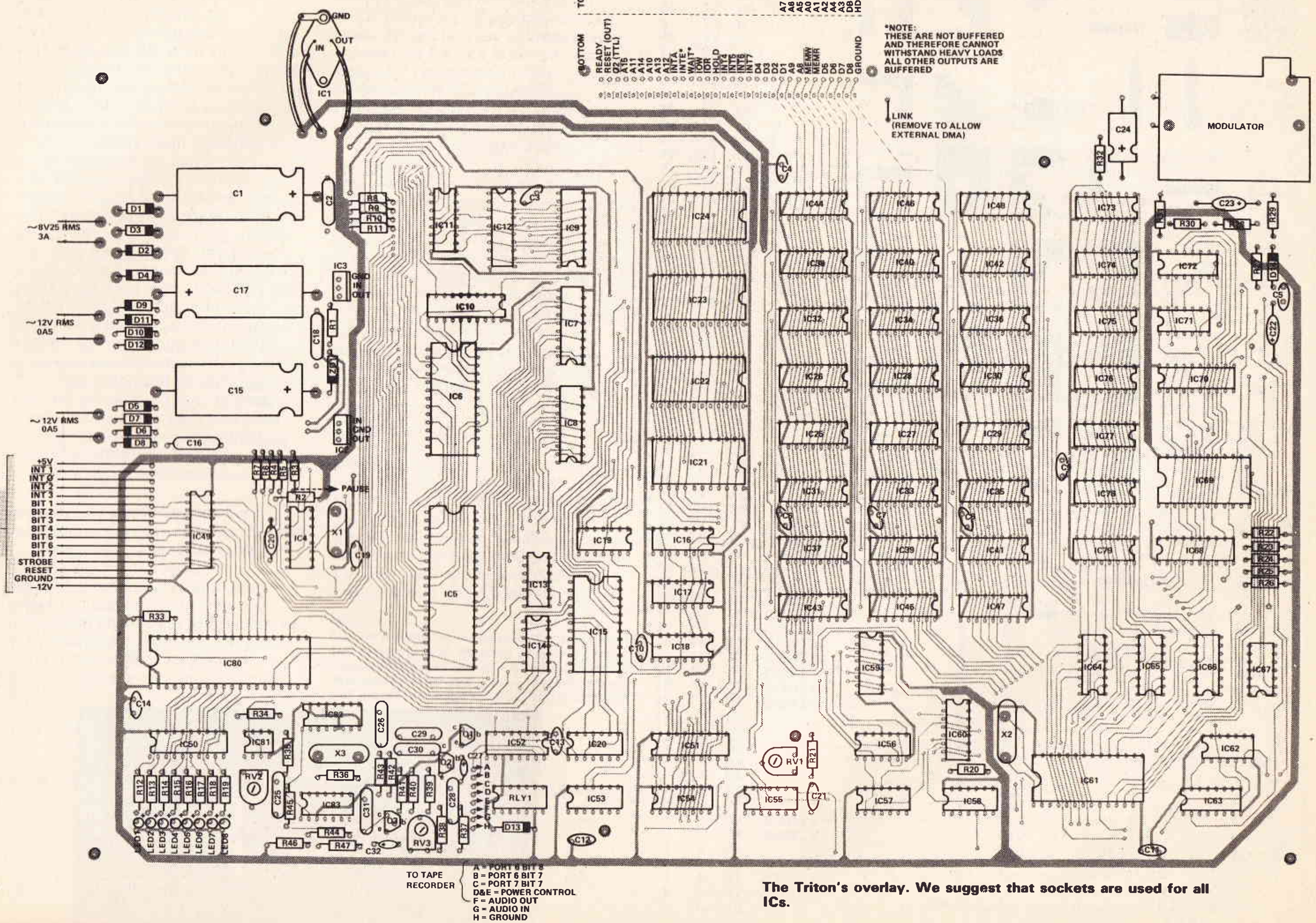
Switch off and make up an umbilical cord of wires to go from the keyboard socket on the board to the keyboard and associated push switches. Use colour coded wire and ensure that you make no mistake when connecting the relevant leads to the keyboard Cinch connector. It is double sided and you must make sure to hold it with the correct ▶

The table shows the decimal and hex codes associated with the Triton graphics and, where applicable, the key on the keyboard. The symbols may be used within a BASIC print statement or with the OUTCH monitor routine.

GRAPHIC	DEC.	HEX	
1	0	00	
2	1	01	CONT A
3	2	02	CONT B
4	3	03	
5	4	04	
6	5	05	CONT E
7	6	06	CONT F
8	7	07	CONT G
9	8	08	
10	9	09	
11	10	0A	
12	11	0B	
13	12	0C	
14	13	0D	
14	14	0E	CONT N
16	15	0F	CONT O
17	16	10	CONT P
18	17	11	CONT Q
19	18	12	CONT R
20	19	13	CONT S
21	20	14	CONT T
22	21	15	CONT U
23	22	16	CONT V
24	23	17	CONT W
25	24	18	CONT X
26	25	19	CONT Y
27	26	1A	CONT Z
28	27	1B	
29	28	1C	
30	29	1D	
31	30	1E	
32	31	1F	
33	96	60	
34	97	61	a
35	98	62	b
36	99	63	c
37	100	64	d
38	101	65	e
39	102	66	f
40	103	67	g
41	104	68	h
42	105	69	i
43	106	6A	j
44	107	6B	k
45	108	6C	l
46	109	6D	m
47	110	6E	n
48	111	6F	o
49	112	70	p
50	113	71	q
51	114	72	r
52	115	73	s
53	116	74	t
54	117	75	u
55	118	76	v
56	119	77	w
57	120	78	x
58	121	79	y
59	122	7A	z
60	123	7B	
61	124	7C	
62	125	7D	
63	126	7E	
64	127	7F	RUBOUT

TRITON GRAPHICS





The Triton's overlay. We suggest that sockets are used for all ICs.

PARTS LIST

RESISTORS (all ¼W 10% unless stated)

R1	82R ½W 10%
R2, 34, 44	10k
R3-19, 22-26, 30, 33, 35, 37, 38, 40, 46, 47	1k0
R20, 36	4M7
R21, 31	220R
R27	470R
R28, 29	330R
R32	15R
R39	4k7
R41, 45	220k
R42, 43	100k

POTENTIOMETERS

RV1	100R sub. min. horiz. preset
RV2, 3	10k sub. min. horiz. preset

CAPACITORS

C1, 15, 17	4 700u 25 V electrolytic
C2, 16, 18	470n polyester
C3-14	47n ceramic
C19	47p ceramic
C20, 23, 27, 32	47u 6V3 tantalum
C21	82p ceramic
C22	10u 6V3 tantalum
C24	100u 25 V electrolytic
C25, 29, 30	15n polyester
C26, 28	100n polyester
C31	220n polyester

SEMICONDUCTORS

IC1	LM323K
IC2	LM340T-12
IC3	LM320T-12
IC4	8224N
IC5	8080A
IC6	8228N
IC7, 8, 10, 49	74LS244
IC9	74LS245
IC11	74LS148
IC12	74LS240
IC13, 58	74LS00
IC14, 19, 67	74LS32
IC15	74LS154
IC16	74LS138
IC17, 18	74LS139
IC20	74LS02
IC 21, 22, 23, 24	MM2708Q
IC25-48	2111-2
IC50, 51, 68	74LS374
IC52	74LS75
IC53	74LS74
IC54	74S287
IC55	74LS132
IC56, 57, 71	74LS08
IC59, 60, 64, 65, 66	74LS157
IC61	SFC96364
IC62	74LS86
IC63	74LS163
IC69	RO-3-2513
IC70	74S472
IC72	74LS165
IC73-79	2102-2
IC80	AY-5-1013/TMS6011NC
IC81	555
IC82	MC14412VL
IC83	LM339N
D1-4	1N5400
D5-12	1N4001
D13, 14	1N4148
ZD1	5V1 400mW
Q1, 2, 3	BC148
LEDs 1-8	LD35Y (0.1" spacing)

TRANSFORMER

T1	12V+12V at 0.5A, 8V25 at 3A

SWITCH

PB1	DPDT Mains
PB2-5	SPST

CRYSTALS

X1	7.2000 MHz
X2, 3	1.0000 MHz

MISCELLANEOUS

PCB, Case, DIL Reed Relay type 15005, neon, 3A fuse plus holder, modulator (Astec type 1111E36), Full ASCII Keyboard, 64 way PCB plug and socket (optional) Type CS/CP64, 16 way inline PCB plug and socket Type A23-16, 8 way inline PCB plug and socket Type A23-8, edge connector to suit keyboard, 2 x 5 PIN DIN sockets, IC holders and heatsink (at least 90 x 100mm-matt black).

orientation or you may have disastrous consequences with the power lines. Different types of keyboards have different connections. We refer you to the connection details supplied with your keyboard. The only comment we should make is that the specified keyboard, and some others, give you an option for bit 6 of the data. One option gives you upper case characters only while the other gives both upper and lower case. This application needs the latter. The strobe is the static strobe which goes to "1" as long as a key is depressed.

Procedure

The specified keyboard does not have any built in direct function keys and these have to be provided by separate push buttons. These have to be mounted on the front panel and are used to provide RESET, INT1 (Clear Screen), INT2 (Reset without clearing memory), INT3 (Spare) and TAPE MANUAL OVERIDE — ganged with PAUSE (see descriptions elsewhere). The first four push switches all have a common ground and are "push to make" with a spring return. Use the Common lead and the respective signal leads to go to each of these switches. The fifth switch must be double pole "push to make — push to break". One pair of contacts should take the special "PAUSE" line to ground when it is on. This line does not exist in the umbilical cord coming from the board socket but must be soldered to the end of R3 going to pin 3 of IC4. The other pair of contacts is connected across the tape power control pins of the respective DIN socket.

You can make up all the above on flying leads to test the unit fully before putting it into its cabinet.

Power up again and get the initialisation message. Try pressing any key on the keyboard EXCEPT PGIOLW or T and the computer should respond by saying INVALID. Press CONTROL C and the screen should clear and re-initialise. Press RESET. When the button is released the same should happen. Try INT2 and the machine should, again, reinitialise. When you try INT1 the screen should clear without the message appearing. To get something back on the screen press any keyboard key except those in the "key character" message (P.G.I.O.L.W.T). You should, once more, get INVALID. Depress CONTROL C once more and your computer is re-initialised and ready for test.

Program

We must assume at this stage that you do not know anything about programming so simply follow the instructions and check that you get what is described.

Depress P on the keyboard. You will get:

P
PROG START=

(The computer is asking you to tell it the address of part of memory you wish to inspect)
Type in 0000 followed by carriage return.
The display will now show:

P
PROG START= 0000
0000 31 (31 is the data in location 0000)

Depress carriage return repeatedly and you will get the following as you step through the Monitor program instructions ▶

```
P
PROG START= 0000
0000 31
0001 80
0002 14
0003 FB
etc
```

Reinitialise with CONTROL C and then type L. The computer will again ask you for a start address but this time will list out the contents of 15 adjacent locations starting from that address. We can use this to test that our memory is there and working in the RAM area.

Answer the computer with the address 1600 and a carriage return (if you make a mistake before you press CR you can backspace with CONTROL H and change an entry but you must then type through the rest of the line on the screen). The computer will list the contents against the memory addresses and then stop and ask for "MORE?". If all is well you should see 00 in all locations. To continue type Y and keep doing this checking all the locations up to the highest order RAM on the board. Above that address the computer will read FF which indicates that there is no memory there. If you see any data above address 15FF that is anything other than 00 or FF you can be sure you have a bad connection to the RAM IC which contains the data in question. This test only holds true immediately after first initialisation and cannot be used if you have attempted to write programs.

To get out of LIST type any character other than Y and the computer will reinitialise. Carry out this or any of the other reset procedures already described and procede to check the G function. This is to facilitate running a machine code program. The computer will acknowledge

```
G
RUN
PROG START=
```

(this means it is ready to run but wants you to tell it from where in memory it should get its first instruction). Give it this information by typing 02B9 followed by CR. You will actually be running a re-initialisation program in the Monitor which should just acknowledge with

The Triton's board mounted in its case. Note that the extender socket is available on the right hand side of the case and that the output of the modulator is brought out to a UHF socket on the back panel. The back panel also carries the DIN sockets and the mains fuse.

```
FUNCTION? P G I O L W T
```

You are now back where you started so you can try typing W which turns the computer into nothing more than a video display typewriter. You can type away to your heart's content testing out all the alpha numeric and graphics characters using the keys in unshifted, shifted, and control mode. Do this while inspecting the coding tables shown in the section describing the VDU and get used to the cursor move commands. Type a full line of characters and adjust RV1 for best line length. To get out of this mode of operation use CONTROL C or any of the other methods of resetting.

The next test sees BASIC L4.1 in action; depress T. The computer acknowledges with

```
T
BASIC L4.1
OK
>
```

Type in NEW followed by CR to make sure the memory is cleared and the computer re-acknowledges with the BASIC header. Very carefully type in the following message line by line with a CR at the end of each line. Remember you can correct by backspacing with CONTROL H before you hit CR.

```
>10 FOR A=1 TO 10
>20 PRINT "HELLO"
>30 NEXT A
>RUN
```

You should not re-type the "greater than" prompt signs — the computer is prompting YOU with these. When you press CR after typing RUN we hope you will be surprised — you have just written your first program!

You can now be pretty well assured that your computer is working correctly and it only remains to test and adjust the Tape I/O circuits. This must be done in stages.

First check the Tape Output software. Connect an audio monitor (simple amplifier or crystal earpiece) between the "Tape Out" socket on the board and ground. You should hear a continuous tone. Call up BASIC by typing T and enter the above program again. Once you have done this get back to the Monitor without erasing your BASIC program (use CONTROL C). Now press O to call up the Tape Output routine.

The computer will ask you for a TAPE HEADER which can be anything you like written in alpha-numerics. Preferably do not use a title longer than 20 characters as you might run out of input buffer space! We suggest you type in TEST ROUTINE. Follow this with CR while listening to the tone on the ear piece. Nothing will happen on the VDU but after a pause of between 5 and 6 seconds (longer if you are using a master clock crystal lower than the 7.20MHz as specified) you will hear about 1 second of regular high speed pulses followed by a few seconds of what can best be described as ''burble'' (this is your program going out). The burble will stop and you will hear just the continuous tone you heard at the beginning. After a further 5 or 6 seconds the VDU will confirm that the file has finished by displaying END followed by the re-initialisation heading.

On A Plate

Repeat this excercise but this time connect a continuity meter across the tape power control sockets on the board. (The manual overide switch must be open circuit). While you type in the tape header code the meter should show that the relay is open circuit but as soon as you depress the CR to start the operation the relay closes and stays closed until the VDU types END. It is obvious that the 5-6 second delay at each end of the routine is to allow a portion of blank tape to go by to reduce the chance of you overlapping files or missing the start of the active tape at the beginning of a new cassette.

You must now set the Baud rate for your system. The simplest way is to use a frequency meter connected to pin 3 of IC81. Adjust RV2 until the meter reads exactly 4800 Hz. A better way, and probably more viable for most constructors, is to use a standard test tape. It is better because different tape recorders might operate at different speeds which would influence the play back baud rate of your system. This does not matter if you are only recording a playing back your own programs but if you wish to use those from other sources your *overall system* MUST operate at 300 baud. Using a standard test tape calibrates your overall system to 300 baud as viewed from the outside world.

Monitor Manipulation

To carry out this test properly you must have a master clock crystal having a frequency greater than 4.5MHz otherwise the VDU may not print out as fast as the data is coming in from the tape. You must also enter and run a special machine code program to facilitate the test. We will not explain how the program operates in this article except say that it accepts any data on the tape and displays it, verbatim, on the VDU. If garbarge is received and decoded garbarge will be printed. The test tape contains the alphabet followed by CR and Line Feed repeated many times over a period of a few minutes. All you have to do when the program is running is set RV3 to its midway position and adjust RV2 until you get the alphabet reliably repeated on the screen. If, at the best setting of RV2 you still get the occasional bit of rubbish try altering RV3 for best sensitivity. You should, of course, be using the phono output from your tape recorder but if you do not have this use the extension speaker socket with the volume set about 20% up from minimum.

TRITON Trials

Carry out the following instructions TO THE LETTER!

Initialise the computer with RESET; type in P and enter the start address for the program as 1600. For zero always use 0 and not o. Press CR and location 1600 will be shown to contain 00. Now use the memory change facility to start writing your program. Simply type in the following list of hexadecimal instructions — each pair of digits should be followed by CR. You will end up with a column showing address locations to the right of which is a column showing what was in that location (should have been 00 in all cases) and to the right of that the new data you have just typed in. When you have typed in the complete list of instructions use CONTROL C to re-initialise then type L and list from location 1600 (as previously described). Check that the codes in each location correspond **exactly** with those in the published program. Use CONTROL C to re-initialise and then type G. Enter 1600 without pressing CR at this stage. Make sure your tape recorder is properly connected to the board and switch on the recorder in PLAY mode. Press CR and procede to adjust RV2 as previously described. You should see:

ABCDEFGHIJKLMNOPQRSTUVW-XYZ
ABCDEFGHIJKLMNOPQRSTUVW-XYZ
ABCDEFGHIJKLMNOP etc

until the recording ends or you switch off the tape recorder. While this is happening your computer is locked within a program loop and you will *not* be able to get out of this with CONTROL C. You will have to use INT2 to re-initialise.

Here is the program you must type in:

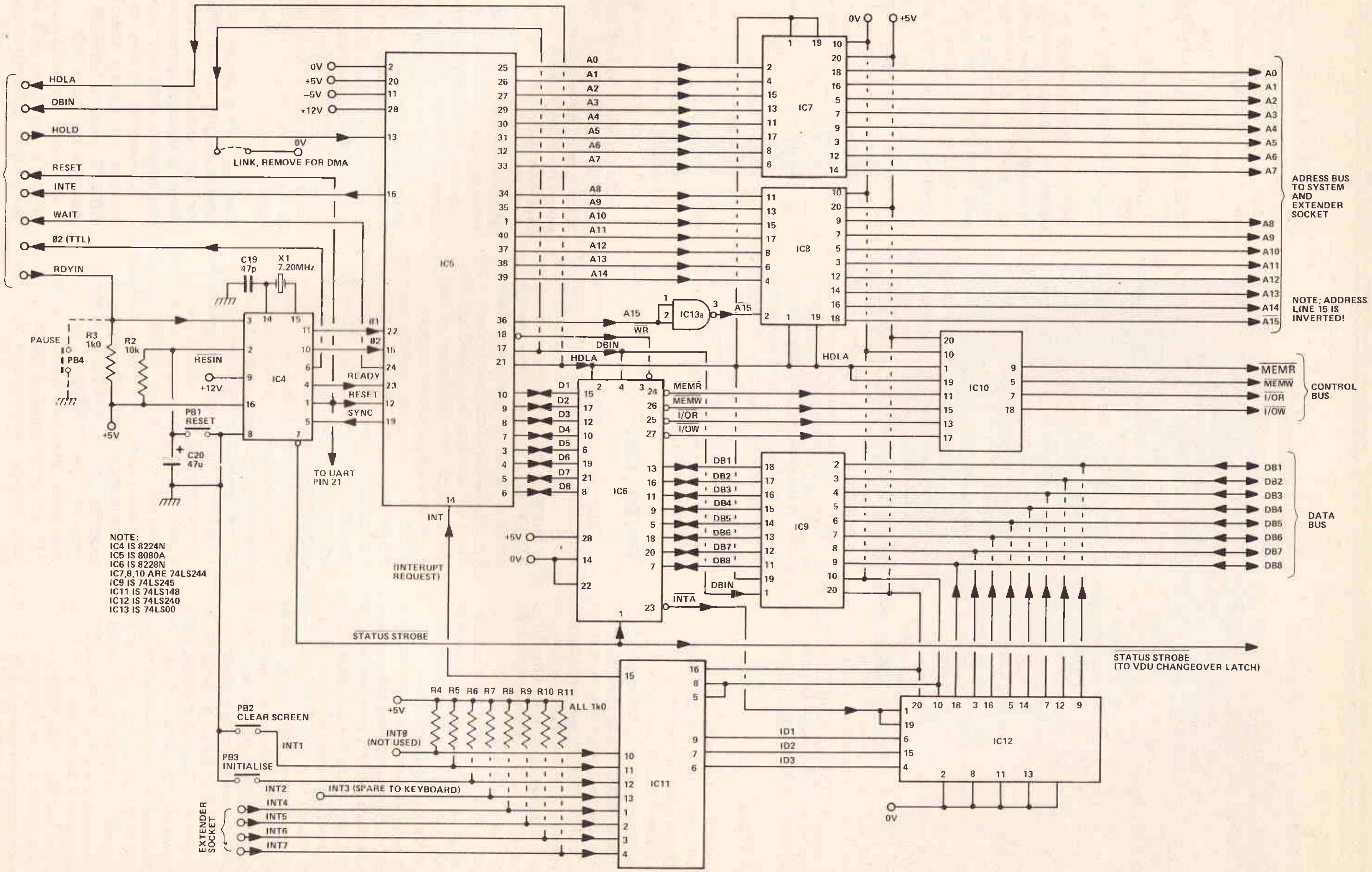
Address location	Data you must enter
1600	CD
1601	27
1602	03
1603	CD
1604	1D
1605	03
1606	CD
1607	13
1608	00
1609	C3
160A	03
160B	16

Your computer is now completely set up and ready for use. You have already been shown how to enter and run simple programs in BASIC and Machine Code. Why not now read the further articles in the Supplement which will show you how to make more full use of the TRITON. You have made an extremely powerful computer whose applications are only limited by your own imagination and the development of more sophisticated software — coupled with extender boards to give you extra I/O functions (Floppy Disks, Line Printers, extra Tape Recorders, more Memory etc). Keep reading ETI for further exciting applications and developments.

The following pages contain the circuit diagrams and descriptions for the complete Triton design. 'How It Works' sections refer to the diagram they accompany.

Computing Today carries an article on using the Triton's BASIC and a review of the machine by John Coll.

A fuller description of the Triton's monitor will follow in next month's Computing Today.



The CPU section of the Triton.

HOW IT WORKS

IC4 is the master clock oscillator which contains divider circuits to provide the two phase clock (ϕ 1 and ϕ2) for the 8080. You can use different frequency crystals for X1 but the ideal value is 7.20MHz and this value should not be exceeded. Lower frequency devices are fine but the system will operate proportionally slower. If you put in a higher frequency crystal not only will you run into memory access time problems but the system will be operating at a rate faster than the VDU can handle. The Monitor program has provided the maximum permissable print out rate for a clock frequency of 7.20MHz.

A TTL compatible output of ϕ2 is available but not used on the main board; this is fed to the extender socket. The chip also contains gating circuits to synchronise the externally generated RDYIN command before feeding this to the CPU. An internal Schmitt Trigger on the reset input line ($\overline{RESIN}$) allows a very simple charge up circuit comprising R2 and C20 to provide power on reset. Manual reset is carried out by momentarily taking $\overline{RESIN}$ to 0 volts via a push button. The clock receives a feedback signal (SYNC) from the CPU which is gated with ϕ1 to give a STATUS STROBE pulse at the precise moment the data busbars are carrying the status byte. The pulse ($\overline{STSTB}$) is fed to the System Control chip (IC6) to latch the status byte and is also used by the VDU to enable Memory Mapping changeover.

C19 discourages the crystals from harmonic operation. This shifts the operating frequency by about 10Hz but this is of no real significance.

A description of the inner workings of the CPU (IC5) is beyond the scope of this article. It's general operations will however become apparent as this How It Works is read.

Note that certain outputs (namely HDLA, DBIN, INTE and WAIT) are taken to the extender socket directly from the CPU. These are unbuffered and account should be taken of this if you expand the system. Each line will adequately drive a single TTL load and maybe a handful if you use low power devices.

The HOLD line going to pin 13 of the 8080 is not used within the main board and is used to carry a DMA request which, via the HDLA signal puts all the busbar buffers into a high impedance state. This could facilitate a take over of the complete memory of this system by a peripheral device or, possibly, another computer. Normally this line should be at logic level "O" so we have hard wired it thus with a board link. This link MUST be removed, or a switch substituted, if use is made of this line!

RDYIN is normally held at level "1". If taken to "0" it causes the CPU to stop operating. Nothing happens as long as the signal is low and the contents of all internal registers within the MPU are maintained. When the signal returns to "1" the MPU carries on operating as if nothing had happened. By taking pin 3 of IC4 via a push switch to ground we have a ready made "PAUSE" control which will enable the TRITON to stop in mid program; say, the middle of long high speed VDU output to inspect the screen.

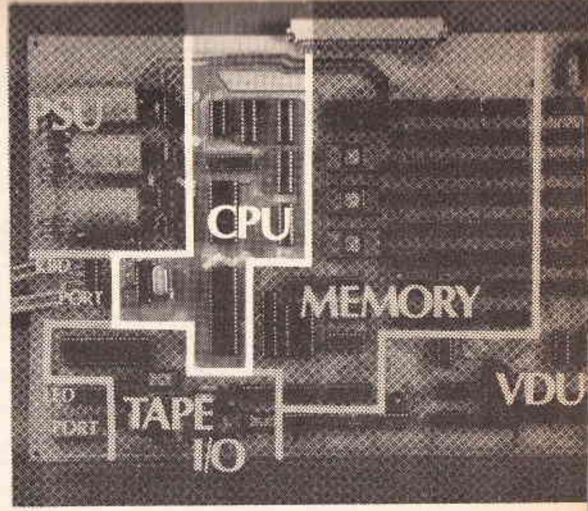
The chances are very high that you will not need RDYIN for external systems so the feature could be built in permanently. Note should be made that it is bad practice to have a push switch hard wired to ground on this line if at any time in the future you derive the RDYIN signal from a gate. Press the button and bang goes the output stage of one innocent gate.

IC6 is an 8228N 8080 System Controller which gates out the five main control busbar signals from the status byte at the time of $\overline{STSTB}$ and holds these on latches. The chip also comprises a set of bi-directional buffers for the data busbar; the direction of these buffers is controlled by DBIN and their outputs are disabled on the receipt of a DMA request by the HDLA signal. We were not happy that this buffer alone would be capable of supporting a fully extended system hence a further buffering stage in the shape of IC9 (74LS245). Like the System Controller the latter chip is supervised by the HDLA and DBIN signals. Integrity of any DMA request is maintained on the data bus.

ICs 7 and 8 are uni-directional tri-state buffers which should allow the address busbar to feed a fully extended system. Note that we have inverted A15 prior to putting it on the bus. By doing this we have been able to economise on chip select decoding circuitry elsewhere in the main board system. This should present no problems to anyone working with extender boards provided that this fact is remembered.

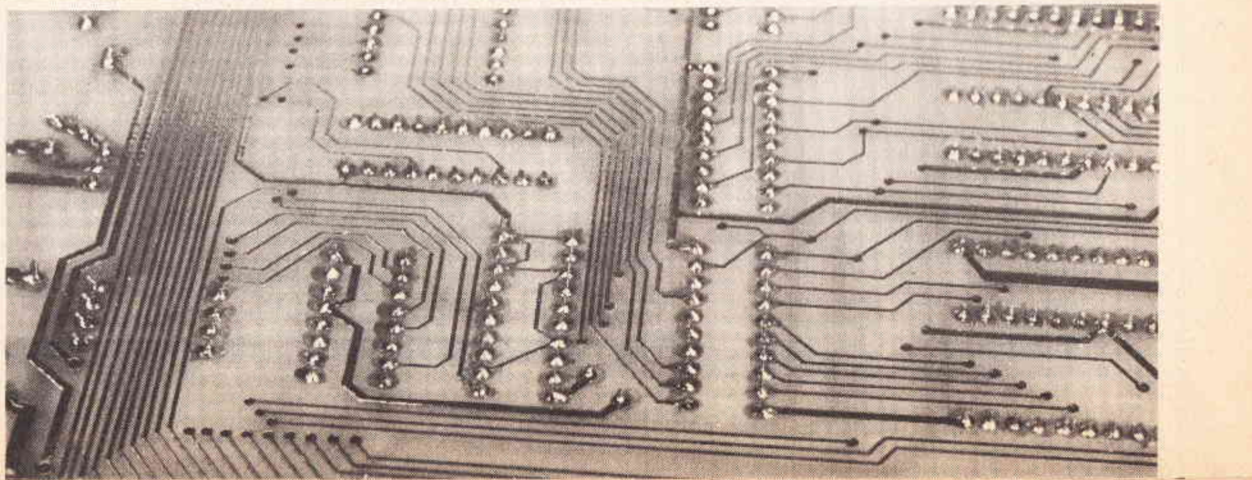
Remember, you must disable the push switch in this mode, that is why we have shown it dotted in and why Transam have not built this facility into their PCB in an obvious way. Why not use common sense and make use of this extremely valuable facility — all that is needed is the cost of 20cms of wire! You do not even need another push switch because you can use a spare pair of contacts on the Tape Control Manual Overide. It does not normally matter if you press this button provided the cassette recorder is switched off with its own control.

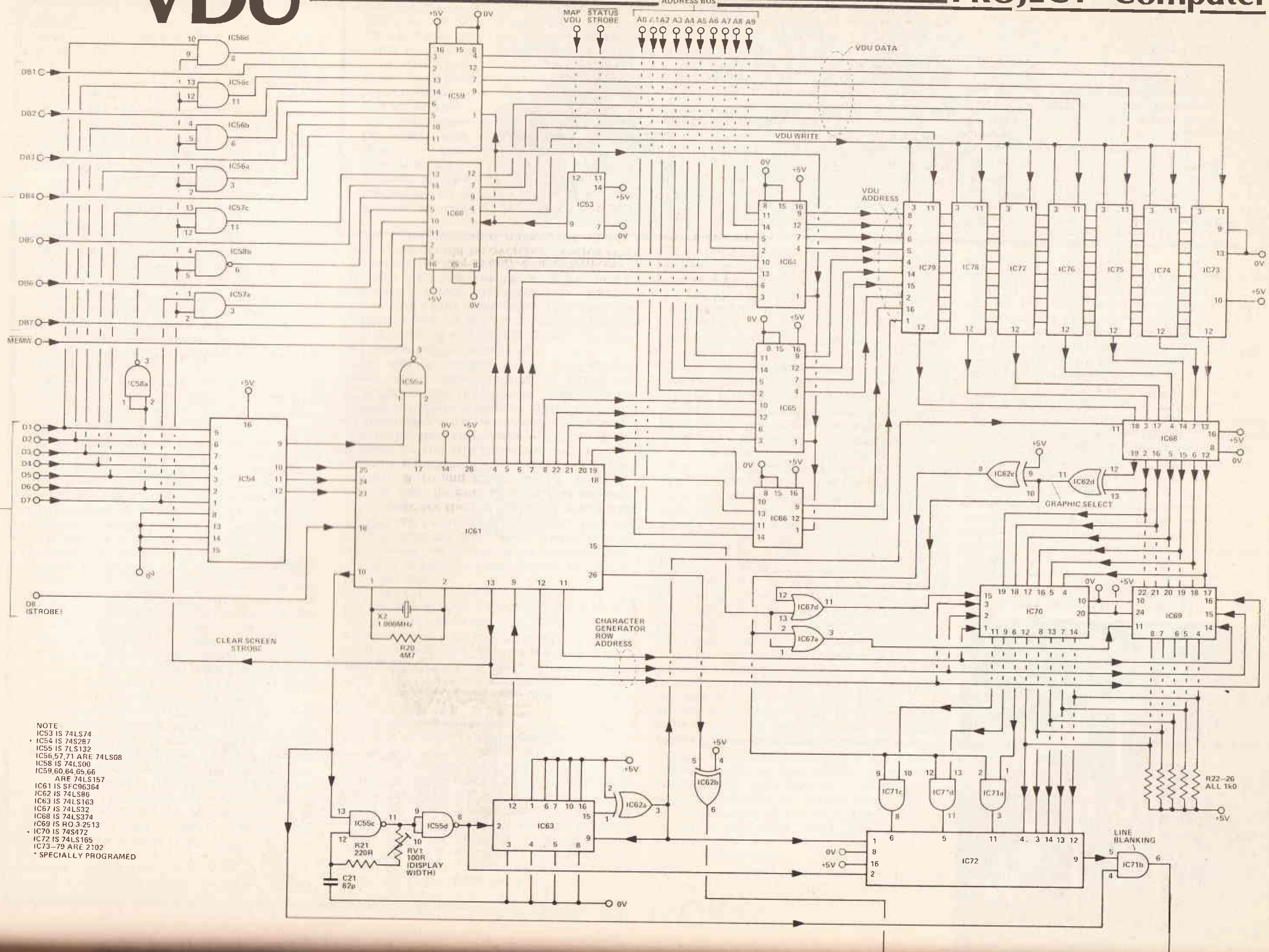
IC11 is the Interupt Encoder which has eight lines going in to it. These are normally held high by pull up resistors R4 to R11. The encoded three-bit nibble is output at pins 6, 7 and 9. If all the inputs are high all the outputs are high and a "0" is placed on the Enable Output line at pin 15 (the latter is used to generate the $\overline{INT}$ signal — Interupt Request — to the CPU). If any single input is pulled to 0 volts, via the push switches or external logic, an equivalent code to describe that line number is output as the Interupt Data Nibble and pin 15 goes high telling the MPU that an interupt has been requested. The MPU will carry on operating until it reaches a perissable point in it's cycle to service the interupt. When this point is reached the MPU outputs an Interupt Acknowledge signal (INTA) through the status byte which is decoded and latched by the System Controller. This signal is used to activate the Output Enable of IC12 (an eight wide tri-state inverting buffer) which formats the ID nibble to make an eight bit Interupt Data byte which is then accepted by the CPU as a RESTART instruction. The program counter jumps to one of eight fixed locations in memory — the location is defined by the ID byte — while the STACK preserves all current register data and status information. The MPU then operates on the interupt routine and returns to its main program when it comes to an RET instruction.



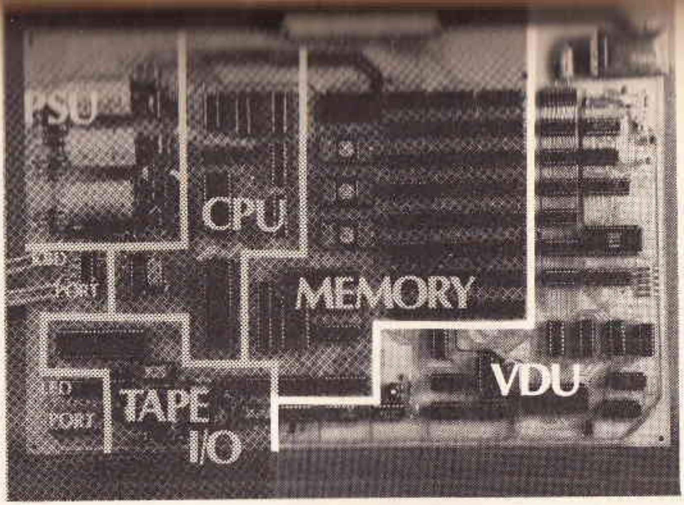
Interupt 0 should not be used even though it is available on the PCB. It simply duplicates the manual reset operation but would create problems if used with the TRITON's Monitor program. INT1 is dedicated by the Monitor to provide a Clear Screen and Reset Cursor facility which can be carried out at any time. INT2 is also a dedicated function. The Monitor includes memory test facilites as part of the power up routine and use of the reset button will clear all memory. To by-pass this problem we are using INT2 as a non-destructive reset which, as far as any programs that are running are concerned, is just like reset and the system will re-initialise but the memory will not be cleared. ALWAYS use INT2 for reset unless one of your programs has corrupted the Monitors stack!! Only then should you press manual reset or carry out a Power On Reset by swit switching the machine off and on.

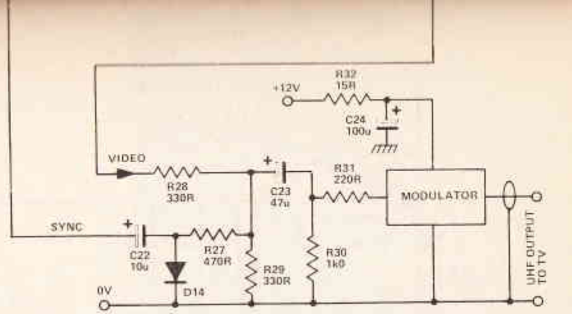
Photo of the underside of a section of the Triton's PCB. Note that although it appears that there are no connections to some IC pins — ALL pins must be soldered as these pins are used on the topside of the board.





NOTE
IC53 IS 74LS74
• IC54 IS 74S287
IC55 IS 7LS132
IC56,57,71 ARE 74LS08
IC58 IS 74LS00
IC59,60,64,65,66
ARE 74LS157
IC61 IS SFC96364
IC62 IS 74LS86
IC63 IS 74LS163
IC67 IS 74LS32
IC68 IS 74LS374
IC69 IS RO 3 2513
• IC70 IS 74S472
IC72 IS 74LS165
IC73–79 ARE 2102
* SPECIALLY PROGRAMED





VDU section of the Triton.

HOW IT WORKS

IC61, the Thomson CFS VDU control integrated circuit, has a built in clock which generates standard TV synchronisation pulses (line and field sync) on pin 26. Random interlace is used and a simplified field sync train is generated as opposed to the full CCIR specification.

The chip, synchronously with this train of pulses, generates addresses for the VDU RAM so that the correct code of the character is selected as the TV raster spot is traversing the respective part of the television screen. An external "Picture Point Oscillator" (IC55c and d) in conjunction with a divider chain (IC63) sets the horizontal width of a character and steps the address of the control chip, output from pin 12(IC63) to pin 9 (IC61). The inverted output of IC63 pin 15 is used to latch the data being addressed by the controller into IC68 (a seven wide latch), latch the picture point pattern generated by the character generator ROM into the serialiser (IC72) and reset the picture point divider chain (IC63) at the end of each character width.

The picture point width (hence the character width and number of characters per line) is set by the frequency of the oscillator control RV1.

We are using a 7 bit wide RAM to hold the FULL ASCII code — we need this to provide capacity for graphics. The outputs of the latches feed both the standard alpha-numeric character generator (IC69) **and** a specially programmed ROM (IC70) which contains picture point data for the 64 graphic symbols. We use the EXCLUSIVE OR function (IC62d) on bits 6 and 7 of the ASCII code to select either the graphics or alpha-numeric ROM. The select signals go through further gating (ICs67a and d) to ensure that the integrity of the cursor generating pulse (pin 15 of IC61) is not corrupted.

Three further address lines from the VDU controller (pins 11, 12 and 13) address the picture point data ROWS in both ICs 69 and 70. Due to a limitation caused by the internal operation of IC61 chip the row address code 000 is output for the top row and the bottom four rows of the character cell. Normally rows 0, 8, 9, 10 and 11 are used to provide inter line gaps for alpha-numeric displays while rows 1 to 7 carry alpha-numeric picture point data. We have had to take this into account when designing the font of graphics symbols — some of which cannot fill the complete character cell rectangle on the screen. Look at the table of graphics characters and you can see how we have adjusted the graphics to suit this restriction.

Further complications caused by this limitation are that a graphic must not appear on the topmost line of the television screen if that graphic contains picture points in its top row. IC61 requires there to be zeros present here in order to derive field blanking. This problem could be overcome with extra gating but this would have been at the expense of simplicity.

A similar problem (involving line blanking) is resolved by gating the video output with the INI function (pin 26 of IC61) in IC71b. Without this any graphics symbol having a picture point in its most left hand column would have caused a "wrap around" while a line that interferes with the DC level of the line sync pulse. The only problem that remains in this respect is that you will now get a single "extra" picture point showing to the right of the 64th character down a line if you use a graphic in the most left hand position of a line. This does not happen with all graphics — only those that have picture points in their most left hand column.

The five outputs from the alpha-numeric ROM are wire ORED with five of the eight outputs from the graphics ROM and held high via pull up resistors R22 - 26. They are then fed to the correct positions in the serialiser shift register IC72. Note that the remaining three outputs from the graphics ROM have to be ANDED with a signal defining whether or not the character is a graphic (done by ICs71a, c and d). This is to ensure that if alpha-numerics are printed there is a correct inter-character gap.

So far we have avoided talking about how the VDU RAM is addressed by the control chip. Let's deal with that now.

We are allowing the CPU to memory map the VDU RAM. To do this we have had to allow the MPU to take over addressing control of the VDU RAM. This is done by taking all the address lines from IC61 and their equivalents from the system's busbar to a set of data selectors (ICs64, 65 and 66). If the MPU addresses the VDU memory location (any address between 1000H and 13FFH) the block select line (MAP VDU) is activated. This of course, could happen if ever the address busbar went into a high impedance state (during HOLD etc) so to prevent any spurious pulses affecting the operation we gate the VDU block select line with STSTB which only occurs when valid address information is on the busbar. We do the gating in a D type latch so that during the complete cycle of a VDU memory map the data selectors are set to allow the computer address bus to be transmitted to the inputs of the VDU RAM. At the end of that cycle and at all other times the data selectors hand over address control to IC61.

A similar transfer of responsibility takes place between the normal input data to the VDU (which gets to it via an output port) and the main system data bus. In this case the data is selected by ICs59 and 60. These also receive their changeover instruction from the changeover latch IC53. Note that we also have to do a changeover between the internally generated memory write command (pin 17 of IC61) and the MPU's MEMW strobe. This is done within IC60.

It only remains to describe the gates on the VDUs internal data lines and IC54. The former are used to force the ASCII code for "Space" on to the data lines when pin 13 (IC61) is at "O" in coincidence with a writing pulse to the VDU memory. This is to allow for the very useful internal function provided by the IC61 to clear the screen and reset the cursor in one operation.

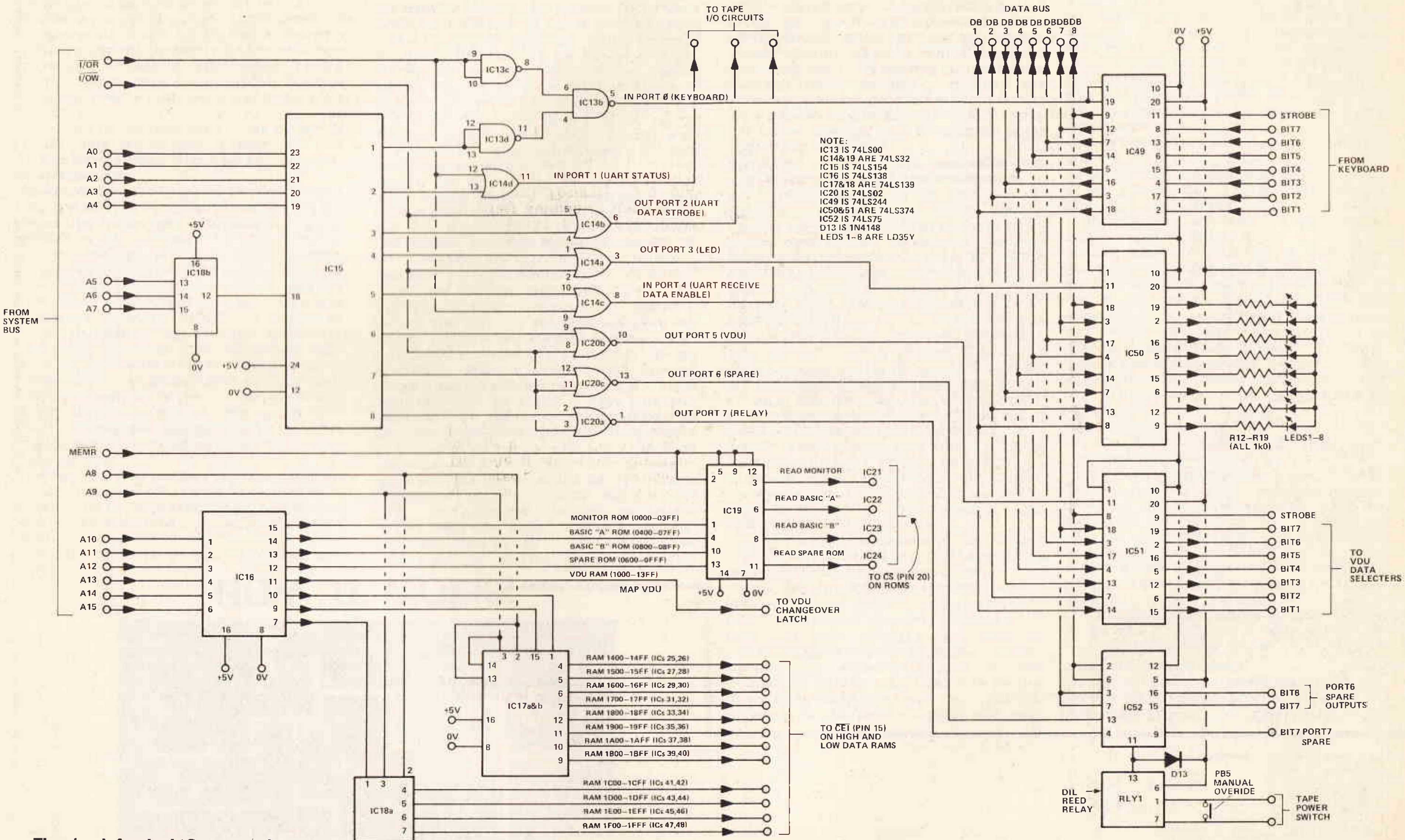
The VDU controller carries out a number of non writing functions as well as entering and addressing data within its memory. By using some of the ASCII codes as control it is possible to do such things as move the cursor in steps to any position on the screen, reset the cursor, carry out a line feed or do a carriage return clearing only the unused part of the line. There are also a couple of control codes that we wish the VDU to ignore — OOH and O4H — respectively these are NUL (or no operation) and EOT (end of text) flags. Recognition of all these special codes is carried out by the VDU CONTROL ROM (IC54). This has had to be specially programmed for the TRITON.

To get best use from the TRITON and its VDU you need to know hexadecimal and decimal values of all the ASCII codes that are used to generate alpha-numerics, graphics, and control characters. You also need to know which of the keyboard keys correspond to each graphic character. To help you we show all the graphics with their respective codes and key names in Fig. 00. Alpha-numeric codes are shown in Fig. 00 and the control codes in Fig. 00.

Normally you may output a character to the VDU for printing in I/0 mode every 8.3mS. The standard TRITON monitor errs on the safe side and has a built in delay which outputs a character roughly every 9mS. If ever you write your own software you must take this speed limitation into account. Furthermore there are two I/0 operations which take a considerably longer time: these are "Clear Screen and Home Cursor" and "Home Cursor". These instructions must be followed by a delay of at least 132mS. Again the TRITON's monitor makes allowance for this but you can get direct access to these functions if you use either the "PRINT CONTROL" or "VDU" commands which exist in BASIC L4.1. If you use these in BASIC you MUST follow them with a delay loop having a time constant greater than 132mS. (In practice we found that a 200 step "FOR — NEXT" instruction was quite safe.)

KBD PORT

PROJECT: Computer



The circuit for the I/O ports and memory select.

HOW IT WORKS

During an INPUT or OUTPUT instruction cycle the MPU will generate the address of the I/O port required on the least 8 significant bits of the address busbar. This has to be decoded to provide a single line signal which will activate the port. It is not sufficient to provide this address on its own because there is no way that the port can tell whether the select signal has come from a genuine port select instruction or whether it is the low order byte of a memory read/write cycle. Furthermore there are times within the machine cycle when the address busbar can be in a transient, or high impedance state which could cause indeterminate address information to be decoded by the port select circuits.

To prevent these problems and also to differentiate between input and output ports the decoded port line is gated with either the I/OR or I/OW control line. One or other of these lines goes to "O" after the ports select address has been placed on the busbar and terminates **BEFORE** the address data changes. This pulse is of the correct duration to strobe the I/O data on the data bus into or out of the port in question. Take, for example, the control of the Keyboard INPUT port. The port itself is simply an eight wide set of non-inverting tri-state buffers permanently connected to the data bus.

Pins 1 and 19 enable the output of the port when they go to level "O". Normally these pins are at "1" and held there by the output of IC13b and keyboard data cannot affect the data bus. IC18b and 15, between them allow 16 lines to be uniquely decoded from address bits 0 to 7. We only use 8 ports on the main board so part of this facility is redundant hence not all the outputs from IC15 are used. IC18b is a 2 to 4 line decoder operating as a 3 input NAND gate. The reason for this is that the device was one left over in a half used package and its use avoided having to put in an extra IC just for the sake of one 3-input gate. When address OOH is present on the bus pin 1 of IC15 goes low which points to Port 0 (the Keyboard). This signal is ORED with I/OR by IC13c, d and b so when there is coincidence IC49 receives "0" on pins 1 and 19. Whatever data is coming from the keyboard is transmitted on to the data bus and then accepted by the CPU as genuine input data. The reason for using three NAND gates to provide the OR function is again to use spare capacity in partly used ICs.

While on the subject of the keyboard port some might question the use of only ONE port for the keyboard instead of having a second one to check the status. We get around this apparent deficiency in the INCH (Keyboard Input) sub routine of the monitor. Interconnections with the keyboard put the 7 bits of ASCII on bits 1 to 7 and instead of parity we are using bit 8 to carry the keyboard strobe. Output port 3 works in similar fashion. IC15 decodes its address on pin 4 and IC14a ORs it with, in this case, I/OW. The resultant pulse is used as a clock to the D type latches within IC50. The data is entered into the latches on the rising (trailing) edge of the pulse. Using the trailing edge does not matter here. There is just sufficient current sinking capacity in a 74LS374 (IC50) to drive a small LED direct through a 1k0 limiting resistor. The byte of data is therefore transferred from the busbar to the latches and displayed in binary fashion on the LEDs. Note that the LEDs are illuminated when a "0" is output.

The VDU, when operating in I/O mode, is situated at PORT 5. This works in much the same way as the LED port but we are using a NOR gate to give a positive going port enable pulse. Bits 1 to 7 carry ASCII data and bit 8 the VDU strobe which is formatted to have the correct timing characteristics by the OUTCH (VDU Output) sub-routine of the Monitor program.

A further output port was required to switch the relay of the tape recorder power control (to effect automatic starting and stopping of the tape). Theoretically a single bit port was all that was required but as things turned out in the design this would have required a new integrated circuit (there were no spare latches left over anywhere else!). Because of this it was felt sensible to use a 74LS75 (IC52) which contains four latches connected as two pairs. This way we were able to provide a tape control signal to the relay at pin 11 (the Q output of one latch) by using data bit _ and this left a spare line on that port (bit 7) which can be used by the experimenter as an output line. The port to call for this line is number 7. At the same time the other pair of latches in IC52 are used as OUTPUT PORT 6 which comprises bits 7 and 8. These are also spare.

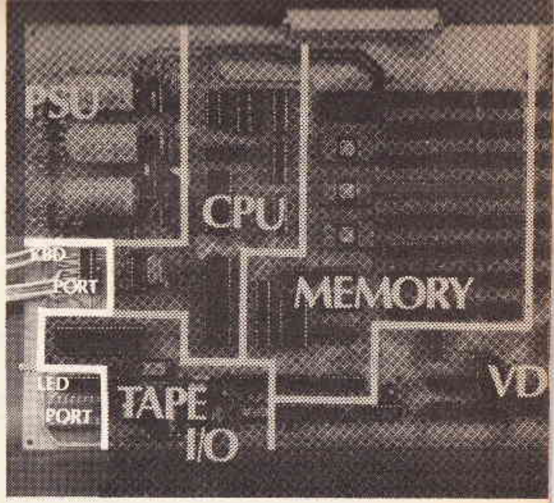
As we've moved on to the subject of tape control take note that there is a push button switch connected across the relay contacts. This is to allow manual override so that the cassette recorder can be rewound etc. under manual control without having to unplug the remote control lead. See the relevant section for more details about the serialiser I/O ports and MODEM for the tape recorder.

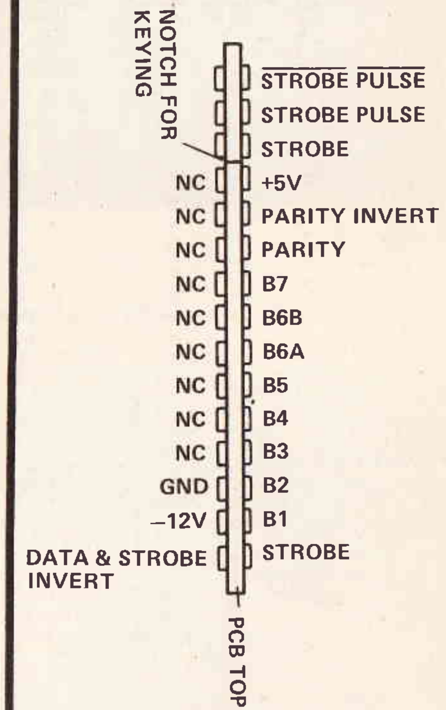
The memory of TRITON comprises four 1K blocks of ROM, one 1K block of VDU RAM and twelve 256byte blocks of Read/Write RAM. The high order addresses are used to decode individual lines which enable each block while low order addresses point to a specific location within the previously decoded block.

IC16 is a 3 to 8 line decoder but we are able to use it to decode, uniquely, eight individual blocks of 1K from the six most significant address lines. This is made possible by using A15 in inverted form and the internal gated Select inputs of the 74LS138. The four lowest order selected lines correspond to memory blocks which start at 0000H, 0400H, 0800H and 0C00H respectively and these hold the MONITOR. BASIC "A", and BASIC "B" read only memories. The block starting at 0C00H is a spare block reserved for ROM expansion. The line decoded at pin 11 of IC16 addresses the block of VDU RAM and the remaining three lines are fed to three 2 to 4 line decoders ICs 17 and 18a along with address bits A8 and A9.

The latter three decoders break down the remaining 1K blocks into 12 blocks — each containing 256 bytes. Each of these 12 lines goes to a specific pair of random access memory integrated circuits that form the main work area of the computer.

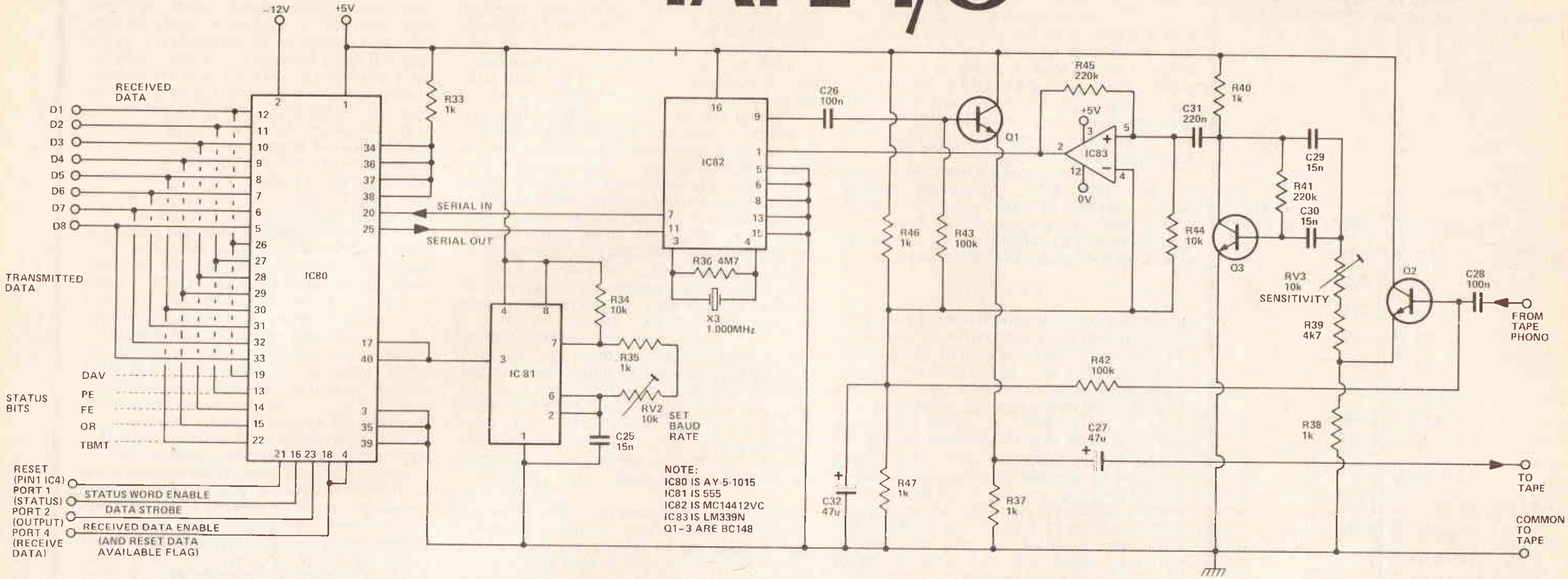
Except for the ROMs, gating with MEMR and MEMW is carried out within the memories themselves. The 2708 read only memories only boast a chip select input and it is necessary to gate the MEMR control signal with each of the chip select lines prior to making connection with the appropriate pin. This gating is carried out by the quad 2 input OR gates contained within IC19.





The connection details for the keyboard recommended for the Triton.

TAPE I/O



The tape I/O section of the Triton system.

HOW IT WORKS

The AY-5-1013 Universal Asynchronous Receiver transmitter features tri-state outputs for received data and all status bits. Note that respective bits of the data in and data out terminals of the chip are commoned together before joining the TRITON's data bus. The Status bits of the UART are similarly commoned with the DAV (Data Available) bit tied to bit 1 on the bus; PE (Parity Error) to bit 2; FE (Framing Error) to bit 3; OR (Over Run Error) to bit 4 and TBMT (Transmitter Buffer empty) to bit 5. Note however that TRITON's standard Monitor only samples DAV and TBMT.

The DAV and TBMT flags are used to tell the system when the UART has received and has ready a complete byte of new data or when the UART has finished a current serialising cycle and is ready to accept a new byte for transmission. In actual fact the UART will accept a second byte while it is still transmitting the first due to the double buffering nature of its transmitter buffer should be set on a frequency meter.

In order to transmit data the TRITON Monitor first checks to see whether the UART transmitter buffer is empty by activating the STATUS WORD ENABLE which is, in effect, PORT 1. This places the status word on the data bus and the MPU checks to see whether bit 5 (TBMT) flag is at "1". If so it indicates that the UART is ready and the Monitor then outputs its data on to the busbar while activating the DATA STROBE (PORT2). DATA STROBE starts the transmission serialising cycle and the serial data is output to the MODEM (IC82) at pin 25. If the TBMT flag was at "0" the Monitor goes into a loop and waits until the UART is ready.

In order to receive data the MPU asks for status information, again through input port 1 but this time checks bit 1 (the Data Available flag). This goes high as soon as a complete serial byte has been received and formatted into parallel form in the UART's byte of data is received. Clearly the software cycle, which carries out this operation, MUST have a shorter loop period than the period between one received byte and the next otherwise overrun errors will occur.

The Motorola single chip MODEM seemed highly attractive from the word go as it is extremely economical on external components and needs no adjustment.

The MC14412VL is such a versatile chip that it was again difficult to decide which mode it should be used in. Eventually, in order to have a frequency pair that would give best reliability with most tape recorders and to allow the MODEM to receive at up to 600 baud (not that this is used at present) we opted to go for the USA standard "originate" mode in which the transmitted frequency pair is:

MARK ("1") = 1,270 Hz
SPACE ("0") = 1,070 Hz

Clearly we need to be able to demodulate the same pair of frequencies so have to

The MODEM interfaces directly with the UART and only needs a crystal and resistor to lock it to the correct frequency pairs. It is most important that a crystal of exactly 1.0000MHz is used here otherwise you will not be able to use pre-recorded tapes! The transmitted carrier of the MODEM is an eight level digitally synthesised sine wave of about 300mVrms which is buffered by TR1 before being fed via C27 to the tape recorder phono input.

To carry out a demodulation satisfactorily the MODEM IC requires a very precise unity mark/space waveform at pin 1. The tolerance on the mark/space ratio has to be better than ±4%. If the carrier being played back from the recorder carries any harmonic distortion this will result in an asymmetric sinusoid which will be difficult to convert to a square wave of the above specification. To further purify the sine wave it is amplified and filtered by Q3. To some extent the input sensitivity can be adjusted by RV3 but under

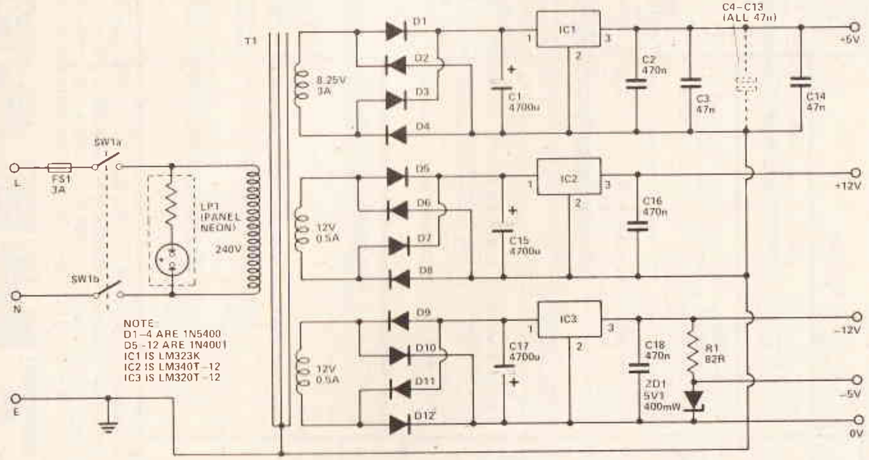
The format of serialised data in TRITON is a START bit, 8 data bits, a parity bit and 2 STOP bits. These are transmitted at a rate of 300 baud set by the clock comprising IC81 (an NE 555). Baud rate is adjustable by about ±50 percent by means of RV2 and, of course, it is important that this is accurately set if tapes from other sources (recorded in TRITON's format) are to be played back. To obtain a rate of 300 baud the oscillator must run at precisely 4800 Hz and ideally this

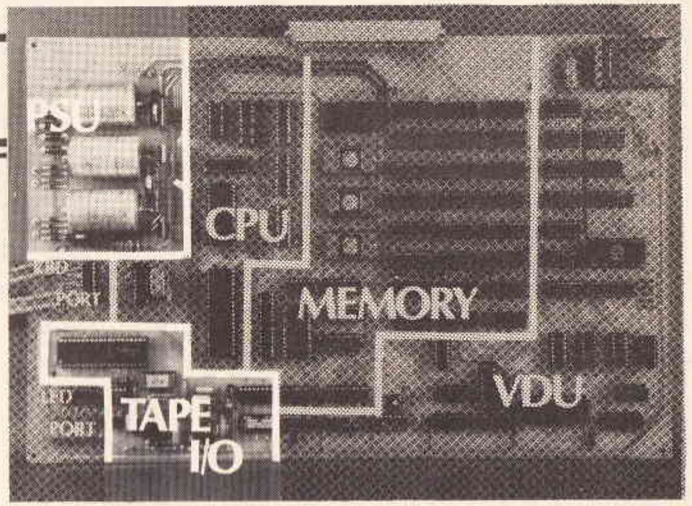
output latches. The MPU will loop until this condition is met. When the flag goes to "1" the MPU uses port 4 to send a "Received Data Enable" strobe to the UART. This enables the outputs of the receiver buffer latches and places the data byte on the system busbar. To prevent the system reacting a second time to the same DAV flag the pulse from port 4 is also used to reset DAV which then stays low until a completely new

operate in Simplex mode hence pins 2, 10 and 14 of IC82 are allowed to be "1". Internal pull up resistors within the chip do away with the need for external pull ups hanging on these pins! Pin 2 actually is the "Self Test" control input which makes the MODEM's receiver demodulate the same frequency pair that is being transmitted. Keeping this active prevents any ambiguity as to whether one is "originating" or "answering".

normal circumstances (within the range of input voltages mentioned above) this should always be set in its mid-point position. The high purity sinewave at the collector of Q3 is fed to IC83 which is a zero crossing comparator which will sense the zero crossing of a sine wave to within about 3mV. With a good input signal this results in a square wave that more than adequately meets the input specification of the MODEM.

PSU





The power supply section of the Triton is based on three terminal regulators.

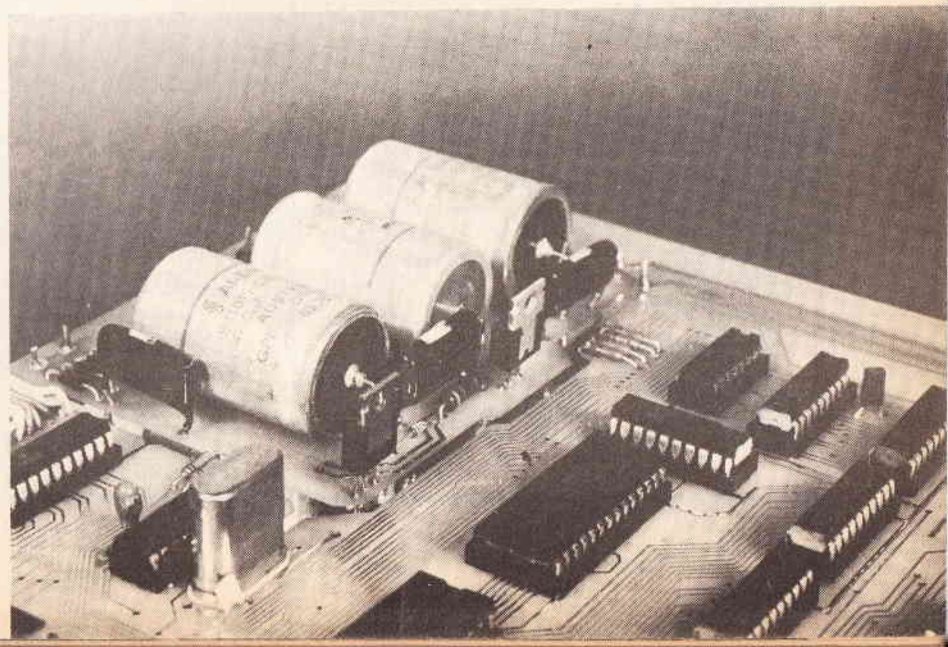
HOW IT WORKS

THE POWER supply has been kept as simple as possible, utilising three IC regulators to provide the main rail supplies which are +5 V at 3 A (the TRITON does not draw all this but do not rely on there being any to spare if you are thinking of hanging any other bits and pieces on this line!) +12 V at 0.5 A and −12 V at 0.5 A. A few milliamps are needed by the ROMs and the 8080 at −5 V and this is catered for by a simple zener shunt off the −12 V rail.

The ±12 V rails are straightforward. Dissipation by the regulators is low and no heat sinks are necessary. The 470n capacitors on the outputs of the regulators are to prevent any parasitic oscillations. Note that the +5 V rail has a dozen 47n capacitors (C3 to C14) shunted across it. These are anti-spiking devices and have been placed in strategic places on the board.

To avoid excessive dissipation in the main +5V regulator (IC1) we decided on a specially wound mains transformer, hence the rather obscure specification for an 8.25 V winding.

A close-up photograph of the PSU. Note the orientation of the IC regulators.



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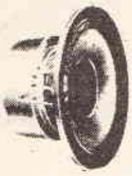

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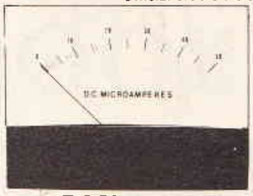

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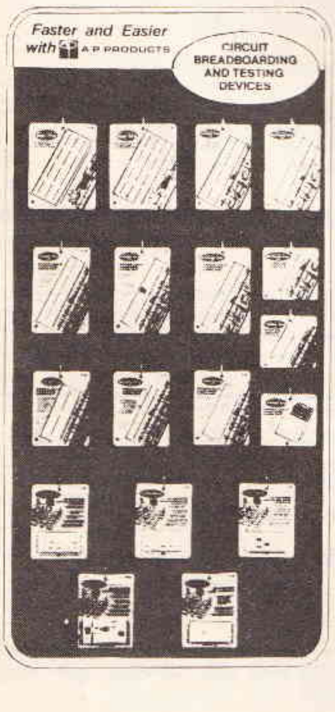

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ETI 1

VENUS PROBE

Venus, the shrouded planet of Edgar Rice Burroughs and Ray Bradbury, has fascinated men and telescopes for many decades. It was the favourite choice to house monsters and the scientists' choice for life of a more mundane type. Conditions are not that favourable, however, but are still interesting enough to warrant the launch of the Multiprobe which should tidy up some of the mysteries remaining.

Fig. 1. The Pioneer Venus Multiprobe spacecraft; a thermal test model is shown.

THE TWO Pioneer spacecraft should reach Venus around the end of this year, being sceduled to rach orbit on the 4th December. One of these probes, known as the 'Orbiter', will circle the plant for at least one Venusian year. It will collect data on the upper atmosphere of the planet (including field strengths and the types of particle present) and will also record events occuring on a global scale on or around the planet over a fairly long period of time.

The other spacecraft will consist of a transporting vehicle, known as a 'Bus', which will convey one large probe and three small probes to Venus. All five parts of this spacecraft will enter the Venusian atmosphere at widely separated points and will transmist data back to earth. The four probes will fall to the surface of the planet and should provide much information about the lower atmosphere at four widely separated points.

Although Venus is our closest planetary neighbour, it is always covered in very thick cloud; our knowledge of this planet is therefore very limited, especially as regards its lower atmosphere. The early probes have shown that Venus has a high surface temperature and an atmospheric pressure nearly one hundred times that of the earth, but a great deal of work remains to be carried out. It is expected that the two Pioneer spacecraft will increase our knowledge of this planet by a factor of about ten. They will also greatly increase our knowledge of the solar system and are expected to provide much information which will add to our theories about the origin of the earth.

Pioneering Spirit

The Pioneer missions were conceived as long ago as 1970 as a result of recommendations made by the Space Science Board of the US National Academy of Sciences who decided that there is a need for relatively low cost orbiter and probe landing systems for Venus investigations. Overall responsibility and control of the mission has been given to the National Aeronatuic and Space Administration (NASA) Research Centre at Moffett Field, California.

The Hughes Aircraft Company gained a contract to manufacture both space vehicles for the Pioneer mission in February 1974 after a series of competitions which started in 1972. The scientific instrument payloads were selected in June 1974, thirty instruments being included on the list. The spacecraft will be launched on top of Atals SLV-3D Centaur D-1AR rockets from Cape Canaveral, Florida. The vehicle tracking, command signal transmission and data reception will be carried out by the established US Deep Space Network stations in California, Spain and Australia.

The Multiprobe Mission

The Bus, the large probe and each of the small probes include payloads of scientific instruments. The Bus will be destroyed by burn-up in the Venusian atmosphere after its two instruments have transmitted data back to earth. It is, perhaps, somewhat surprising that work on the atmosphere and weather on Venus is expected to teach us more about the weather on earth.

The multiprobe vehicle is a circular, spin-stabilised craft with an array of solar cells around its exterior. The large probe will examine the atmosphere surrounding the planet, measuring the clouds, the atmospheric composition, etc. The three identical small probes will separate and enter the atmosphere some 7,000 miles apart two of them on the dark (night) side. They will collect information on the general circulation of the lower atmosphere. ▶

Structure

The structure of the multiprobe unit is shown in the exploded view of Fig. 2. The cylidrical solar panel is 2.54 m (100 inches) in diameter and 1.22 m in length. The equipment shelf if 2.47 m in diamter, the electronic units and the scientific instruments being mounted on this shelf.

The large probe is at the centre of the spacecraft on an inverted conical structure, whilst the three small probes are symetrically placed around the main probe. Each probe is fixed by spring loaded clamps which can be released (pyrotechnically) about 20 days before the craft arrives at Venus so that the five sections move independently.

The probe weight, including the interfacing connection with the launching vehicle, is designed to be 920 kg. Great care has been taken in the thermal design of the craft to ensure that the temperature is kept between suitable limits; heaters and thermal blankets are included and appropriate materials with suitable thermal properties are used.

The control system employs a sun sensor and a solid state sensor which can detect the radiation from 24 stars. The vehicle contains two tanks which will be filled with 32 kg of liquid hydrazine propellant. When this liquid is allowed to pass into a chamber containing a suitable catalyst, it decomposes into nitrogen and provides a thrust of about 0.5 kg as a jet for controlling the spacecraft's trajectory, attitude and spin rate.

The power for the spacecraft is obtained from the cylindrical array of solar cells which has an area of just over 6 square metres. This provides 228 W when the spacecraft is near the earth, but extra power can be obtained for a limited time from two 7.5A-hr nickel-cadmium batteries. The solar cells and batteries provide a 28 V supply; overload protection and undervoltage detection circuits are included in the power supply system.

Command signals are transmitted from the Deep Space Network ground stations to the Bus at 4 bits/second using pulse code modulation or frequency shift keying. The electronic on-board equipment can store command instructions for execution at some later time. Six command output modules on the equipment shelf can distribute 384 pulse commands and 12 quantitative (or analogue) commands to scientific instruments and to the spacefraft units. Commands from the earth stations modulated onto a 2115 MHz carrier wave are received by the spacecraft transponders.

Data for transmission to the ground is convolutionally encoded, assembled into 8 bit words in a 64-word frame and modulated into a data stream. Eight data input modules on the equipment shelf can receive the signals and establish up to 253 data channels with the telemetry processor for transmission to earth.

The data is transmitted on a 2300 MHz beam at a power of 10 or 20 W using one of three antennas and a data rate of between 8 and 2048 bits/second. The antennas comprise two omnidirectional types (forward and aft) to provide spherical coverage at both the transmit and receive frequencies together with a medium gain horn antenna at the aft end of the craft.

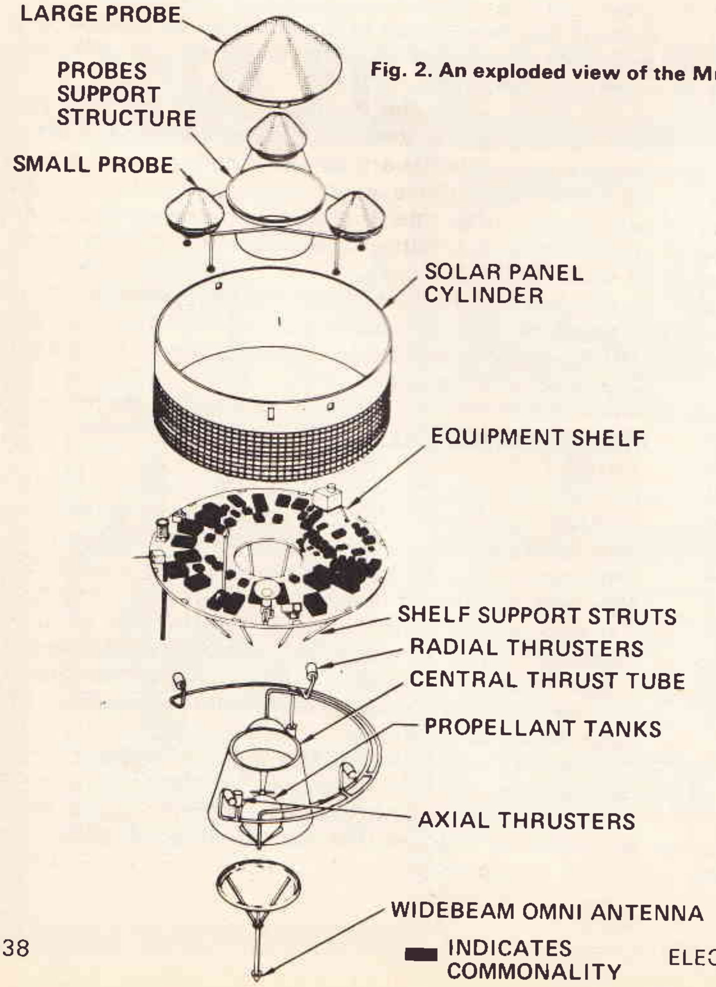


Fig. 2. An exploded view of the Multiprobe unit

Fig. 3. The large probe with shield and pressure vessel

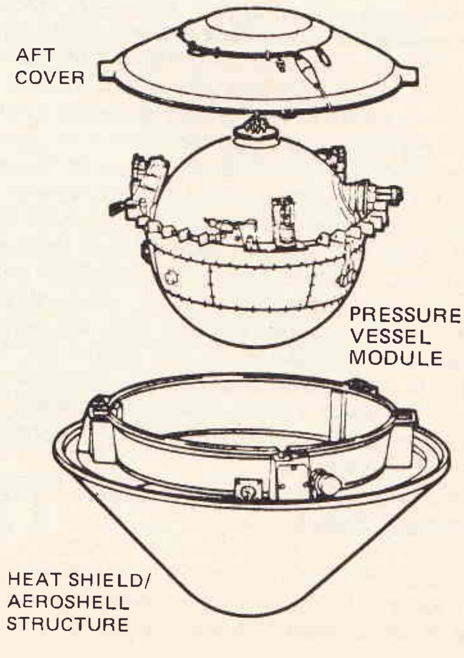


Fig. 4. An exploded view of the Orbiter spacecraft

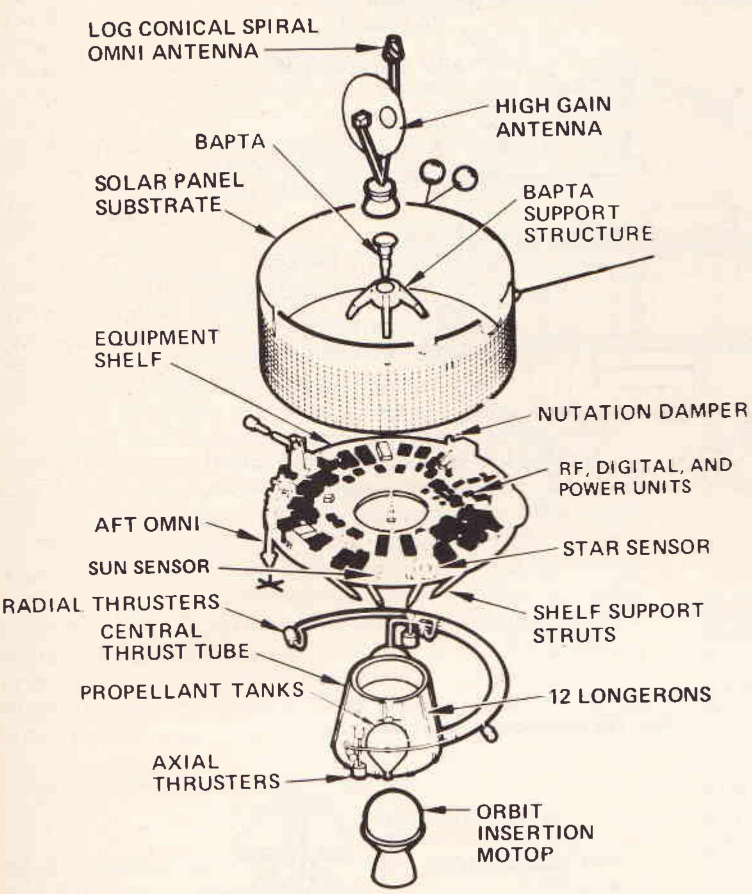
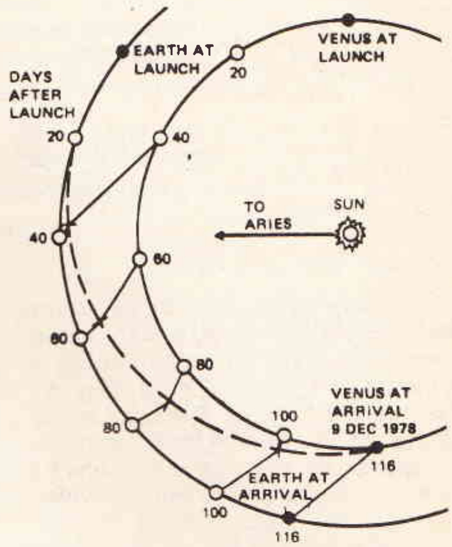


Fig. 5. Trajectory of the Muliprobe unit on its flight to Venus.



To Boldly Go . . .

The launching vehicle will place the multiprobe spacecraft into an earth parking orbit about 167 km above the earth where it will remain for 18 to 23 minutes before adopting the interplanetary trajectory shown. The spacecraft will initially be spinning at 5 RPM, but it is expected that contact with the ground station at Canberra will occur within four hours from launch and the rate of revolution will then be increased to 15 RPM by a command from the ground.

During the passage of the spacecraft towards Venus, the forward antenna will be employed to communicate with the 26 metre diameter dish aerials of the Deep Space Nwtwork. A velocity correctin of up to 12 m/s can be made five days after launch and further corrections at 20 days after launch, etc. Command signals for these corrections will be transmitted from one of the huge 64 metre diameter earth station aerials.

The large probe will be separated from the Bus about 24 days befora arrival at Venus. The spacecraft axis will then be precessed so that the medium gain horn can be used for earth communication. A velocity correction of 5.1 m/s will be made to achieve the required small probe trajectory and the three small probes will be released about 20 days before reaching Venus. The spin rate will have been previously increased to 48.5 RPM so as to provide a suitable tangential velocity at separation for the small probes to acquire the desired trajectory.

The velocity of the Bus will be corrected 18 days before its arrival at Venus to achieve the desired arrival point and to delay its arrival by 90 minutes so that all of the probes will have impacted on the surface of the planet by the time the Bus arrives in the upper atmosphere. Burn-up will occur at some 120 km above the planet.

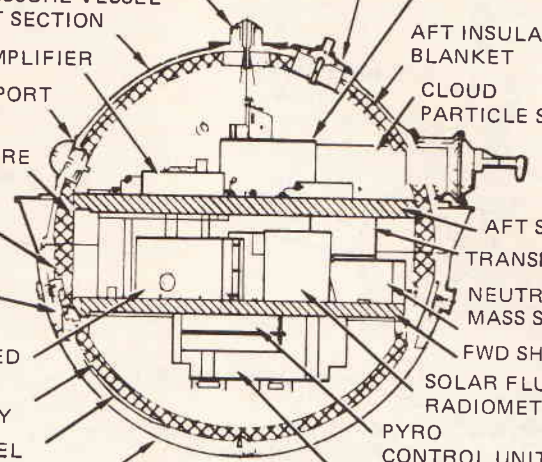
All five vehicles will enter the atmosphere in a two hour period and all will be transmitting simultaneously, so the time of entry will be arranged to be one at which two of the Deep Space Network stations can simultaneously receive signals to avoid possible loss of data.

Large Probe Mission

The large probe is to be aimed at a point on the daylight side of Venus, decelerations of up to 400 g being possible at times during entry. The large probe parachute opens at a height of 67 km and for the next 18 minutes the probe descends under the stabilising influence of the parachute to a height of 46 km at which point the parachute is jettisoned. The probe then falls to the surface of the planet over a period of some 38 minutes.

The probe is not required to survive impact with the surface of the planet, but will withstand the pressure and temperature at the surface. This requirement together with the requirement that the probe can withstand the fierce acceleration presents many design problems unique to this mission. ▶

Fig. 6. The interior of the large probe



The large probe and its deceleration module have a total weight of some 316.6 kg. The deceleration module provides thermal protection during atmospheric entry; it consists of a pointed nose cone of 45° angle with a diameter of 1.42 m. The base of the probe is thermally protected by a coated fibreglass aft cover.

The dacron main parachute has a diameter of nearly 5 m and is deployed by a much smaller pilot chute 0.76 m in diameter ejected by a mortar. The pull of the parachute extracts the pressure vessel module from the deceleration module.

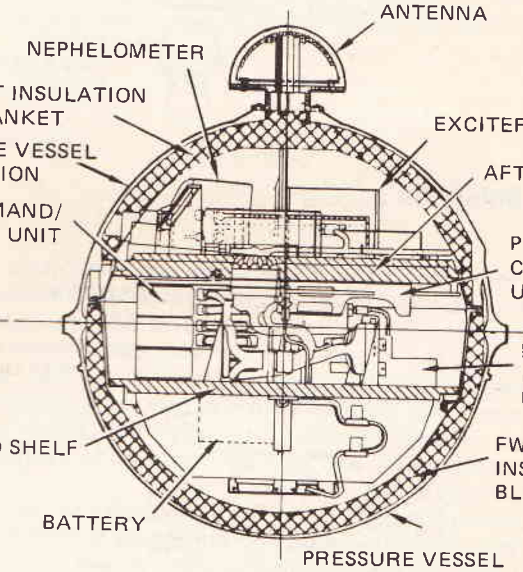
Pressure Vessel

This vessel contains nitrogen at a pressure of between about 0.5 and 2 earth atmospheres, but can withstand an external pressure of about 100 atmospheres. The 73 cm diameter titanium pressure vessel is constructed in three pieces and is about 6 mm in thickness. There are 15 apertures and 7.6 m of sealing are required to prevent gas leaks at the high temperature of the Venusian surface. The thermal insulation ensures that the electronics and instruments inside this vessel remain at a temperature not greater than 50°C even when the external temperature reaches 480°C.

A 19 cell 40 A-hr silver-zinc battery supplies power to the pressure vessel assembly. A total of 15 magnetic latching relays provide on/off control, whilst parallel fuses provide overload protection. Four solid state amplifiers, each rated at 10 W, feed a cross dipole antenna mounted on the rear of the pressure vessel which sends the data back to earth. A data rate of 128 or 256 bits/sec in a convolutionally encoded format is used, the system being capable of providing 72 data channels and 2 minor frame formats in an 8-bit word, 64 word frame. A 3072 bit memory provides storage facilities during the entry communications blackout; this blackout will have a duration of about 10 seconds.

The entire sequence of 128 commands is predetermined and programmed prior to the multiprobe launch. A timer with a 24.27 day capacity and a stability of ± 32 seconds turns on the system prior to entry.

Fig. 7. The interior of a small probe



The seven scientific instruments in the large probe weigh a total of 35 kg and require 106 W for their operation. Three of these instruments require inlets for sampling the atmosphere and four require windows for viewing the atmosphere. All of the windows except one are made of sapphire, the exception being the window for the infra-red instruments which is a 13 carat diamond nearly 2 cm in diameter; diamond is the only material able to transmit infra-red in the 10 micron region and to withstand the temperature and pressure at the Venusian surface.

The Small Probes

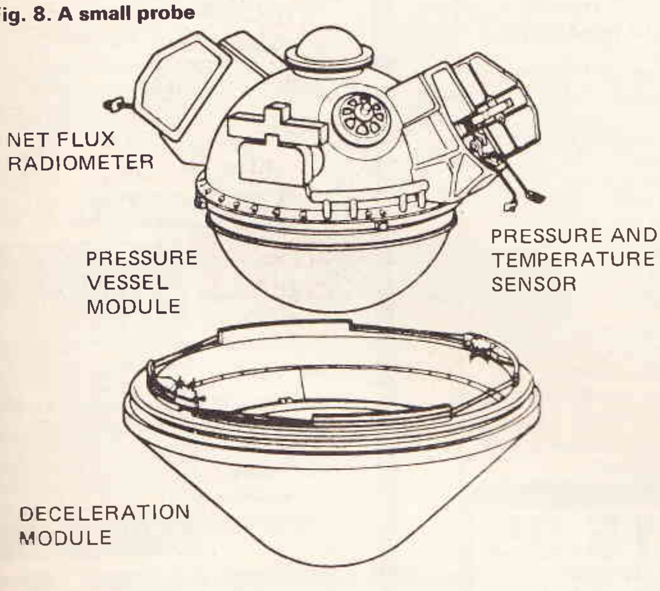
The three identical small probes are designed to measure the characteristics of the Venusian atmosphere simultaneously at three widely different locations. They are designed to withstand the high temperature and pressure at the surface of the planet, but need not necessarily withstand the impact with the surface. During entry into the atmosphere at a speed of about 11.6 km/s, a deceleration as great as 5652 may be encountered. The time of descent to the aurface will be about 59 minutes.

Each small probe contains a pressure vessel and a deceleration module. The total weight is some 97 kg. Unlike the large probe, there is no parachute with each small probe and the deceleration module is not detached during descent. The cone of the deceleration module has a diameter of some 76 cm.

The small probe pressure vessels which contain the electronics and the instruments are designed to operate with an internal atmosphere of xenon at between 0.25 and 2 earth atmospheres pressure. These vessels consist of a two piece titanium shell of about 46 cm diameter.

The small probes are each powered by a battery containing 20 silver-zinc cells with an 11 A-hr rating. Each probe employs a single, solid state power amplifier rated at 10 W RF output; this amplifier feeds a crossed dipole antenna mounted on the rear of the pressure shell. A stable oscillator maintains the S-band downlink frequency to 1 part in 10^9. The data rate used from the small probe to earth is 16 or 64 bits/second, whilst a 3072 bit memory is used for storage during entry blackout and when the bit rate is being changed. A 24.27 day timer turns on the system prior to entry into the Venusian atmosphere.

Fig. 8. A small probe



The 64 bit/second data rate is used initially, but at an altitude of some 30 km above the surface the data rate is reduced to 16 bit/second to allow for the attenuation of the radio frequency signal as it passes through the denser parts of the Venusian atmosphere.

The Orbiter Mission

The main aim of the Orbiter mission is to put 12 scientific instruments in orbit around Venus and to receive informaiton from these instruments. It can be seen that the Orbiter spacecraft has much in common with the multiprobe vehicle, including a rather similar structure. Some of the most noticeable differences are the replacement of the probe structure by a high gain aerial system which can provide communication with the earth at distances of up to 250,000,000 km. A 4.5 m long magnetometer boom is also used in the Orbiter craft.

The size of the Orbiter spacecraft is similar to that of the multiprobe craft. The diameter of the cylinder of solar cells is the same 2.54 m, but the surface area of the cells is greater, being almost 7.2 m^2. The Orbiter is lighter than the multiprobe unit, being just under 600 kg and only 372 kg in orbit.

The slightly large solar cell area of the Orbiter provides a little more power than in the case of the Multiprobe Bus, this power being about 325 W in Venus orbit. Two 7.5 A-hr nickel cadmium batteris are also incorporated in the Orbiter spacecraft.

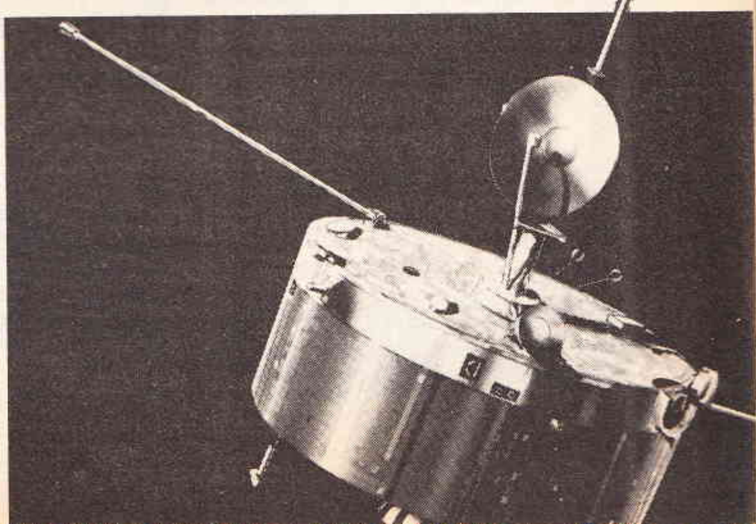
A bearing and power transfer assembly (BAPTA) serves an electrical and mechanical interface between the spinning part of the spacecraft and the despun aerial which must always point towards the earth. As in the case of the multiprobe Bus, 32 kg of liquid Hydrazine propellant is carried in two tanks and can drive seven jets, each with a thrust of about 0.5 kg, for the control of the trajectory, attitude and spin rate.

A solid propellant rocket motor, the Thiokol TEM-604, is to be used to place the Orbiter in Venus orbit. It has a velocity change capability of 1060.6 m/s for the maximum design weight.

Conclusion on Cost

A special feature of the Pioneer missions is the relatively low cost for such an ambitious programme. In order to reduce the cost, no experimental prototype craft have been built — only the one multiprobe and the one orbiter will be made, tested and orbited. Economies have also been made by using the same type of components (such as the RF amplifiers) in the Bus, Orbiter and in the probes. Identical command and data handling circuits are used in all of the probes, whilst about 78% of the Bus and Orbiter parts are identical. The cost of developing the probes themselves has been relatively high, since they involve new techniques, whilst special facilities have had to be developed to simulate the hostile Venus atmosphere.

It seems likely that craft similar to the Pioneer type will be useful for relatively economical missions to Mars and for flying through the tails of comets. ETI



The Orbiter craft. Note the long magnetic probe to measure the magnetic field well away from any interfering field from the craft. ▶

TELEVISION

Last month we described the operation of the Tolinka chess recorder — this month we deal with construction.

LAST MONTH WE described the overall principles of the Tolinka Chess Recorder and in this final part of the project we shall describe the circuit from the hardware viewpoint and go on to give constructional details.

First inspect the board on both sides to see if any of the holes have been blocked by tinning. The easy way to clear such holes is to melt the solder and apply the sharp point of a pencil. Wipe the iron frequently on a damp sponge or cloth to avoid solder splashes.

A Small Step

The first step in construction is to make the through board links support the board 4mm approximately away from the bench surface by putting bolts in the corner holes. The side without the IC pads should be uppermost. Each of the small round pads which has a counterpart on the opposite side of the board is a pin-through whereby connection must be made through the board. A piece of wire must be inserted into each of these holes and soldered on both sides of the board.

The board should now be cleaned of flux with a cleaning agent and inspected against a strong light. Look for missed pin-throughs, solder bridges and lifted tracks checking with a continuity meter any suspected opens or shorts. Spend a lot of time at this stage because this is where faults are most likely to exist—it is possible for another observer to find obvious faults on a board which has passed a lengthy examination.

The ICs are inspected next.

Socket It To Me

Use the socket strip provided for any IC with more than 16 pins. The best way of socketing an IC is to push the pins into the socket strip and then trim off the surplus strip. Do not break off the pin carrier part of the strip until you are ready to switch on the power. This will keep the IC pins shorted together during the soldering and assembly process. If desired socket strip or sockets may be used for the other ICs—and this is a wise precaution.

It is recommended that components be installed in the following sequence—first all discrete parts like resistors, capacitors and diodes; next integrated circuits and last the larger power supply capacitors and voltage regulators. Switches need not be installed until preliminary tests are completed and installation of the PCB behind the front panel has been carried out. The panel then forms a template which aligns the switches correctly.

Remember that the space above the board is limited and solder any bulky components beneath the board: this is certainly necessary for the power supply electrolytics. Leave the output pins of the voltage regulators unsoldered so that supplies may be checked without damage to the circuitry. Note that the power supply components are soldered directly to the tracks on the top of the board and only the wires of the electrolytics pass upwards from the underside of the board through holes. All voltage regulators are 'face down', the main 5 volt supply regulator being bolted to an area of circuit board which acts as a heat sink.

Testing Time

Turn on the mains and test power supply voltages before soldering the regulator output pins down to the supply rails. Remove all ICs from their sockets and break off the pin carriers. Test voltages on supply rails again with the rails connected—do not of course fail to switch off the mains between tests. If all is well then instal the ICs and check the rails again.

Tune the TV set to receive a picture. There will be more than one picture available in the tuning range and the best one should be found. If the picture has chessmen set up for the start of a game and move status information is correct then the printed circuit board may be installed beneath the lid of the box with the nuts, bolts and spacers provided and the keyboard switches soldered in place. If the device now functions correctly then attention may be turned to the cassette interface.

In an ideal world you could buy audio equipment which had standard sockets using standard signal levels at a standard impedence. This you could connect together with standard leads. The manufacturers of our world do not see things that way, however, and they make equipment with sockets, signal levels and impedances which are different from those of their rivals.

It will therefore be up to you, to decide upon these things as far as your own tape recorder is concerned. You might become involved in designing an attenuator to get things working properly. If you do not know how to do this and do not feel confident after reading the general remarks which follow, perhaps you really ought to be playing at something else.

The Ins and Outs

Outputs vary from millivolt level for a 5 pin DIN socket, but could be only available on a microphone input and earphone output. If inserting a plug into the socket cuts out the internal speaker the cutout switch should be disabled—try bridging it with a 33 ohm resistor. It is essential to hear the data and commentary.
(Input/Output can be the same pin)

It may be that volume and tone controls have an effect on the output signal but this is not usual.

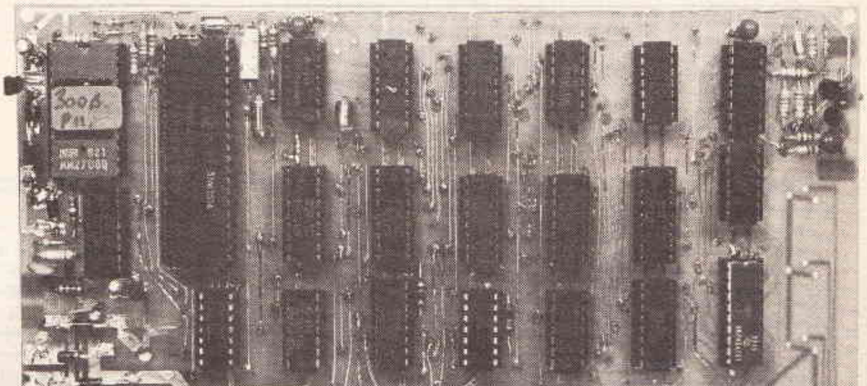
Inputs vary from millivolt level for a dynamic mike to a high level—sometimes marked AUX. The high level input should be used if

CHESS PART 2

available. The signal must be attenuated for a low level input to avoid overloading. Most recorders have Automatic Volume Control and this helps. The output from Tolinka is bursts of 3.9khz at the data rate, which is 300 baud—or 150Hz maximum. Every high bit generates 12 cycles aapproximately of the carrier. The main source of interference may be regarded as being the data rate itself and some sort of high pass filter is needed at the input and output to remove it. Attenutation may also be required to match the recorder's input characteristics. A series capacitor followed by a shunt resistor will perform both these functions and in some cases even the shunt resistor is not required—it depends upon the recorder's input impedance.

If an oscilloscope is available the recorder's output may be observed and should consist of clean bursts of 3.9 kHz separated by level blank intervals. If the signal swings up and down with the data the recorder is receiving too much signal and the shunt resistor should be reduced until this effect disappears. This process should not be carried to the point where the output level is reduced.

If in doubt use the following rules of thumb:
a) Put a 10k pot between the output and ground, taking the signal from the slider. Reduce the input level until the sound loses volume o n playback.
b) Take the output from the earphone or headphone socket. This will almost certainly cut out the recorder's internal speaker, but the switch should be easy to find and bridge with a 33 ohm resistor as described earlier. Adjust volume on playback to obtain satisfactory RECALL function. Note setting of both controls and check this setting each time.



Photograph of the circuit board taken during construction. The switches are not fitted until the board is ready to be mounted in the case — Initial testing being done without them in position.

One of the exclamations often heard at a Chess Congress is 'J'Adoube' which is not a Russian four-letter-word but a polite way of informing one's opponent that a piece is not situated in the centre of the square it is supposed to be occupying;—and this fact is bugging the exclaimer who intends to adjust it but does not wish to be committed to moving it subsequently according to the rules of the game.

Tolinka has provision for moving the pieces into the exact centre of their squares. the 'J' ADOUBE' capacitor. This component (C5) loads one of the outputs of a binary counter introducing a propagation delay which is passed down the divider chain. The value mentioned in the parts list is satisfactory for all but the most neurotic. In order that centralization may be optimized provision has also been made to fit a resistor for fine adjustment which will explain two of those redundant holes ▶

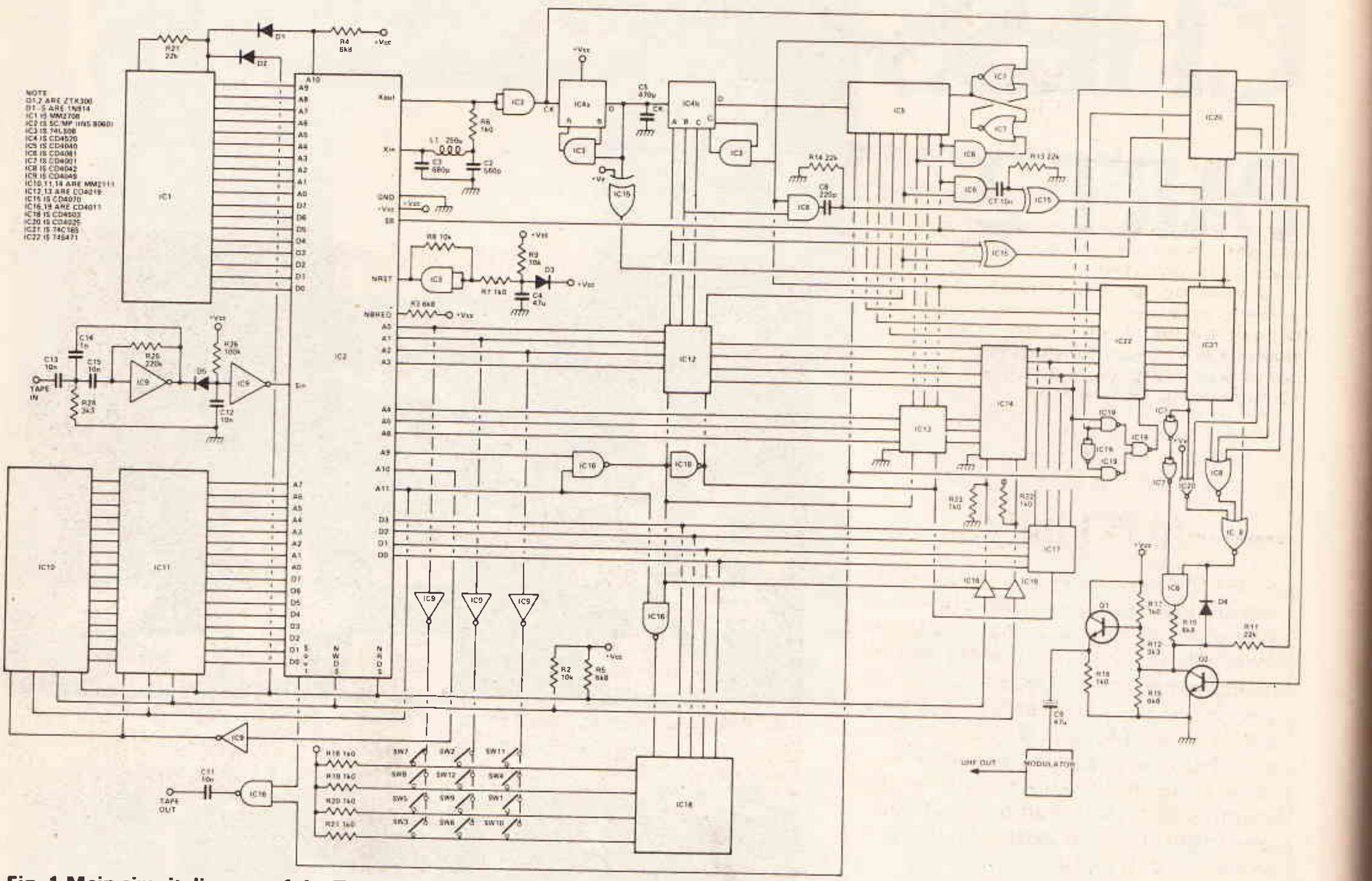


Fig. 1 Main circuit diagram of the Tolinka.

IC2 is National Semiconductor's SC/MP II. Its Program memory is stored in a 2708 type EPROM (1024 bytes). The character generator PROM (IC22) is a 74S471, 256 x 8 in structure. The RAM chips are 2111s, two (IC10 and 11) for game memory and one (IC14) for on-screen information. (There are 8 bits in game memory but only 4 in screen memory.) Top locations in game RAM are used as temporary stores for other information and this restricts the number of moves per player to 62 instead of 64 (four bytes are required to store a move).

Screen RAM is normally addressed by the VDU divider chain's outputs but the MPU must be able to address the screen as well to move the pieces around and change the status information. The address lines are multiplexed through a pair of CMOS And/Or gates (IC 12 and 13). The vertical blanking signal is wired to a sense line of the MPU so that the MPU does not access the screen during the VIDEO INTERVAL which would produce annoying flicker.

The three lowest address lines of the MPU are connected to inverter gates (ICXX) which matrix the keyswitches in a three by four arrangement. Pressing any switch connects an inverted address line signal to one of four inputs of a tri-state buffer normally held high by a resistor (R18-21) to Vcc. When the buffer is selected the inverted address line may be read as data and the switch identified with a unique code by a process already described in the Software: How it Works.

Generation of a Video Signal

All frequencies used are derived from a single MASTER CLOCK which is the MPU's own on-chip oscillator. An L/C combination sets the frequency to 1.92 MHz which defines the shortest horizontal change interval on screen at about half a microsecond. The MASTER CLOCK is divided by ten (IC4a) to give the FILE interval. Eight FILES form the visible board but the FILE interval is divided by twelve in a four-stage binary counter. The A, B & C outputs of this counter are the LETTER addresses, the D output being the LINE BLANKING interval. Thus two-thirds of linescan are the chessboard.

During LINE BLANKING a R/C monostable (C18, R14) supplies the LINE SYNC pulse. Further division of the line interval by 32 gives the RANK interval which is taken from the 5th stage of a binary ripple counter (IC5): the 2nd, 3rd, 4th & 5th outputs of this counter being the address lines to the character generator PROM. This PROM supplies the horizontal piece information as eight outputs in parallel and changes this information every other line. The 6th, 7th & 8th outputs of the ripple counter are the FIGURE addresses. The 9th output is the FIELD BLANKING pulse which is 'Anded' with the 7th stage to reset the counter after 320 counts. 256 counts, or lines, are visible as the chessboard. During FIELD BLANKING monostable (C7, R13) supplies the FIELD SYNC pulse.

LINE BLANKING is also connected to the character generator PROM to select Status Figures presentation instead of chess pieces. The same LINE BLANKING signal also permits the 4th output of the Board RAM, which contains the COLOUR BIT during the Chessboard interval, to address the character generator PROM instead of the 2nd output of the vertical binary ripple counter. (The COLOUR BIT is normally 'Exclusive-Or'd' with the pieces during the Chess board interval to control their colour.) This is because the larger character set of Status Figures symbols are required than Chesspieces — and loss of vertical resolution (cut by half) is the price which must be paid.

The eight parallel outputs of the character generator PROM are converted to a serial data stream in the Video Shift Register (IC21), driven by the MASTER CLOCK and loaded by the FILE signal.

SQUARE COLOUR is derived from RANK and FILE by Exclusive-Or function. SQUARE COLOUR, LINE BLANKING and COLOUR BIT are aligned with SERIAL VIDEO by a D type Flip Flop clocked by FILE.

LINE SYNC and FIELD SYNC are also passed through an Exclusive OR gate to form MIXED SYNC.

SERIAL VIDEO is combined with COLOUR BIT, LINE BLANKING, FIELD BLANKING, etc. to form two mutually exclusive signals WHITING and BLACKING.

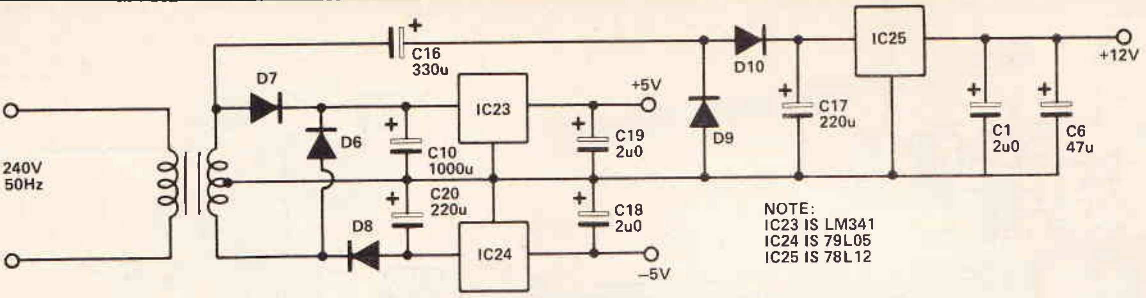
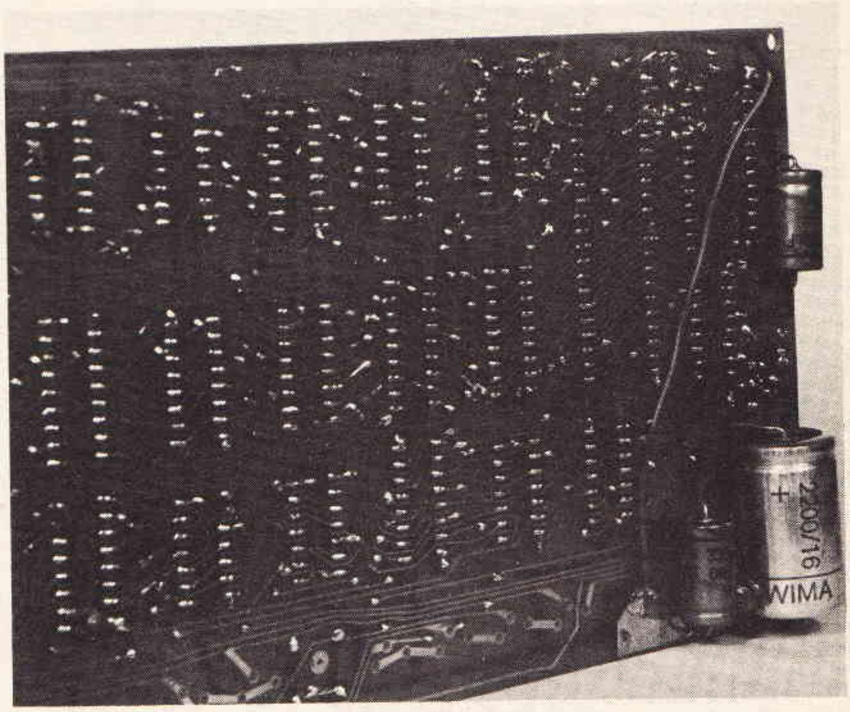


Fig. 2 The Tolinka's power supply is a straightforward design based on three monolithic regulators.

The photograph right shows how the power supply capacitors are mounted beneath the board and the wire link. Note that this photo was taken before the board was complete and not all components are in position.



BUYLINES

A complete kit of parts for this project will be available only from Videotime Products, 56 Queens Road, Basingstoke, Hants, RG21 1REA for the all inclusive price of £109.50.

Individual parts are also to be made available but Videotime will offer help, advice and a repair service only to readers who purchase the complete kit. Note also that software, piece design PCB pattern, etc, are subject to copyright.

HOW IT WORKS

Forming a Video Composite

The video signal is formed by combining SYNC, SQUARE COLOUR, WHITING and BLACKING at a summing point. SYNC is connected to Q2 which clamps the summing point (junction of R10, 12 and 15) to ground when SYNC is high. BLACKING is a negative going signal connected to the summing point through diode D4: when BLACKING is low the summing point is clamped a diode drop above ground. WHITING pulls the summing point up towards the positive rail through resistor R10. SQUARE COLOUR is connected to the summing point through a higher value resistor R1 and supplies two shades of grey when no other signal is present.

The signal is attenuated and passed through an emitter-follower to form a low impedance standard form video signal of approximately 1 volt peak to peak. This signal is used to drive a UHF modulator.

The reason that the SERIAL VIDEO output of IC21 is passed through a couple of spare inverter gates is to equalize propagation delays. Otherwise the black pieces have white edges.

Cassette Interface

The limited bandwidth available in audio cassette recording equipment does not permit serial data to be recorded directly. Some form of modulation is required.

In Tolinka data is recorded as bursts of a single frequency. On playback other frequencies can be filtered out and the demodulation process performed with a diode.

Three CMOS gates are used as the Modem in the final design. Any CMOS inverter will operate as a linear amplifier if a resistor is used between input and output. In this condition it may be regarded as an Op-Amp which has its non-inverting input connected to ground. A limited voltage gain of about 60 is available. The output data comes from the serial output port of the MPU and is combined with a signal of 3.9 KHz from the VDU divider in an AND gate. This supplies bursts of 3.9 KHz at data rate which can be recorded on tape.

The recovered signal is filtered by a CMOS inverter configured as a high pass filter. This rejects low frequencies at data rate and in the speech band. The output of this inverter, which consists of high amplitude bursts of 3.9 KHz, is connected to the cathode of D5. The anode of D5 is taken to the input of another inverter and a low pass filter, consisting of a resistor (R26) to the positive rail and a capacitor (C12) to ground. Gates in the same package have similar transistion points — so when there is no input the output remains at ground level. If 3.9 KHz oscillations are present at the input the output is high. The demodulated transmission is fed to the MPU's serial input.

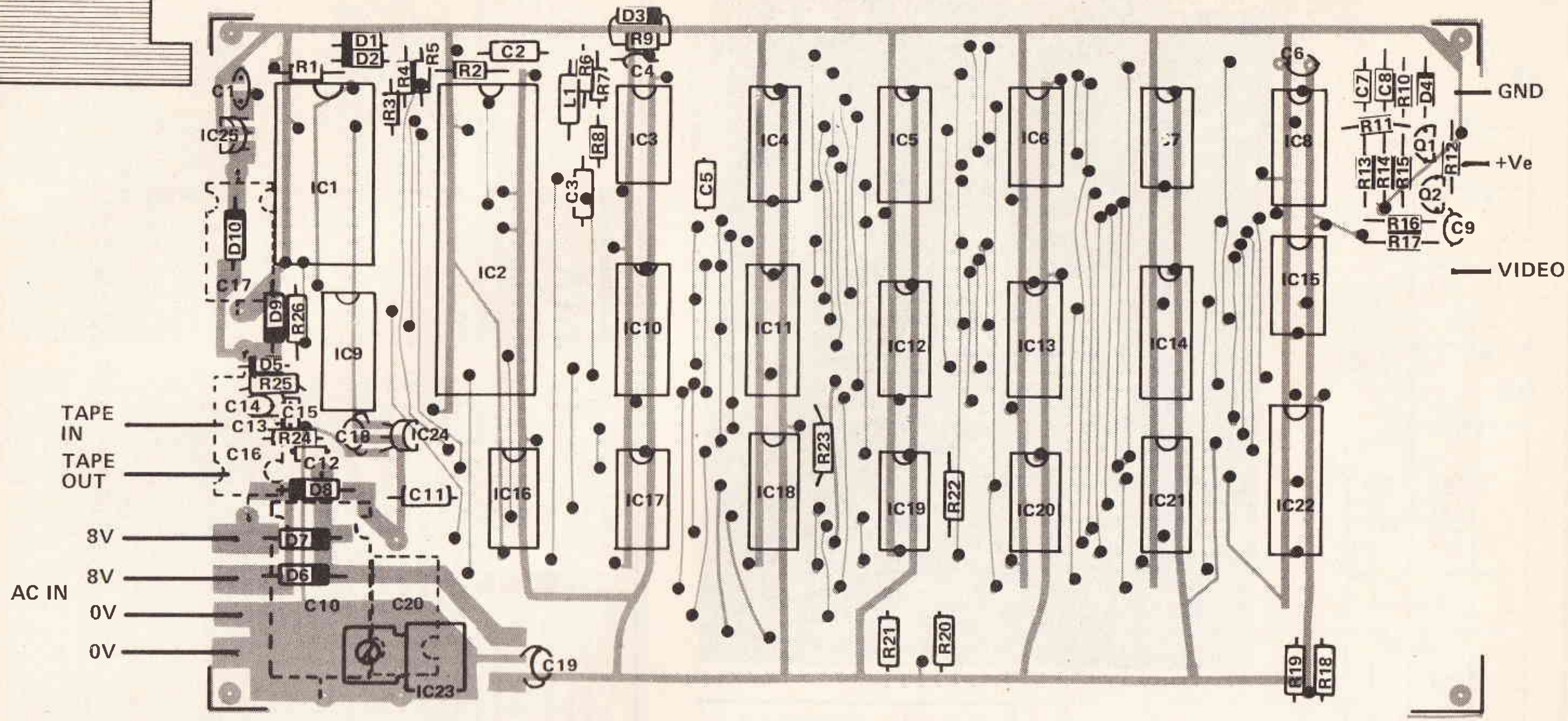
Power-on Reset

The MPU has a Reset input which clears all internal registers and restarts operations with the first instruction after it has been brought low for a specific interval of time. This function occurs when Tolinka is first switched-on and is not required again by the user.

At first sight this circuit seems to be overdesigned. In fact correct initiation of proceedings is vital and reliability suffers if any of the components are omitted. The diode connected across the charging resistor ensures that the capacitor will discharge if the power is interrupted only briefly.

ROM Select Diodes

The ROM occupies the first kilobyte of addressing space and it would seem logical to connect its Chip Select input directly to A10 because no write instructions will be made in this area. Conflict would still take place because the MPU outputs data on the bus at the start of the instruction fetch operation — this data consists of flags and upper address bits and none of it is used by Tolinka. The conflict would be harmless but for the fact that a Video Signal is being produced and processed at the same clock rate as the MPU which produces a faint pattern on screen if the Chip Select diodes are omitted.



PARTS LIST

RESISTORS

R1, 11, 13, 14	22k
R2, 8, 9, 18, 19, 20, 21, 22, 23	10k
R3, 4, 5, 10, 15	6k8
R6, 7, 16, 17	1k0
R25	220k
R26	100k
R12, 14	3k3

CAPACITORS

C1, 18, 19	2u0 6V3 tantalum
C2	560p polystyrene
C3	680p polystyrene
C4, 6, 9	47u 6V3 tantalum
C5	470p polystyrene
C7, 11, 12, 13, 15	10n ceramic
C8	220p polystyrene
C10	1000u 16V electrolytic
C14	1n0 ceramic
C16	330u 16V electrolytic
C17	220u 16V electrolytic

SEMICONDUCTORS

IC1	MM2708
IC2	INS8060
IC3	74LS08
IC4	CD4520
IC5	CD4040
IC6	CD4081
IC7	CD4001
IC8	CD4042
IC9	CD4049
IC10, 11, 14	MM2111
IC12, 13	CD4019
IC15	CD4070
IC16, 19	CD4011
IC17	CD4066
IC18	CD4503
IC20	CD4025
IC21	74C165
IC22	74S471
IC23	LM341-P5
IC24	78L12
IC25	79L05
Q1, 2	ZTX300
D1-5	1N914
D6-10	1N4001

INDUCTOR

L1	250u

MISCELLANEOUS

PCB, transformer (0-8; 0-8 at 500mA), UHF modulator, switches (Schoeller- 12 off), case to suit, sockets, cable, nuts, bolts etc.

SWITCH IN LINE SAVES NONE?

Stan Curtis of Mission Electronics, author of our series on super-fi amp design is back with us again to explain the faults inherent in many widely used comparative hi-fi tests. In particular he has a few things to say about switching methods ....

A SIGNIFICANT RE-APPRAISAL of amplifier design has been seen in the past few years. The revival of serious listening tests (so called "subjective" testing) has shown that laboratory measurements alone are not sufficient to indicate the performance of the amplifier when it is connected to real loudspeakers and pick-up cartridges and fed with a music signal. But it is crucially important that these listening tests be set up with great care. When different amplifiers are compared their gains should be equalised so that their outputs are within 0.1 dB of each other and preferably within 0.05 dB.

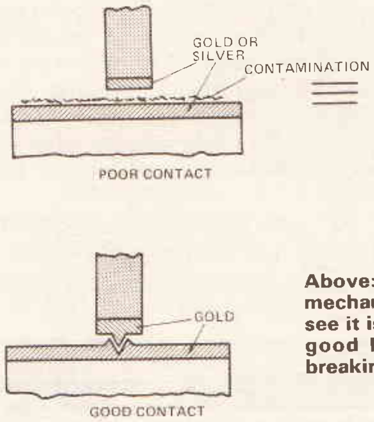
Such level changes could be incorrectly interpreted as differences in amplifier performance. The design of the passive attenuators is important to prevent any significant loading of the circuitry or any imbalancing of impedances which could upset passive filter roll-offs and so alter the frequency response of the system. Even the choice of test signal is important when setting levels. Traditionally a sine wave of 1 Hz or 400 Hz has been used. However, the author prefers to use a noise source fed via a bandwidth limiting filter (to prevent any error by the different frequency responses of the amplifiers) as this more realistically simulates the dynamic conditions.

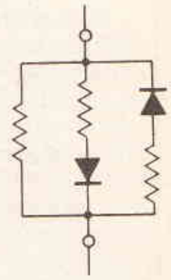
Care should also be taken in the interconnection of the different amplifiers. All connections should be as short as possible using very high quality and identical (in length and quality) cables. Wherever connections have to be made (other than at the amplifier or loudspeaker) high-quality gold-plated instrumentation connectors should be used in preference, to the rather suspect RCA Phono and DIN Connectors.

Switch Your Contacts

The next problem area is that of switching. Switching the outputs of the different amplifiers to a loudspeaker can be done using high-current, high-conductivity lever of knife switches. Relays can cause problems unless they have very strong springs; good contact design; high-current capability; and are new. The subject of switch contacts is quite complex but can be summed up as follows. A metal to metal contact is rarely a true "short circuit."

An almost invisible layer of oxidation or contamination forms on the contacts. This oxidation increases the contact resistance but more importantly forms a non-linear junction that can in some ways be considered to be a voltage dependent diode-rectifier. The effect on the music signal at low levels can be imagined and — more importantly — heard! Even "pure" gold contacts and "self-cleaning" contacts suffer from this problem. A good contact can only be achieved when one contact breaks the surface of, and penetrates, the other contact metal. However, only a limited number of switching actions can occur before the contact material is sufficiently worn or damaged for inconsistent performance. Although this problem is discussed here in relation to testing it has as much significance in the design of the switches used in the amplifier.





Above: equivalent circuit of a mechanical switch. As you can see it is far from simple! Left: a good linear contact involves breaking the metal surface.

When it comes to switching the output of the cartridges the imperfections of the switches have so much effect upon the audible quality of the signal that the listening test ceases to have any real validity.

Test point

The test itself needs further thought. The listening panel should be experienced listeners and yet not be part of a "clique" where views are remarkable for the way they follow the "party line." Testing should be conducted over two or more sessions. Short sessions to perceive the performance of the amplifiers before aural fatigue sets in; and longer sessions with each individual amplifier to judge whether such fatigue is caused by the amplifier and to judge whether the apparent improvement it offered was a "flash in the pan."

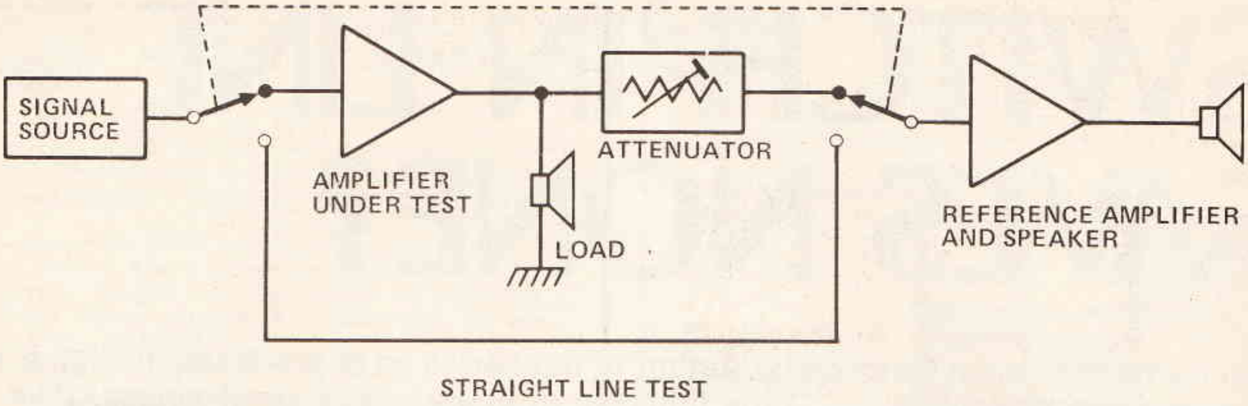


Fig. 2. The straight wire test. First popularised by Peter Walker of Acoustical Manufacturing (or Quad!) this test method has gained wider acceptance of late. It has its faults however.

During the initial sessions a number of "check" changes should be made to detect cheating (deliberate or involuntary) i.e. running amplifier No. 3 a second time as amplifier No. 7. Between each piece of music the reference numbers should be changed to minimise the effects of pre-conception. For example; if amplifier No. 3 is disliked for its reproduction of a bass drum, it may then be subconciously disliked on other pieces of music. Of course the tests should as far as possible, be conducted blind.

A popular "subjective" test in use is the "Straight Wire Test." In this test the amplifier under evaluation is fitted with an attenuator at the output and substituted for a straight wire. The resulting signal is fed to a "reference" amplifier and loudspeakers of known performance. Such a test is of help in evaluating the dependence of the amplifier on the loading made by different loudspeakers. But otherwise this test must be considered suspect. The "reference" amplifier may be far from perfect and it may well mask subtle changes. The dynamic interactions of two units in series can be quite complex and very difficult to predict in advance.

The foregoing (brief and incomplete) discussion of subjective testing serves only to indicate the difficulties that can be encountered. The reader should only consider seriously those comparative reviews where considerable effort has been expended to eliminate errors due to equipment and human beings.

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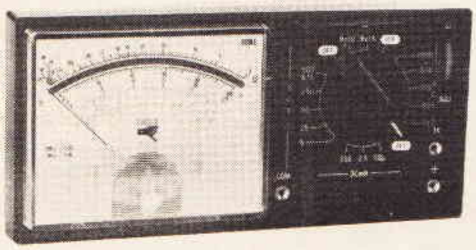

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0-8-9, 0-8-9	1A 1A	208	**3.50**	55
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FM Tuner and decoder, 2 very well made units, nice clear dial, excellent reproduction. £11.20 the pair.

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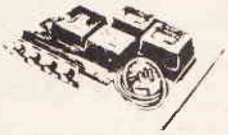

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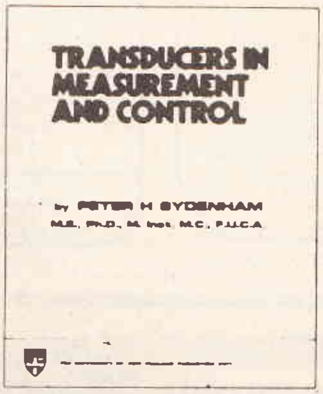

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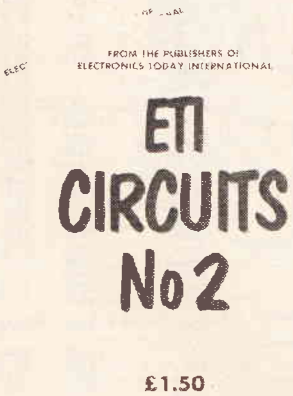
This book is rather an unusual reprint from the pages of ETI. The series appeared a couple of years ago in the magazine, and was so highly thought of by the University of New England that they have re-published the series splendidly for use as a standard textbook. Written by Peter Sydenham, M.E., Ph.D., M.Inst.M.C., F.I.I.C.A., this publication covers practically every type of transducer and deals with equipment and techniques not covered in any other book. Enquiries from educational authorities, universities and colleges for bulk supply of this publication are welcomed. These should be addressed to H. W. Moorshead, Editor.



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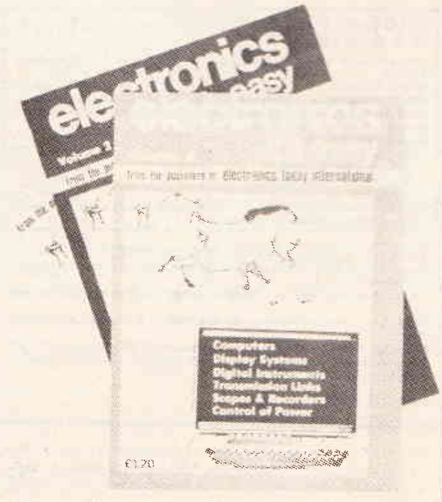

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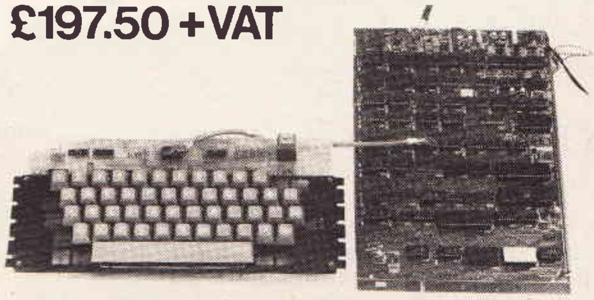

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Microcomputer Seminar

Nascom Microcomputer's highly successful seminar is coming to Bristol. The programme will be similar to London and Manchester, both of which were sold out. The day includes five lectures, demonstrations and an open forum. Venue is the Dragonara Hotel, Bristol, Saturday, October 14th, 09.50 to 17.30.

Admission: £4.50 (inc. VAT). Lunch will be available at £4.00 (inc. VAT) per head if there is sufficient demand.

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NO 1 november 1978

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INTRODUCTION

The first issue of any magazine is an exciting time — certainly for the people working on the project and, hopefully, for the readers. Computing Today, although presented free with ETI, is just such a new magazine, which will have a style and identity of its own.

Computing Today will cover the fields of computing, from the home, education, and small business viewpoints. Computing to us will mean everything from the complete small business system, floppies and all, to a single bit micro in a control application.

The growth of small systems over the past few years has been astounding the reasons for this growth are many and varied — we won't go into them here — and it is our hope that the next few years will see this expansion maintained.

One of the reasons for launching Computing Today was the fact that it was no longer possible to devote enough space within ETI to cover this important area of small systems without sacrificing other features of ETI that are equally important to many of our readers. ETI plus CT will allow us to keep everybody happy.

Although this first issue of CT is only 32 pages, if the growth we mentioned is maintained, rest assured that CT will grow to keep pace.

This first issue of CT is published to coincide with the launch of the TRITON, an exciting new system for the hobbyist/education areas. CT has similar, equally exciting projects in the pipeline and if you don't want to miss out on important news and developments in Computing be sure to read us every month.

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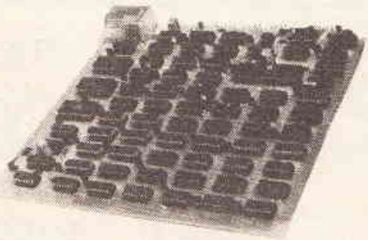

The new low cost VDU - Tangerine 1648
(See page 16, ETI, Oct. '78 for feature details)

ORDERING INFORMATION

The normal **KIT price is £139.86,** which includes postage, packing and insurance and VAT @ 8%. HOWEVER, as an introductory gesture we are **discounting this price by £10,** for all orders received postmarked **BEFORE 12th December, 1978.**

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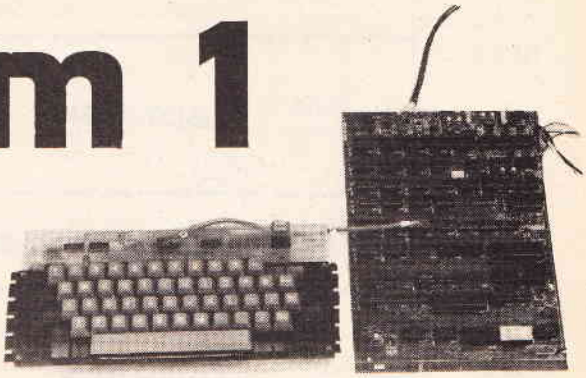
We take a look at one of the most advanced CPUs evaluation kits

The Nascom 1 Reviewed



THE NASCOM 1 Microcomputer kit was launched by Lynx Electronics at the Wembley Conference in November 1977. At that time, a sales figure of 500 kits was anticipated but it has been so popular that orders in excess of 10 000 kits have now been received. A look at the main features of Nascom 1 will explain this success.

For £197.50, you get:

- A Z-80 CPU,
- an uncommitted PIO,
- 2K of static RAM,
- a powerful 1K monitor (in a 2708 EPROM),
- a TV modulator,
- a full keyboard (assembled),
- cassette or RS 232 interface (but not both at the same time),
- an IM6402 UART,
- a double-sided PCB with plated-through holes,
- all other active and passive components, wire, solder and complete documentation.

The system is easily expandable through a 43-way edge connector but there is no on-board buffering (due to cost) although Nascom's plans for future expansion include a buffer board. In order to have a working microcomputer, only a power supply and a domestic TV need be supplied, plus an ordinary portable cassette machine for program storage.

Construction

Constructing the kit is an easy task for the experienced constructor and even the first-timer should have no difficulty, providing the detailed and comprehensive instructions are followed carefully. It is, if anything, a little tedious — there are over 50 ICs, sockets are provided for all of them.

The PCB is worth special mention for its superb quality — a really professional job. All component and wiring positions are clearly marked on the board in a totally unambiguous fashion and since the instructions include a detailed section on component identification, there should be no location problems. The PCB has wire links to be made, each selecting a possible user option. Two deal with I/O port and memory selection, three with the UART and one with the on-board crystal clock. The instructions show standard connections for these links and explain the variations. They could also be replaced by miniature toggle switches to allow experimentation.

The keyboard is supplied pre-assembled and needs only the addition of the RESET switch to complete it. Again due to cost considerations, it is not ASCII coded, but is scanned by hardware under software control. Early keyboards had no engraving on the key tops for shifted characters but this has been corrected in a new version, which also has a more positive key action. However, both suffer from the amazing lack of a left-hand shift key!

Another minor criticism is the method of connection between the PCB and the keyboard. A multicore cable with a 16 pin DIL header plug is used at each end, which means that any strain on the cable is taken by the soldered joints. A proper ribbon cable with crimped connections to header plugs would be a much more satisfactory solution.

Power supply

The power supply requirements are:

+12V @ 150mA,
+5V @ 2A,
—5V @ 90mA
and —12V @ 12mA (for RS232 only).

Lynx supply a PSU kit as an extra but it does rather let down an otherwise excellent product. The kindest thing I could say about the design is that it is unusual. It allows for further PSU kits to be 'parallelled off' for expansion. Early PCBs also has the + and - rail markings reversed — one of the IC regulators' connections are incorrect, although the outline is right. There is no provision for diodes to protect against

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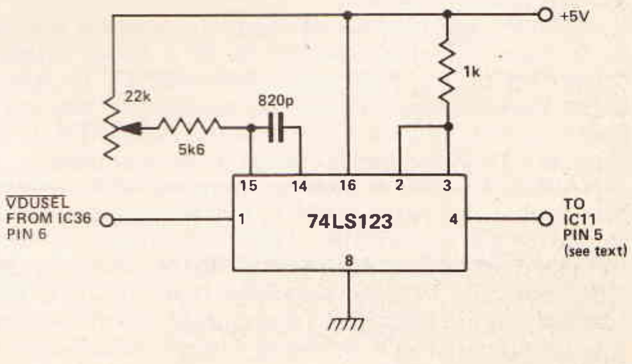

Fig. 1. Circuit to overcome 'snow' on multiple VDU RAM access.

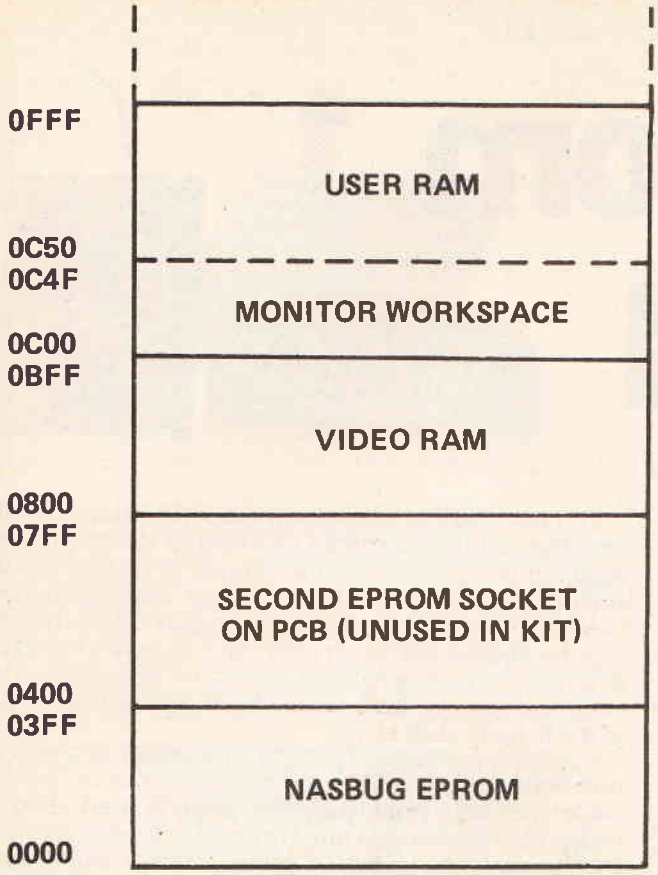

Fig. 2. System memory

voltage crossover (although diodes are supplied in the kit).

Now for the good news — the PSU is being completely re-designed and the parallel expansion approach dropped. Instead there will be an 8 amp kit for larger systems.

Memory and VDU

Before moving on to the operation of the kit, there are a couple of other hardware points to be mentioned. Firstly, the arrangement for resetting the CPU (by means of the RESET switch) would have to be altered for use with dynamic RAM expansion. CPU operation is suspended for as long as the RESET button is held down, so dynamic RAMs (assuming they are refreshed by the Z-80) would soon forget what they were doing. The buffer board will contain circuitry to correct this.

Secondly, the modulator seems to produce a very noisy signal. Picture quality is, to a large extent, dependant on the ability of a domestic TV to reject noise. Fortunately, commercial modulators are very cheap to buy and easy to fit to the NASCOM 1, as there is a 1V video signal output from the board.

NASCOM 1 uses a memory-mapped VDU, which means that the video RAM is shared with the CPU, the latter having priority. The instructions say that the video is blanked during VDU RAM access by the CPU but this is only partially true. In fact, the blanking signal (VDUSEL) is not long enough, so that a noise signal which shows as 'snow', especially on multiple VDU RAM access, appears on the screen. This can be simply corrected by using the circuit in Fig. 1 Pin 5 of IC 11 should be bent out from the socket and the connection made with an insulated 'sodercon' socket. Increase the potentiometer value until the snow just disappears.

Display Format

The format of the display is 48 characters wide by 16 lines deep, which produces a very readable picture on a domestic TV. The remaining 256 bytes (1024 — (48 x 16) = 256) of the 1K video RAM block are in the margin of the display, since the video RAM address counter is not disabled during the undisplayed portions of the video signal. In addition, the bottom 15 lines of the display (plus margins) are scrolled by the monitor, making the unused RAM locations useless.

The fact that only 15 lines are scrolled leaves the top line for header text or data. This is a very useful feature, since almost all programs can make use of a fixed display line. Figure 4 gives details of the VDU addressing and scrolling.

Operating System

The operating system is held in a 2708 (1K x 8) EPROM, which goes by the name of NASBUG. Since July, kits have been supplied containing NASBUG MK2 as the original version contained an error in the serial input routine and a couple of errors in the keyboard look-up table. However, these facts should not detract from the excellent software which is crammed into the 1K of NASBUG.

To call a command, only a single letter need be entered, followed by a number of arguments in HEX. Leading zeroes may always be omitted on input. The commands are as follows:

modify: M aaaa
The monitor responds by printing address aaaa followed by the contents of that memory location, followed by a prompt and the cursor. If only examination of the memory location is required, pressing NEWLINE will step through the memory sequentially, printing information in the same format. The command is aborted by fullstop newline. Memory may be modified by entering new data after the prompt.

tabulate: T aaaabbbb
Prints on the screen the contents of memory between addresses aaaa and bbbb.

copy: C aaaa bbbb cccc
Copies a block of memory, length cccc, from address aaaa to bbbb. Care must be taken that either bbbb is greater than aaaa plus cccc or that bbbb is less than aaaa, otherwise the data block will be corrupted.

execute: E aaaa
Executes a program starting at address aaaa. There are two occasions when no argument is required. Firstly, if a program is aborted by the RESET button, E NEWLINE will cause execution to start at the same place as the previous E command. Secondly, at a breakpoint, E with no argument will cause execution to resume from the breakpoint.

break: B aaaa
Will insert a special code at address aaaa in a user program. When this code is encountered during execution it will cause the program to stop, display

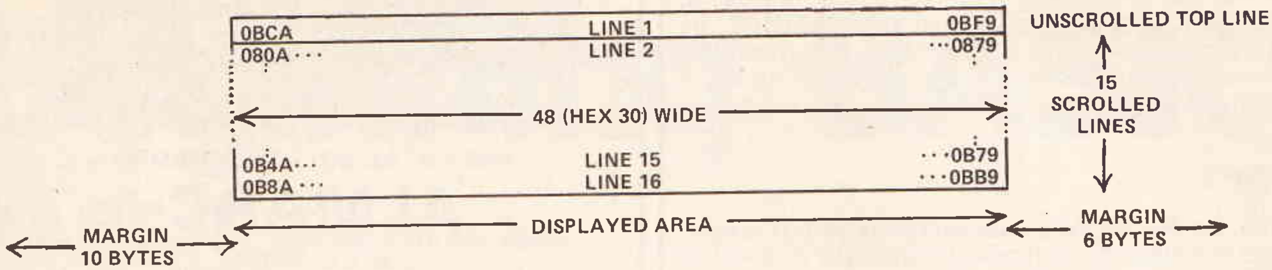

Fig. 4. VDU diagram

the registers and transfer control to the monitor. This means that any of the monitor commands may then be used. The BREAK command together with the STEP command provide very powerful debugging tools.

step: S aaaa
Will cause single step execution from address aaaa, with the registers displayed as in break at each step. Once single stepping is started, only NEWLINE need be pressed for the next stop and as with the execute command, the address will be assumed at a break-point.

dump: D aaaa bbbb
Dumps the contents of memory locations aaaa to bbbb to the serial output. Data is sent in blocks of 8 bytes, each with an address and checksum.

load: L
The opposite of dump. Loads data from the serial input (usually from cassette). The input format is the same as the dump output format (which is useful!).

Reflective Addressing

The monitor is made even more powerful by the use of 'reflective addressing' in the RAM. Some of the major routine addresses and data are found by the monitor by looking in certain RAM locations. The locations are set up at RESET but they can be changed manually (or during the course of a program).

The following data are found reflectively:
NMI routine address (used in single step and breakpoint exit),
command table address,
CRT address which controls cursor and scrolling,
keyboard scanning routine address,
address of the keyboard lookup table and its length and the stack pointer address for user programs (i.e. end of RAM).

The use of reflection and a scanning keyboard gives NASCOM 1 the advantage that the meaning of the

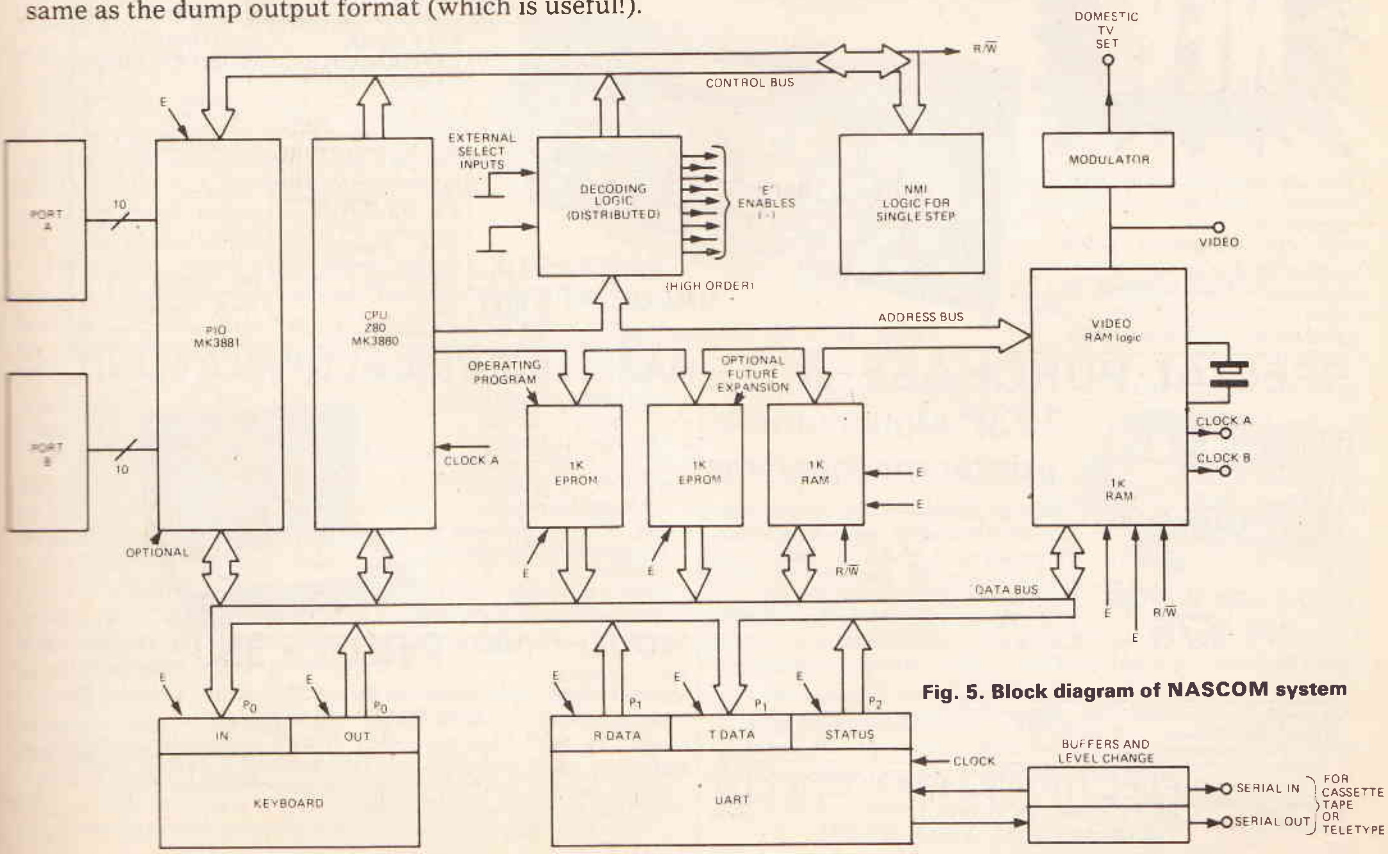

Fig. 5. Block diagram of NASCOM system

Nascom

keys may be changed with ease and various combinations of simultaneous key pressing can easily be detected and acted upon. An example of the use of this feature is a program called SUPERSHIFT, by Richard Beal. The @ key is utilised as a sort of control key, enabling the complete character set of the MCM 6576 character generator to be used via the keyboard.

Summary

Overall, the NASCOM 1 is an excellent unit. It is easy to level criticism at any product, especially one which has been designed down to a price, rather than up to a specification, but I think that the compromise has been very successful in this case. There have been delays in the delivery, mainly caused by underestimation of demand, which in turn has caused delays in the development and despatch of the advertised add-on goodies (up to and including mini-floppy). Hurry up, Lynx.

To finish on a personal note, I've been using my NASCOM 1 for about 5 months (it worked first time) and I am very happy indeed with it. I can hardly wait for 16K and an assembler (MENTAL NOTE: Must send Christmas card to bank manager), although I am continually surprised at what *can* be squeezed into the 944 bytes available. The monitor is easy to use and fairly comprehensive, bearing in mind that it is only 1K. Debugging is a doddle with breakpoint and single step. NASCOM 1 is a real microcomputer at a relatively low cost and should be easily expandable to a really powerful system.

CTI

This month we feature the first part of a software teaching series

Beginning BASIC

PART 1 Algorithms and flow charts

IT IS, UNFORTUNATELY, VERY EASY when watching a computer in action to subconsciously endow the machine with intelligence — under no circumstances is this the case.

Regardless of whether you are programming in the simplest of machine codes or the most sophisticated of high level languages, there is no way that the computer can do anything other than what it has been programmed to do, and the signs of intelligence that we seem to detect are present only because of the skill of the programmer. In fact, programming today is becoming quite a major business area, simply because of the amount of skill involved. As with every other trade, however, there are various tools which are at the disposal of the programer to help in in his work — one of the most important of these being the flow chart.

It does not matter what language we program in, be it machine code or BASIC, the technique of drawing and using flow charts is always the same.

We start with a problem, find an algorithm (finding an algorithm for a problem means finding a method of giving a complete and correct solution to the problem in a finite number of steps) to solve the problem, draw the flow chart and then write the program from the flow chart. In order that one programer can understand another's work, certain conventions are adopted when drawing flow charts (see Fig 1).

As a first example of algorithm and flow chart drawing, we will take the case of a young person applying for membership of a Social Club, wishing to discover what fees are payable as an annual subscription.

Consider the following —

"The annual subscription for a man is £10, unless he is under the age of 25, when the subscription shall be halved. The annual subscription for a woman shall be £8, unless she is under 25, when the subscription shall be halved. Married women applying for membership shall be charged half the amount payable by a single woman over 25."

In this instance, it is unnecessary to find an algorithm to solve the problem as we are only going to use the flow chart as a means of simplifying the wealth of information given above (see Fig 2).

So, for example, if you are a married female, it takes only a moment's glance at Fig 2 to answer the questions "Are you a man?" (no) and "are you married?" (yes) to arrive at the knowledge that your annual subscription shall be £4.

You can see from this example how the flow chart helps to clarify and simplify an otherwise apparently complicated problem.

We will now go on to consider the generation of an algorithm, and to see how a flow chart can be drawn once an algorithm has been obtained. As an example,

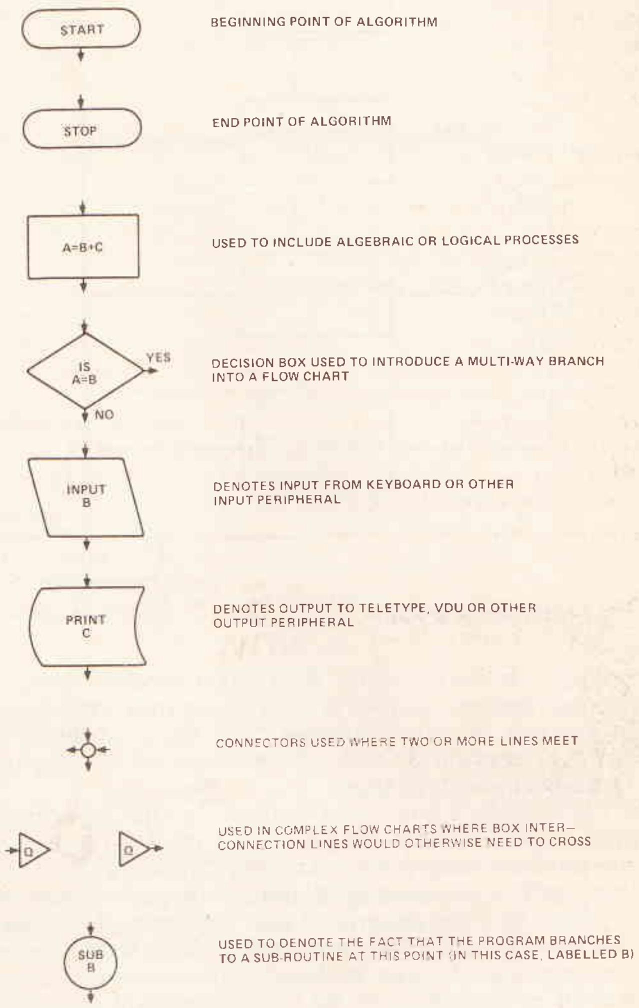

Fig. 1. Flowcharting symbols

we will look at how it might be possible to get a computer to generate a representation of, and randomly shuffle, a pack of cards.

The first thing we need to do is to decide what would be an acceptable representation of the pack. We could reasonably consider the problem solved if the computer could be made to generate a list of the numbers 1 to 52 in a random order, so that each number from 1 to 52 would represent a different card.

The first method that springs to mind is to get the computer to open a set of 52 storage locations. The first random number between 1 and 52 can then be generated and placed in storage location number 1 (the method used to generate the random numbers is

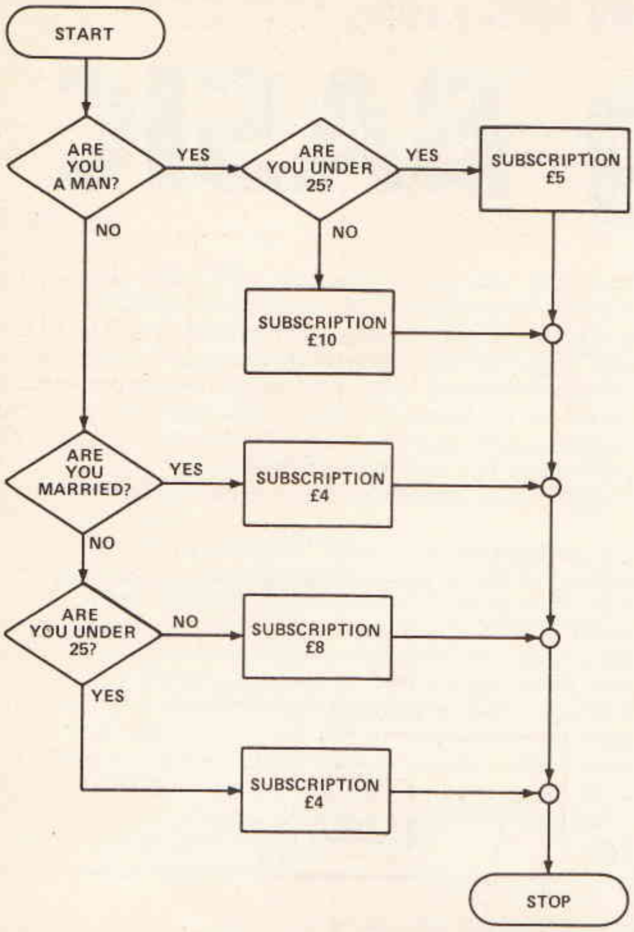

Fig. 2. Fee fie foe or fum?

unimportant as far as the flow chart is concerned). A second random number is then generated and placed in storage location number 2, a third number in storage location 3, and so on until all 52 storage locations have been filled.

Fig 3 shows a flow chart to describe this algorithm. That appeared quite simple, didn't it? But if we give the problem some further consideration, you will see it is possible, since the numbers we are generating are random, to have generated two numbers which are the same. Indeed, this is most likely. This would mean that we would have at least two cards the same within one pack, and so our algorithm must be considered incomplete (though on the right track). To make the algorithm work correctly, we will have to include some form of check to ensure that when a number is generated which has already been used, it is not included in the list (see Fig 4 for a flow chart which takes this point into account). If you look through Fig 4, you will see that a number is generated and then a check is made through all the storage locations that have already been filled to see if the number we have just generated has occurred before. If it has, then the number is ignored and a new random number is generated and checked; if it has not, then it is inserted into the next empty storage location. We then jump back and generate another random number and the process continues until all 52 storage locations have been filled.

This algorithm and subsequent flow chart would appear to be quite sufficient to solve the problem. But

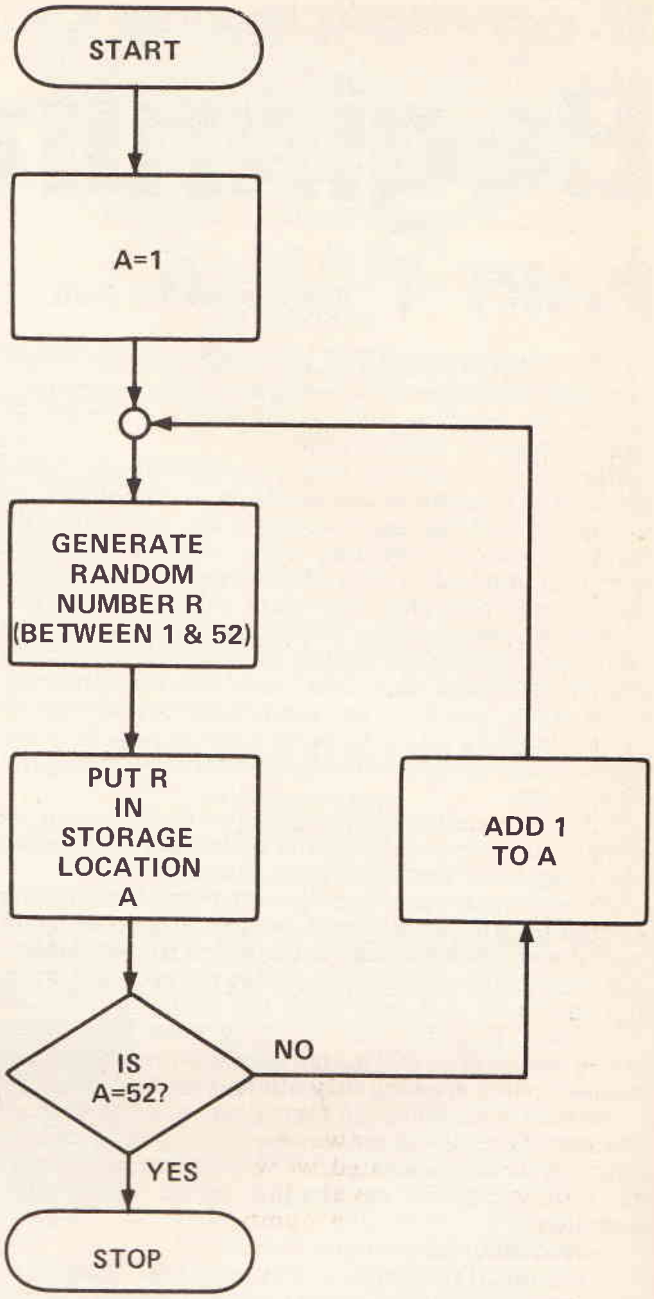

Fig. 3. Take a card, any card . . .

let us now consider this flow chart converted into a program and being run on a computer. Remember, every operation the computer executes takes some finite time to perform, albeit small, so that the more operations that need to be performed, the longer the program will take to run. This may appear to have been an obvious statement, but let us take a look now at our algorithm, bearing this point in mind. When we start off, with all storage locations empty, the first number we generate can be guaranteed not to have occurred before (though looking at the flow chart you will see that the computer does not know this) and can therefore be inserted straight into the first storage location. As the program proceeds, however, and more storage locations filled, it becomes more and more likely that the generated random number will, after some considerable checking, have to be abandoned and re-generated, until, when there are

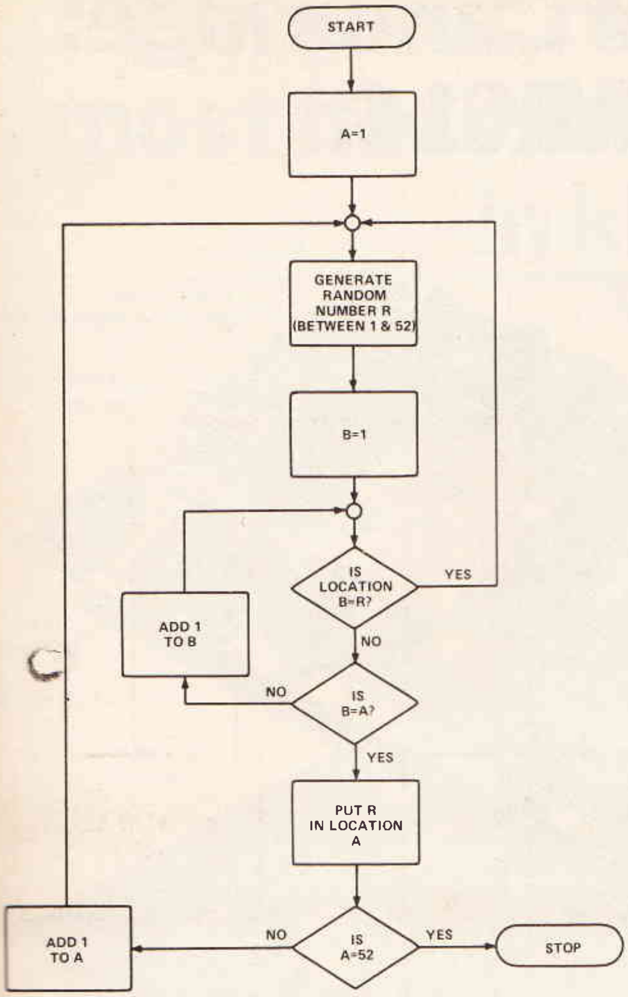

Fig. 4. The new routine.

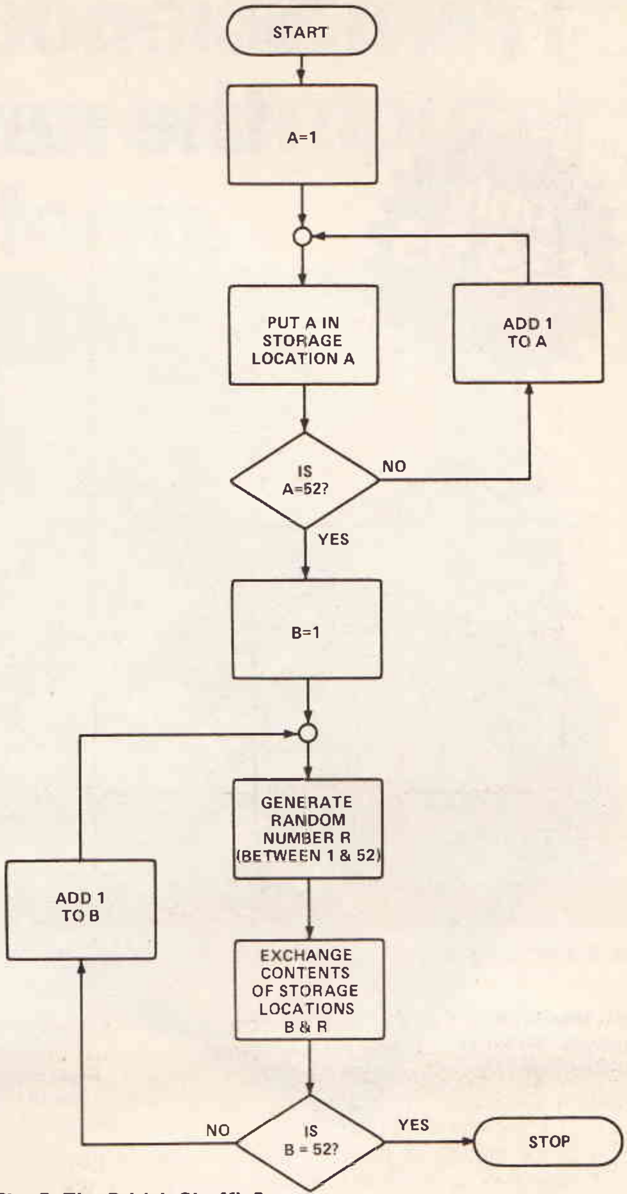

Fig. 5. The British Shuffle?

only two or three locations left to fill, we may have to generate and extensively check many tens of numbers to find one of the few remaining acceptable numbers. If the computer was made to print out each number as it was generated, we would notice a longer and longer time interval elapsing between the generation of consecutive numbers. Problems like this occur frequently when converting algorithms, where a solution which initially appeared to be satisfactory turns out to have some practical difficulties associated with it on closer inspection.

Fig 5 shows the flow chart of an algorithm designed to overcome the previous problem.

It starts by putting 1 in storage locations 1; 2 in location 2; 3 in location 3; and so on until all 52 locations are filled, which in effect lays the cards out in sequence through the pack. It then takes the first location and exchanges its contents with the contents of another randomly chosen location, then the contents of location 2 are exchanged with the contents of a second randomly chosen location; the contents of location 3 are then exchanged with the contents of a third randomly chosen location, and so on until the contents of all 52 storage locations have been randomly exchanged in this manner. You may be a little sceptical as to whether the pack of cards thus generated was truly random. Experiments have, however, convinced us that it is. As you can see, there is never any need to generate more than 52 random numbers, because whatever the number generated turns out to be, we are always guaranteed to use it, as it does not matter whether it has been generated before or not. Converting both of these flow charts into programs and running them on a computer, we discovered that this latter algorithm ran approximately ten times as fast, on average, as the first algorithm, so that there is a great saving in computer time used.

Looking through the algorithms and flow charts, you should begin to see that every operation a computer performs has to be very carefully planned and mapped out if a worthwhile program is to result. Although able to operate at extremely high speeds, the computer is merely manipulating pulses of electrical current according to a set of rules which the programmer lays down which, by careful manipulation and interpretation, can be made to have meaning.

Next month we will go on to consider the high-level programing language, BASIC, but do not forget the above routines, for when we have learnt sufficient BASIC, we will be returning to look at them again and see how they can be implemented **CTI**

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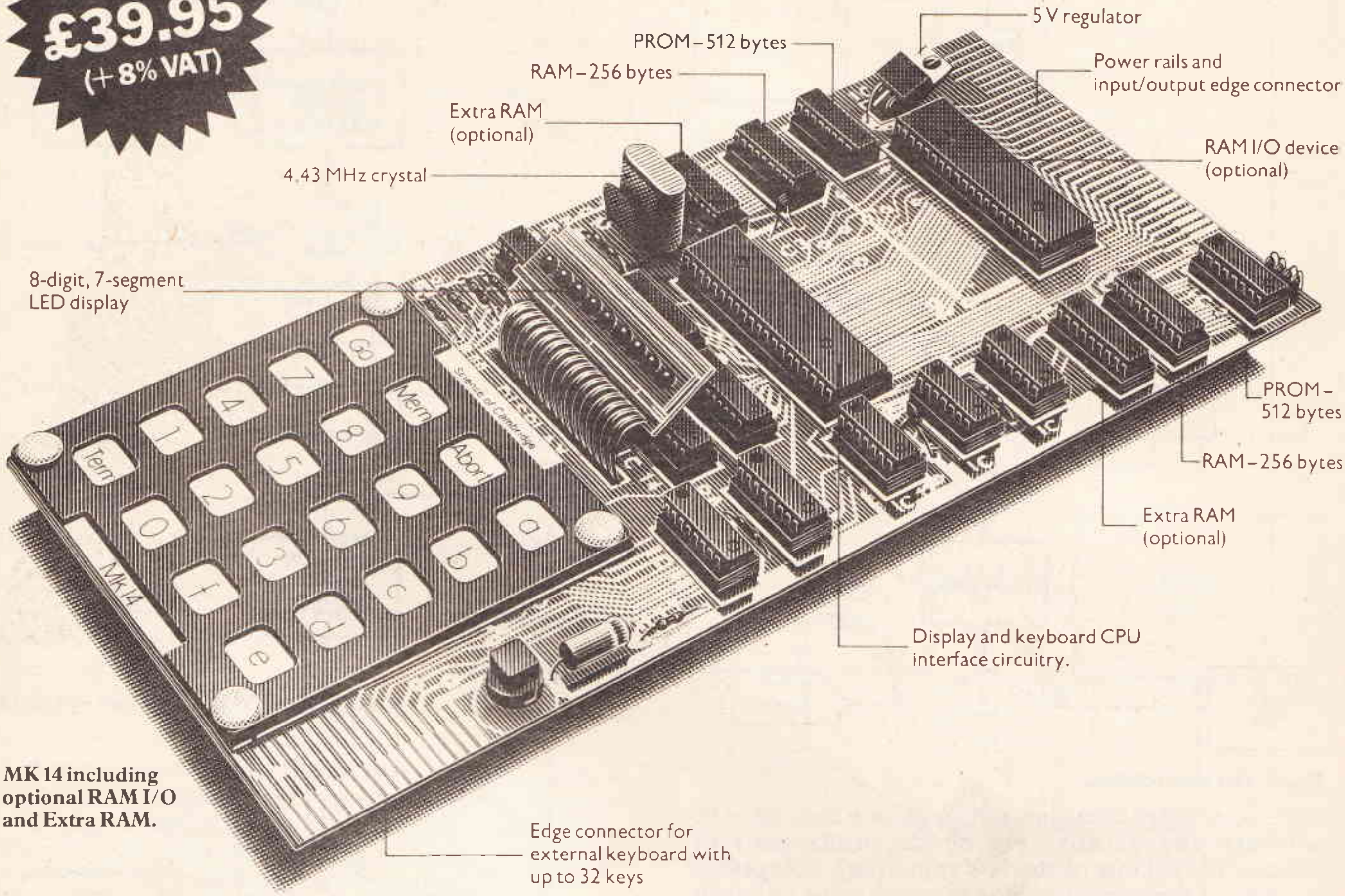

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The MK 14 is a complete microcomputer with a keyboard, a display, 8 x 512-byte pre-programmed PROMs, and a 256-byte RAM programmable through the keyboard.

As such the MK 14 can handle dozens of user-written programs through the hexadecimal keyboard. (20 sample programs are provided in the Manual – which also contains comprehensive building instructions, and instructions on program-writing.)

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But that's only the start ....

The memory capacity of the basic kit is surprisingly powerful – but every computer owner, from a schoolboy to a multi-national corporation, soon feels the need for more memory.

With the MK14, it's yours!

Optional extras include an additional 256-byte RAM, and a 16-line external input/output device (allowed for on the PCB) which give a further 128 bytes of RAM.

And the next step?

The next step is to add your own peripherals!

The first could be a low-cost module which provides an **interface with a standard cassette-recorder.** This means you can use ordinary tape-cassettes for the storage of data and programs.

To get the best from this configuration, you could uprate your system with a **revised monitor** – consisting of 2 replacement PROMs, pre-programmed with sub-routines for the interface, offset calculation and single step, and single-operation data entry.

The second peripheral could be your own **PROM programmer and blank PROMs** to set up your own pre-programmed dedicated applications. (Fusible-link device guarantees program safety.)

All are available now to owners of MK 14 – and remember Science of Cambridge keep you up to date *automatically* with advances in the MK 14 range. A TV interface device is already in the pipeline!

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And, of course, it's a superb education and training aid – providing an ideal introduction to computer technology.

SPECIFICATIONS

MK 14

* Hexadecimal keyboard
* 8-digit, 7-segment LED display
* 8 x 512 PROM, containing monitor program and interface instructions
* 256 bytes of RAM
* 4 MHz crystal
* 5 V regulator
* Single 8 V power supply
* Space available for extra 256-byte RAM and 16 port I/O

Edge connector access to all data lines and I/O ports

Optional Extras

* Extra RAM – 256 bytes
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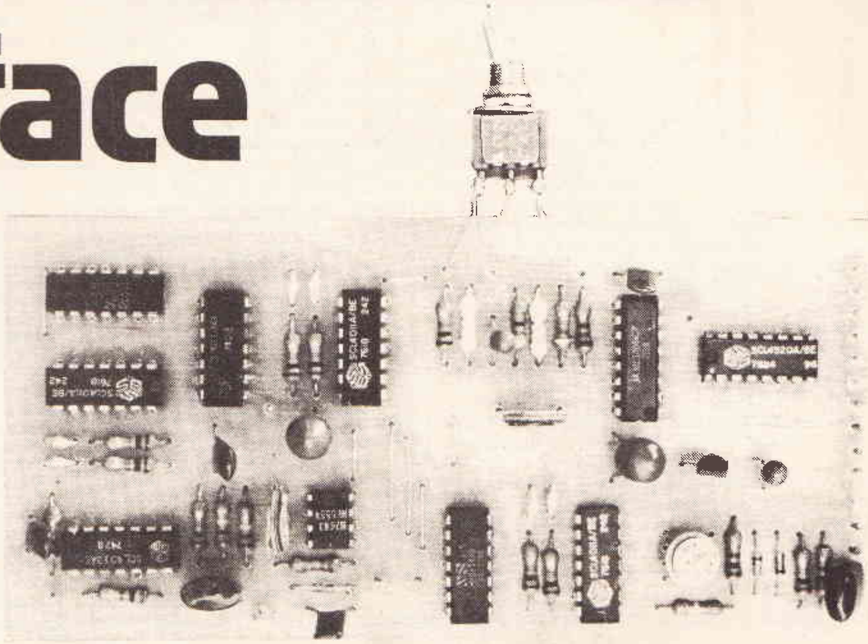
This unit allows you to program your microprocessor from a prerecorded cassette or to record your own program for later use. Design by Trevor Marshall.

CUTS Cassette Interface



REPEATEDLY TYPING IN programs is not what hobby computing is about. Although most systems start life without any form of off-line mass storage, as more memory is added so more programs are written and the need for some form of storage becomes more pressing. The ideal device for this job is probably the floppy disk, but this is (a) expensive and (b) usually dedicated to one processor or bus structure. Many hobbyists are running several small systems, and a device which is less convenient but more suited to their needs (and pockets) is the humble cassette recorder.

This interface is designed to convert the digital signals from your computer to audio tones and back again, using a standard system called CUTS (Computer Users' Tape System), which is also referred to as the Kansas City or Byte format. This records data at 300 baud, with a logic '1' recorded as eight cycles of 2400Hz and a '0' as four cycles of 1200Hz. A byte of data is recorded as a start bit of logic '0', followed by eight bits of data and two stop bits of logic '1', and this is taken care of by the UART in your computer.

Although the standard is 300 baud, the monitor programs in some kits allow only 110 baud operation, and this interface will work at 110 baud. It can also be run faster (up to 1200 baud) to allow faster program loading.

We have not described a case, as most constructors will wish to mount the board either on the back panel of their computer or in the VDU. Also switching between VDU and cassette will depend upon the user's computer — the ideal situation is to have two UARTs for both VDU and cassette, but many systems (or rather their monitors) do not permit this.

Construction

This is simply assembling the PC board. Take care when handling the ICs as most are CMOS. As the unit will probably be built into a system we have not given any mechanical assembly details. The record/play switch can be mounted remotely if desired.

Alignment

The only adjustments on the unit are the record frequency and the monostable period. Switch the unit to record and monitor the frequency at any of the baud rate outputs and adjust RV2 to give the correct frequency. Now inject a 1200 Hz tone into the audio input (take of from the baud rate outputs when in the record mode) and adjust RV1 to give a 300us wide pulse at pin 3 of IC4. If an oscilliscope is not available, setting RV1 to mid position should be close enough.

Recording

For best results recording should be done at a relatively low level. We found that about − 7VU gave the best results.

Unfortunately the use with a recorder with an automatic level control did not prove satisfactory. This is because the level control logic is designed for music where the peak level is about 10dB or more higher than the average. This cannot cope with a continuous tone without it being recorded at too high a level.

One method which has been suggested to us is to record a high level high frquency tone (about 18kHz) as well as the signal. Theory »»

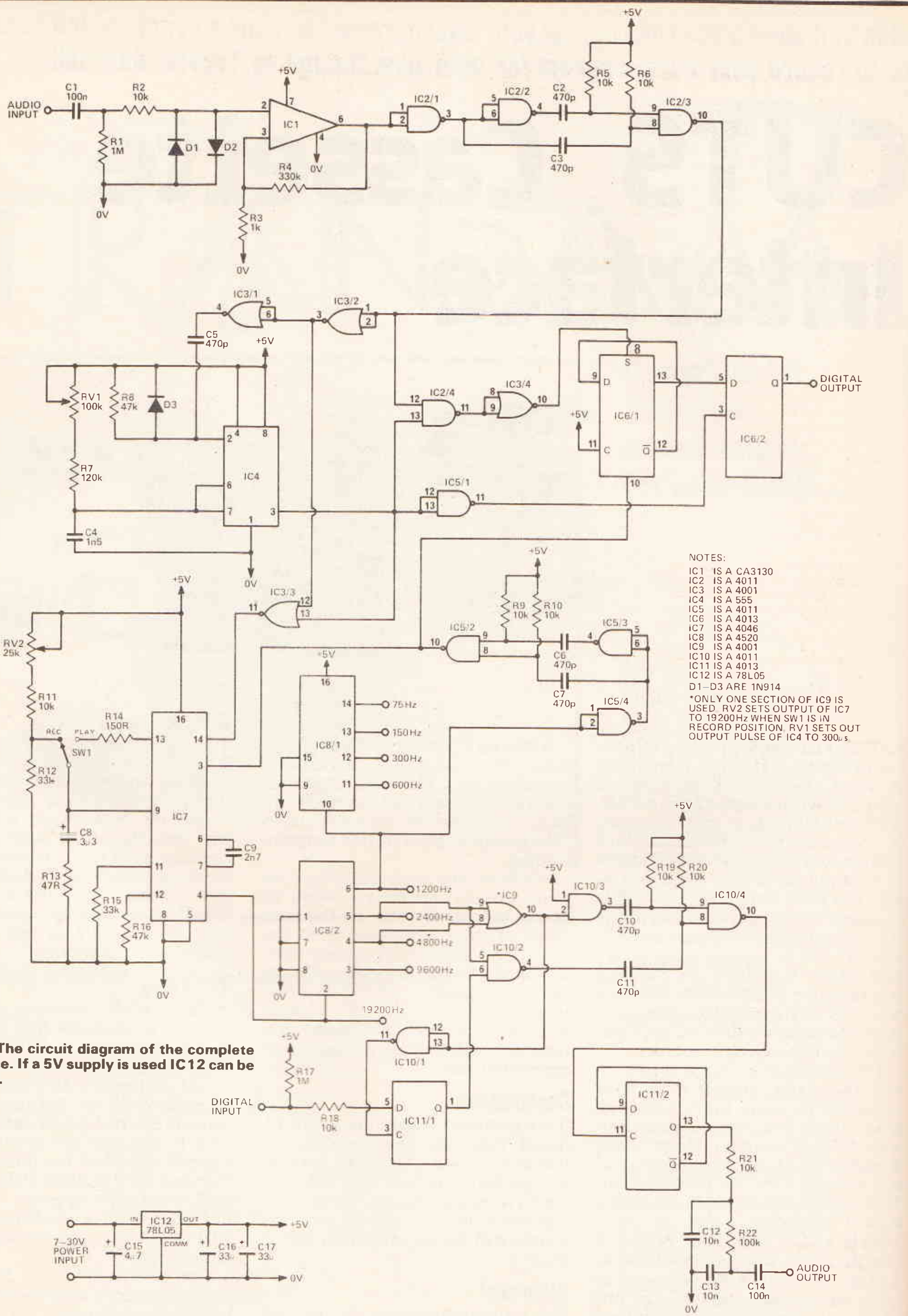


Fig. 1. The circuit diagram of the complete interface. If a 5V supply is used IC12 can be deleted.

How It Works

This unit records digital information on tape in serial form using two tones, 2400 Hz for a "1" and 1200 Hz for the "0". The standard transmission rate is 300 baud but it will work equally well at 600 baud. The designer has operated his unit at 1200 baud with success but with only one cycle of 1200 Hz per bit it is more prone to dropout, etc.

Decoder

We will start the explanation of how it works by assuming you have a prerecorded tape. The output of the tape recorder (alternate tones of 1200 and 2400 Hz) is "squared up" by IC1 which is connected as a schmitt trigger with R3 and R4 providing the necessary positive feedback.

The gates IC2/1, IC2/2 and IC2/3 are used to generate a positive pulse about 3μs wide on both the leading and trailing edges of the output of IC1. This gives a series of pulses at either 2400 Hz or 4800 Hz (417μs or 208μs period).

The pulse chain triggers the monostable IC4 which is 300μs wide. If a second trigger pulse occurs before the 300μs period (as it will if the input is 4800 Hz) the second pulse is simply ignored. The input pulse chain is gated with the monostable output in IC3/3, the resultant output being pulses at 2400 Hz whether the input frequency is 2400 or 4800 Hz.

These pulses are used for the reference for the phase locked loop (PLL) IC7. This IC contains a phase detector and a voltage controlled oscillator. The output of the oscillator is divided by 2^8 in IC8. After dividing by 2^4 (16) IC5/2, IC5/3 and IC5/4 are used to generate 3μs wide pulses on both leading and trailing edges and this output is the second input to the phase detector in IC7. The output of the phase detector (pin 13) is used to control the oscillator (input is pin 9) and the two pulse chains are equalised in frequency and phase. Using this technique the tape speed can be varied by up to ∓20% and the PLL will track it. The outputs of IC8 can be used to control the UART in the computer. If the UARTs own clock is used the allowable tape speed variation is ∓5%.

To decode the pulse chain into "1" and "0" and to ensure correct phasing, IC2/4, IC3/4, IC5/1 and IC6 are used. The monostable IC4 is triggered at 2400 Hz, and its output clocks the D input of IC6/2 into the output. IC6/1 is used as an R-S flip flop being "set" if a pulse from IC2/3 occurs during the "mono" period (if the input is high frequency) it is reset every 417μs by IC5/2. However, the information is clocked into IC6/2 before the reset pulse occurs. If the input is only a 1200 Hz tone the set pulse does not occur and a "0" is strobed into IC6/2. An examination of the timing diagram in fig. 1 will help clarify the sequence.

Encoder

The encoder is a little more complex than needed for 300 baud, but it allows operation at 600 or 1200 baud if needed. The output of IC9, which is a non-symmetrical 2400 Hz, triggers a 3μs monostable IC10/4 which then toggles IC11/2 giving a 1200 Hz square wave output. However, if the "data input" is a "1", IC11/1 is toggled to give a "1" at pin 1 which enables IC10/2. This then triggers the monostable IC10/4 midway between the pulses due to IC9. This then toggles IC11/2 at twice the rate to give 2400 Hz output. The clocking of the data input into IC11/1 is about 100μs out of phase with the rest of the timing to give time for the UART to settle, eliminating any errors due to propagation delays.

The phase locked loop IC is used only as an oscillator in the transmit mode and the VCO input is switched to a preset voltage giving the correct frequency.

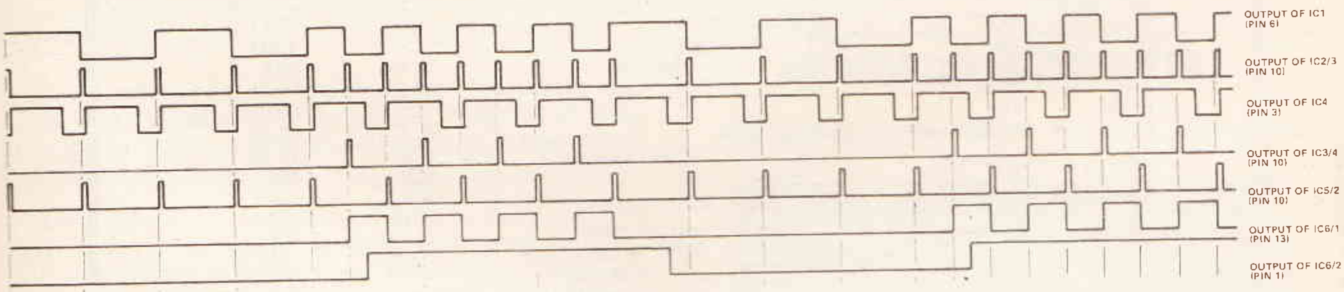


Fig. 2. The sequence of events in the decoder when receiving a '0,1,0,1' input.

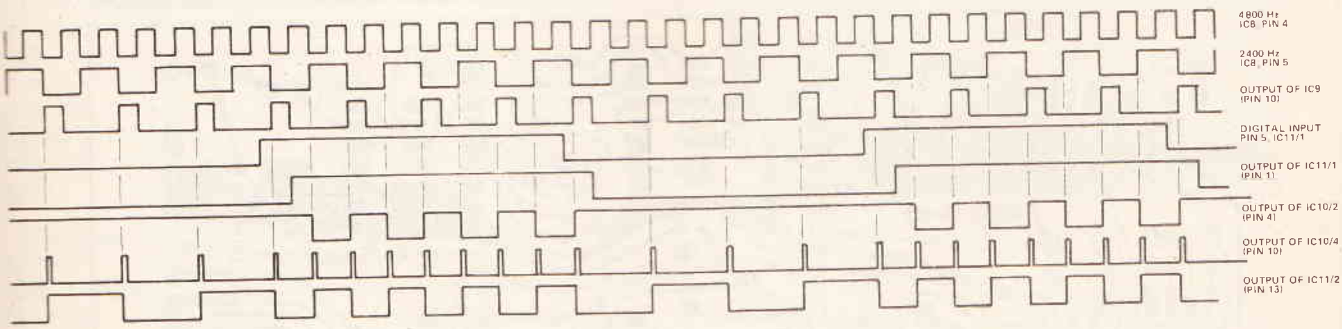


Fig. 3. The encoder waveforms when transmitting a '0,1,0,1.'

is that this tone will adjust the automatic level control while being too high to be reproduced. However it can beat with the bias oscillator causing more problems than it solves.

We therefore recommend that the unit be used only with a recorder with a manual recording control.

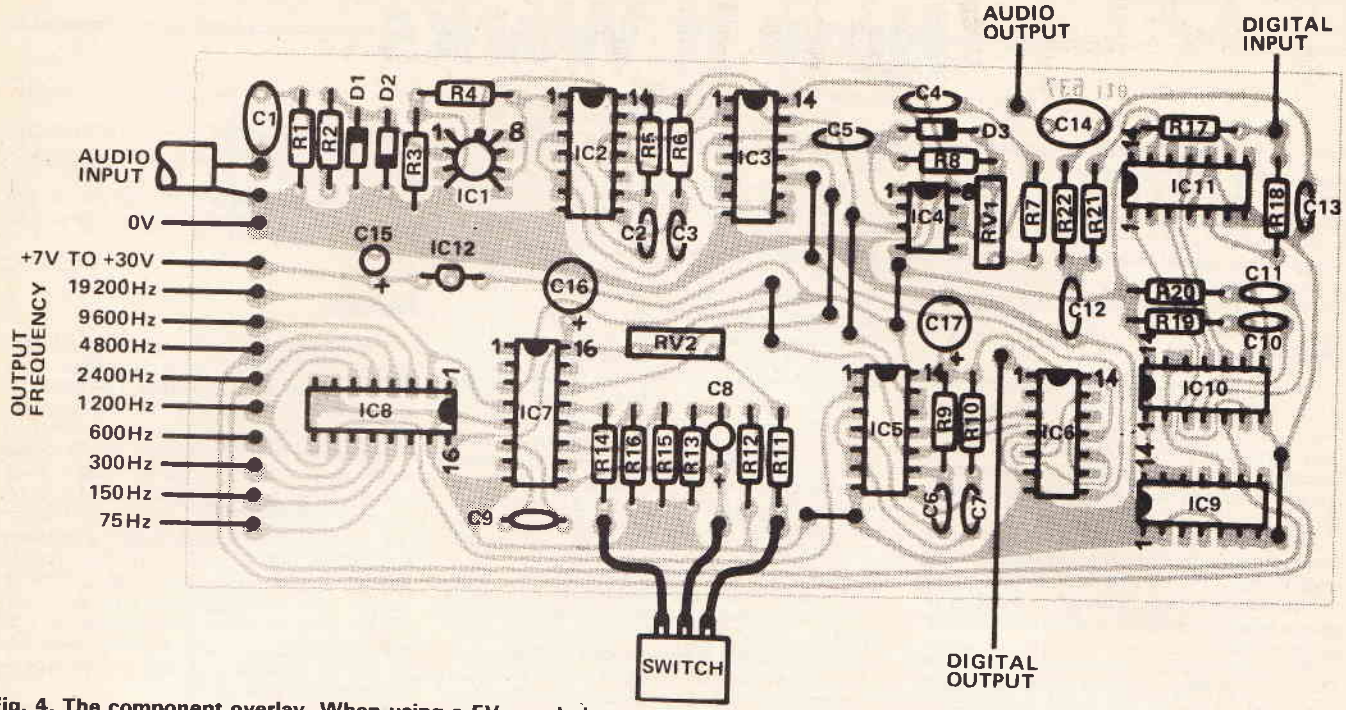


Fig. 4. The component overlay. When using a 5V supply leave out IC12 and add a link between the two outside holes. C15 can also be deleted.

Parts List

RESISTORS
(All ½w 5%)

R1	1M
R2	10k
R3	1k
R4	330k
R5,6	10k
R7	120k
R8	47k
R9-R11	10k
R12	33k
R13	47R
R14	150R
R15	33k
R16	47k
R17	1M
R18-R21	10k
R22	100k

POTENTIOMETERS

RV1	100k trim
RV2	25k trim

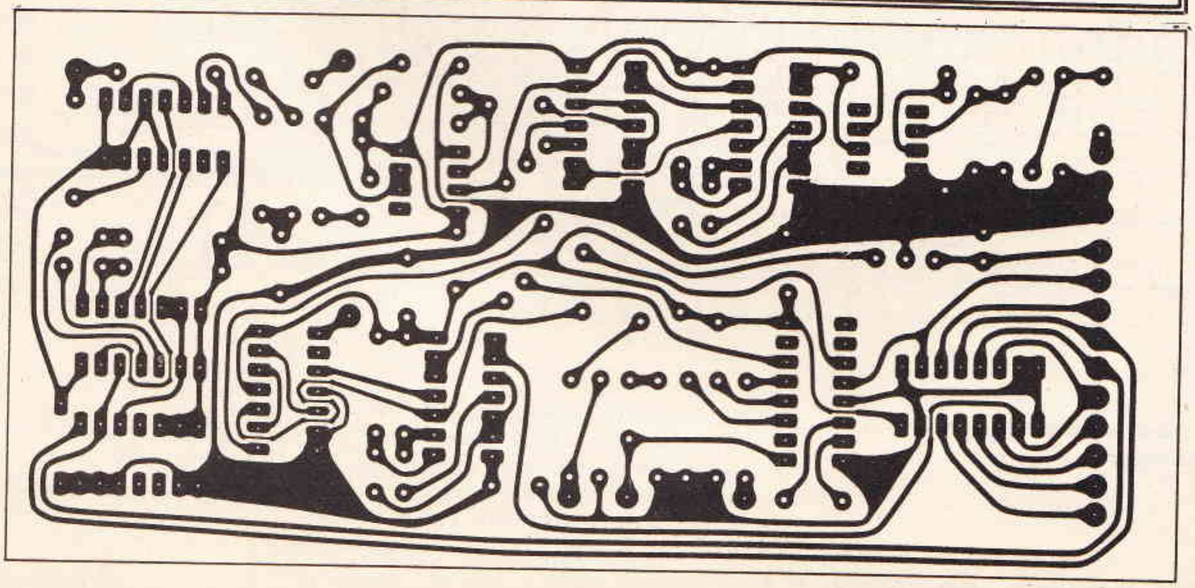
CAPACITORS

C1,14	100n polyester
C2,3,5,6,7,10,11	470p ceramic
C4	1n5 polyester
C8	3u8 25V electrolytic
C9	2n7 polystyrene
C12,13	10n polyester
C15	4u7 35V electrolytic
C16,17	33u 10V tantalum

SEMICONDUCTORS

IC1	CA3130
IC2	4011
IC3	4001
IC4	555
IC5	4011
IC6	4013
IC7	4046
IC8	4520
IC9	4001
IC10	4011
IC11	4013
IC12	78L05
D1-D3	1N914

MISCELLANEOUS
PCB as pattern
SW1 SPDT toggle



TRITON

John Coll, PCW consultant and well known to the computer hobbyist gives his impressions of the TRITON

I've had an early production model of the Triton for some time and I've been most impressed with it and with ETI's approach to the project.

On the hardware side it's clear that the designer Mike Hughes is a professional. The PCB is cleanly designed and good provision has been made for expansion at a future date. The addition of extra memory and of peripherals like printers and floppy disks will be a straight forward process. Whilst economy has been very much borne in mind. There has been no skimping, everything you need is provided to make a simple useful computer using a normal TV set as a display. The fact that where tracks have to go near IC pins, the tracks have been put on the upper side of the board — away from the constructors soldering iron — is typical of the attention to detail which is evident throughout the design.

On the software front the 2K basic interpreter is Li Chen Wang's Palo Alto tiny BASIC which has been around for some time and is therefore pretty much bug free, ie it works.

The monitor on the other hand is very much a version one — it works but could be improved considerably. However, this does not worry me in the slightest because all the software is in EPROM and therefore can be easily and cheaply altered. It is difficult to explain just how important that is — it means that users will be able to return the monitors to Transam and get them reprogrammed with the latest software for a very reasonable sum. It also means that if you want to use the computer for something else you can remove the BASIC and use the whole 4K of EPROM for your special application. This makes the machine potentially important in the process control field.

The documentation is good, however it seems only fair to say that the TOTAL novice would probably find it difficult to diagnose and repair any obscure fault. However, Transam's 'Get it going' service should deal with that in a satisfactory way. The availability of full source listings for both the monitor and BASIC will be useful in specialists applications as well as for the enthusiastic beginner.

It is clear that ETI are determined to 'Get this one right' and to support it in the future with further software and hardware.

I have no hesitation in recommending this kit to you.

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East Coast Report

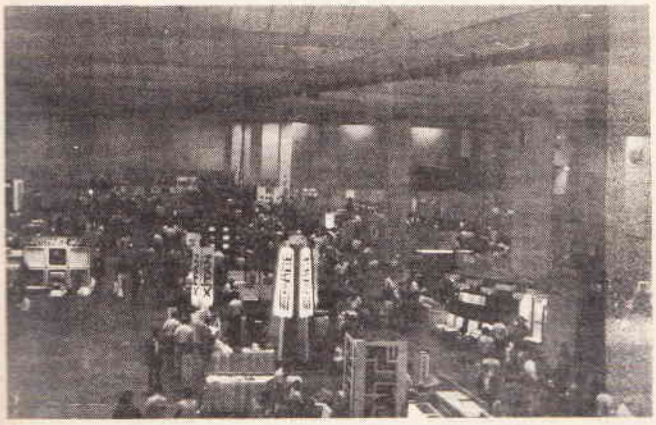
Proclaimed as the largest show ever, Personal Computing '78 was held in the Philadelphia Civic Centre, from the 24th to 27th of August. Computing Today roving reporter Jim Perry was there with his box brownie.

With more than 300 stands and over 100 exhibitors the PC '78 show certainly was large by any standards! To celebrate its third birthday the show had moved to the Philadelphia Civic Centre from its birthplace in Atlantic City. The move of venue was brought about by the tremendous growth in attendance — Atlantic City was just too small for this year's show!

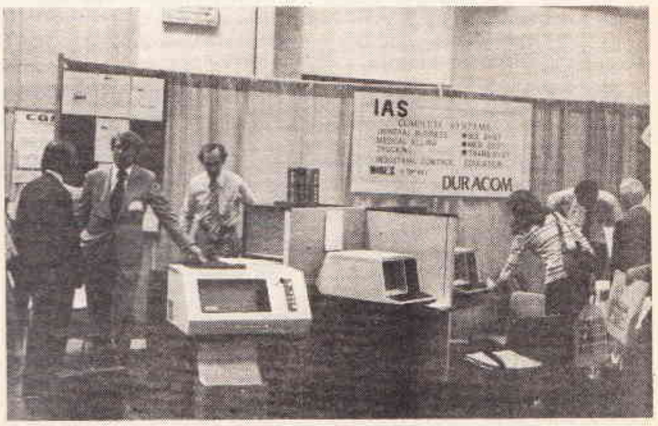
The promoters of the event claim that just over 20 per cent of the American Personal Computer Market is within 2 hours drive of Phildelphia, this is probably because New York is just 2 hours away.

Amongst the many exhibitors there were surprisingly few new products — well, new to the American market at least — most of the products would be new in the UK if available here. With companies such as Heathkit, Radio Shack (Tandy) and Southwest Technical Products in attendance, it was Commodore that was conspicious — by its absence.

To complement the exhibition the organisers had arranged more than 80 hours of seminars, on everything from business systems to computer games. A good point was that all the daytime events were included in the exhibition admission fee. Other activities included a show of computer generated art, a computer music evening and traditional Saturday night banquet (read booze up). ▶



General view of the main exhibition area, early on the first day.



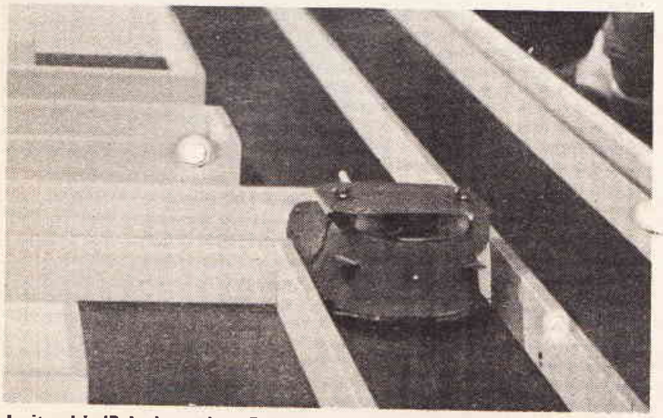
Not quite what you expect at a Personal Computer Show, but a lot of people were looking for complete systems for small businesses.

Software for the TRS 80 was available from many suppliers. This stand is demonstrating a chess recorder program.

The RCA stand was dedicated to their COSMAC VIP, the two small boards plugged into the back are the new music synthesiser and drum machine attachments.

Computer music was the theme on the SOL stand. The interface, between man, machine and music is one of the exciting growth areas.

The Bit Pad is a rather nice (but expensive) device for turning freehand into computer input.



Is it a bird? Is it a plane? No, it's a Micro Mouse! The second trials for the IEEE/Spectrum Micro Mouse Maze competition were held during the exhibition — this MPUed mouse made it through the maze in 4 minutes 45 seconds.

Computalker Consultants did a roaring trade with their versatile speech synthesis units.

The message centre used SWTP equipment to keep everybody up to date via several monitors.

The Radio Shack (Tandy) area was equipped with 12 TRS 80 systems, the complete range of peripherals (printers, floppies etc) was also on continuous demonstration.

Part of the British contingent, Chris Carey and Jim Wood from Comp Computer Components were scouting for new products to unleash on the UK market.

Exidy were demonstrating the Z80 based Sorcerer Computer — a nice feature of this machine is the plug in BASIC, which can be replaced with various other languages virtually instantly.

The TRITON software has some interesting facilities — we take a look at the whole package.

TRITON Software —BASIC

The TRITON BASIC Interpreter was designed to run on small 8080/Z80 micro processor systems. It contains many of the common BASIC commands and most small BASIC programmes will be easily converted to run on the Triton.

Variables

All variables and numbers are stored as 16 bit integers and therefore must lie in the range —32767 to 32767. There are 26 variables each denoted by a single letter A to Z. There is 1 array denoted by @, this array is automatically dimensioned to make use of any memory space left unused by your BASIC Programme. The number of bytes of memory space in this array can be obtained at RUN time using the SIZE function.

Functions

There are three functions available.

ABS(X)	which gives the absolute value of the variable X.
RND(Y)	which gives a random number between 1 and Y inclusive.
SIZE	which gives the number of bytes left unused by your programme. Hence the maximum index for the array @ ( ) is SIZE/2.

Arithmetic Operators

+ Add
— Subract
* Multipy
/ Divide

+, —, * and / operations must result in a value in the range —32767 to 32767 and as they are also integer, any division is rounded down. E.G. 5/2 gives 2, 2/3 will give 0.

Compare Operators

> greater than
< less than
= equal to
≠ not equal to
> = greater than or equal to
< = less than or equal to

The compare operators are usually used with the IF command but can also be used in expressions. The result of any comparison is 1 if true and 0 if not true (false).

Expressions

Expressions are formed from number, variables and functions.

E.G. 10 LET A = 10	A is set to 10
20 LET B = A	B is set to contents of A ie 10

Arithmetic operators are used in expressions and are evaluated from left to right, except that * and / are always evaluated first.

Spaces between numbers, variables and functions are ignored. Spaces inbedded in command words are not allowed.

Parentheses can be used to change the order of evaluation.

Parentheses can be nested, the maximum depth being limited by the size of the stack.

Conditional operators are usually found with the IF command

```
10 IF A = 1 B = B + 1
```

In this statement when A is equal to 1 the expression B = B + 1 is executed and one is added to the contents of B.

Conditional expressions can be combined to form multiple conditions and can also be used in arithmetic expressions.

Statements

A BASIC statement consists of a statement number between 1 and 32767 followed by one or more commands. If a statement contains more than one command, each command is separated by semi colon ;. The statement is ended by a carriage return.

```
10 LET A = 10
20 LET B = A
30 LET C = A + B
```

This can be written

```
10 LET A = 10; LET B = A; LET C = A + B
```

It should be noted that the latter method will be harder to change or correct.

The commands GOTO, STOP and RETURN must be the last command in any statement.

Commands

The following commands are available in the TRITON BASIC L4.1

LET

LET is used to set a variable to the result of an expression.

10 LET A = 10	The variable A is set to 10
20 LET B = (A-1) *2	The variable B is set to the result of the expression (A-1)*2 i.e. 18
30 LET @(3) = B/3	The fourth element of the array @ is set to 6 (The first element is @(0))

The expression need not be an arithmetic expression.

10 LET C = A≠B	If A equals B, C will be set to zero If A is not equal to B, C will be set to one

The LET command can be used to set several variables

```
10 LET A = 1, B = 2, C = 3
```

each part being separated by a comma ,

We can therefore rewrite an earlier example.

```
10 LET A = 10, B = A, C = A + B
```

Rem

The REM (Remark) Command allows the programmer to comment his programme. The interpreter will ignore the rest of the line.

```
100 REM THIS IS THE START OF THE SUBROUTINE Y = A*A + B
```

»»

Print

The PRINT command is used to print numbers, variables, expressions, and text.

10 PRINT A — will print the contents of variable A

10 PRINT A*2 — prints twice the contents of variable A

10 PRINT 'THIS IS A TITLE' prints THIS IS A TITLE

Several variables, etc. can be printed at once. Each item to be printed is separated by a comma.

10 PRINT A,B,C — will print the contents of A followed by B and C on the same line.

Text can be used to qualify printout.

10 PRINT 'THE RESULT IS', A

Text can be contained by either single or double quotes, this allows the other type of quote to be printed.

10 PRINT 'ABC"CBA', "123'321" will print ABC"CBA123'321

Numerical values are printed with leading spaces (Right Justified) in a field of width 8 characters. The field width can be altered using a # sign followed by the new width (i.e. ♯ 3 gives a width of 3).

The field width will then remain effective until another ♯ or the end of the current PRINT statement.

10 PRINT A, ♯3, B, ♯1, C — will print A in a width of 8 characters. B in a width of 3 and C in a width of 1.

♯1 will result in C being printed Left Justified and any following printout will be shifted to the right if C is greater than 9

The field width can also be an expression

PRINT ♯ I, A will print A in a field width equal to the contents of variable I

The maximum field width is 63.

Note that negative numbers require an extra character in the field width for the minus sign.

Extra spaces can be generated by repeated commas.

PRINT ♯ 3,A,,,B will print a 3 character A, 2 spaces and a 3 character B

Several PRINT statements can be made to print on the same line by ending the statement with a comma.

Graphic characters can be printed using the PRINT statement. The description of the graphics font lists those Graphics which can be contained in quotes and will result in graphics being printed.

The PRINT statement can also be used to issue cursor control characters

10 PRINT †H — will issue a control H which will backspace the cursor

10 PRINT †I — will issue a control I which will forward space the cursor

10 PRINT †J — moves cursor down

10 PRINT †K — moves cursor up

10 PRINT †L — will clear the whole screen and reset the cursor. Note that this command must be followed by a delay before the next command (FOR I = 1 TO 250; NEXT I)

10 PRINT †M — will reset the cursor to the start of the line.

Input

The input command is used to read an expression from the Keyboard. Normally the keyboard input is just an integer value between —32767 and 32767.

10 INPUT A — When this statement is executed, the BASIC will first print A followed by a space and then wait for keyboard input. The input is terminated by carriage return. The input is then stored in variable A

10 INPUT A,B — will print A,space,then wait for input, it will then print B, space, and wait for input again.

Instead of just allowing the machine to prompt you with the variable, it is much better to ask a specific question. This is done by enclosing the text of the question in quotes.

10 INPUT 'HOW MANY EGGS HAVE YOU LEFT?' I

The machine will print HOW MANY EGGS HAVE YOU LEFT? and then wait of a number to be typed in.

If during RUN time, the typed input is not a valid expression, the prompt will be repeated and then the machine will wait again.

It is also possible to reprint only part of the prompt.

10 INPUT 'WHAT IS ', 'A+B?'C, 'A-B?'D

The first time the printout will be WHAT IS A+B? and after an invalid input it will just print A+B?

The BASIC interpreter uses its expression evaluation routine to decode the input and therefore the programmer or user can enter an expression using variables already set up.

```
10 LET A=3, B=2
20 INPUT C
30 PRINT C
```

Instead of entering a value for C, the user can enter an expression such as A+B, the expression will then be evaluated by the interpreter and the result 5 stored in the variable C. The machine will then print 5.

It is also possible to enter single characters as a reply by making use of the expression input.

```
10 LET Y=O, N=1
20 INPUT 'DO YOU WANT TO CONTINUE? Y OR N' A
30 IF A=1 STOP
```

If the user replies Y, A will be set to the contents of Y i.e. zero. If the user replies N-A will be set to 1 and the programme will STOP.

If

The IF command is used to compare expressions, using the compare operators. If the result of this comparison is true (non zero) the rest of the statement is executed. If the result of the comparison is false (zero), the rest of the statement is skipped and execution resumes on the next statement.

10 IF A=O PRINT 'A IS ZERO'

The machine will print A IS ZERO only when A is zero.

Note that unlike other BASIC interpreters and compilers, the word THEN is not used.

Either side of the compare can be an expression.

```
10 IF A=B*2 PRINT 'A IS TWICE B'
20 IF A*3=B*2 PRINT 'A=B*2/3'
```

A compare operator need not be used in the IF statement but this practice should be avoided where possible as it can make the programme very hard to follow.

10 IF A— 1 PRINT 'A IS NOT ONE'

»»

the PRINT command is only skipped when the result of the expression in the IF command is zero.

Several commands can follow the IF command

10 IF A=0 PRINT 'A IS ZERO'; GOTO 50

When A is zero, the machine will print A IS ZERO and then jump statement 50.

GOTO

You will probably be fairly familiar with the GOTO command already as it has appeared in several of the examples for the other commands.

The GOTO command is used to break the sequential processing of the BASIC interpreter and cause the interpreter to jump either forward or backwards to the specified statement number.

50 GOTO 10

When the interpreter executes this statement it will jump back up the program to statement 10 and continue its processing from statement 10.

Again, the statement number following the GOTO can be an expression.

20 GOTO A*2

Will jump to the statement number calculated from the expression A*2. If the expression gives a non existent statement number the BASIC will give an error report.

Using a simple expression for a GOTO is useful where different routines may be required as a result of an input.

Another method of using a computed GOTO is to use the array variable and index it.

```
10 LET @(1)=100, @(2)=200, @(3)=100, @(4)=25
20 INPUT I
30 GOTO @(I)
```

If the input for I is 1 the interpreter will jump to statement 100

for I=2 it will jump to 200

for I=3 to 100 again

for I=4 to 25

It is advisable when using the computed GOTO to check the variable for valid values, ie in the above example it would be advisable to insert

```
25 IF I <1 GOTO 20
27 IF I >4 GOTO 20
```

This will only allow an input of 1 to 4, any other input will result in a repeat request for input.

Gosub and return

The GOSUB command although similar to the GOTO command, is used to exit from a statement and jump to a routine starting at the specified statement number. Execution continues from the specified statement number until a RETURN command where upon the BASIC returns to the command following the original GOSUB.

```
10 PRINT 'LETS EXECUTE ROUTINE 100'
20 GOSUB 100; PRINT 'WE HAVE NOW RETURNED'
30 STOP
100 PRINT 'THIS IS ROUTINE 100'
120 PRINT 'I WILL RETURN WHEN I HAVE FINISHED'
130 RETURN
```

This will result in the following printout

```
LETS EXECUTE ROUTINE 100
THIS IS ROUTINE 100
I WILL RETURN WHEN I HAVE FINISHED
WE HAVE NOW RETURNED
```

The GOSUB 100 command causes the BASIC to jump to statement 100 but also to remember where it is in statement 20. It now executes from statement 100 until it reaches the RETURN command. It then returns to statement 20 and continues processing it.

For and next commands

The FOR command is a very powerful command. It is used to make the BASIC interpreter loop 'FOR' a specified number of times, the end of the loop being defined by the NEXT command.

```
10 FOR I=2 TO 10 STEP 2
20 PRINT I
30 NEXT I
```

I is set to 2 when the FOR statement is first encountered. It will then remain at 2 until the NEXT command is encountered. On reaching the NEXT command 2 is added to I and the BASIC returns to the command following the FOR command. This is repeated until I becomes greater than 10 where upon execution continues with the command following the NEXT command.

Hence, the machine will print

```
2
4
6
8
10
```

On exit from the loop I remains at its next value ie 12. If statement 10 had been

10 FOR I=2 TO 11 STEP 2

I will be left at its first value greater than 11 ie 12.

Negative indexing is allowed as long as the first value is greater than or equal to the second and the step is negative.

```
10 FOR I=10 TO 1 STEP —1
50 NEXT I
```

I will start at 10 and step down to 1 in increments of 1.

If STEP is omitted, a step of 1 is assumed.

10 FOR I=1 TO 100

I will start at 1 and step up to 100 in increments of 1.

Once more, expressions can be used in all three positions instead of numbers. The expressions are evaluated when the FOR command is executed and any following changes to the variables used will not effect the loop.

```
10 LET I=10
20 FOR I=I TO I+5
50 NEXT I
```

The initial value of I is evaluated as 10, the final value is 15. Within the loop, I will index from 10 to 15 in steps of 1

FOR and NEXT commands can be 'nested' within each other, the limit being that of the size of the stack.

```
10 FOR I=1 TO 10
20 FOR J=1 TO 5
30 PRINT I*J
40 NEXT J
50 NEXT I
```

This will result in the machine printing I*J when

I=1 and J=1 2 3 4 5 then

for I=2 and J=1 to 5

etc. etc.

until I=10

When a NEXT command is executed, the BASIC interpreter checks that the variable specified is the same as that used by the most recent FOR. If they are not the same, the FOR is terminated and the previous FOR examined. This continues until a match is found.

```
10 FOR I=1 TO 10
20 FOR J=1 TO 10
30 IF J=5 GOTO 50
40 NEXZ J
50 NEXT I
```

Each time J gets to 5, the BASIC jumps to statement

50. This cancels the J FOR loop leaving J at 5 and continues with the I for loop.

If within a FOR loop, another FOR loop using the same variable is encountered, the first FOR loop is terminated.

Stop

The stop commands stops the execution of the programme when it is executed. Any number of STOP commands can be included within a programme.

```
10 GOSUB 100
20 GOSUB 200
30 GOSUB 300
40 STOP
```

VDU

The VDU command allows the programmer direct access to the VDU control chip and its memory hence allowing a wide range of graphics applications.

The VDU command has two parameters, the first being the VDU memory address, the second being the desired graphic symbol specified as a decimal number.

```
10 VDU 5, 126
```

This will result in the graphic —> being placed in the fifth byte of the VDU memory.

The VDU memory is arranged as 16 rows each containing 64 bytes therefore addresses 1 to 64 are on the first row, 65 to 128 on the second etc.

Due to the function of the VDU control chip, care should be taken when using the first row and the first column as certain graphics characters will produce strange effects.

To allow the programmer to use all the VDU control commands, address zero has been allocated.

```
10 VDU 0, 12
```

This does not use memory location zero, instead the value 12 is output to the VDU controller.

12 is the command to clear the screen and reset the cursor.

Note that commands 12 and 28 require an extra delay while the command is executed. A FOR loop should be used (FOR I=1 TO 150; NEXT I before the next PRINT, VDU or INPUT command.

Other useful VDU commands are as follows:

8	Backspace cursor one character
9	Forward space cursor one character
10	Line Feed (Move cursor down on line)
11	Move cursor up one line
12	Reset cursor to top and clear screen
13	Carriage Return — Reset cursor to start of line clearing rest of line
27	Line Feed
28	Reset cursor to top without screen clear
29	Reset cursor to start of line without rest of line clear.

When using the memory mapping option, care must be taken to make sure that the memory address is between 1 and 1024 inclusive. If you exceed 1024 it is possible to overwrite the stack and your programme.

It is possible to make your BASIC programme modify itself using VDU but this is fairly difficult and not really worth the trouble it can cause.

Before using memory mapping it is advisable to use either command 12 or 28 to reset the cursor. If the screen has been scrolling, row 1 will not be at the top of the scan unless this is done.

The graphic symbol specified in the second parameter is a decimal number between 0 and 255 inclusive. If a larger number is specified, only the least significant byte is used.

The graphics and character code are given elsewhere in ETI but some of the more useful are listed below.

0 to 31	see Graphic Font
32 Space	
33 — 47	! ” ≠ $ % & ’ ( ) * + , — . /
48 — 57	0 to 9
58 — 64	: ; < = >? @
65 — 90	A to Z
91 — 95	[ ]
96 — 127	see Graphics Font
128 — 225	Is a repeat of 0 to 127 (The high order bit is ignored)

To print a variable between 0 and 9 using VDU just add 48.

```
VDU 0, I + 48
```

This will print the value of I if it lies between 0 and 9.

To produce moving graphics, it is necessary to use FOR loops to index the memory mapping.

Direct commands

The following are direct commands to the BASIC Interpreter. They are obeyed as soon as they are entered.

RUN will start the execution of the programme at the lowest statement number.

LIST will print out all statement in ascending numerical order.

LIST 100 will print out all the statements starting at statement 100.

LIST 50, 10 will print 10 lines starting at statement 10.

NEW will delete all programme statements ready for a new programme.

Control C will return you (at any time) to the Monitor.

Any BASIC command can be entered as a Direct Command by leaving off the statement number. The statement is then executed immediately and not stored as part of the programme.

This feature is very useful when your programme stops due to an error report. (see Error Reports)

Abbreviations

All the commands can be abbreviated as follows.

It is advisable only to abbreviate when you are tight on memory as the abbreviated programme can be extremely difficult to follow.

Functions

A.	= ABS
R.	= RND
S.	= SIZE

Commands

Implied	= LET ie A=B+C, D=E+F etc

»»

BASIC

REM. = REMARK
P. = PRINT
IN. = INPUT
I. = IF
G. = GOTO
GOS. = GOSUB
R. = RETURN
F. = FOR
TO. = TO
S = STEP
N. = NEXT
S. = STOP
V. = VDU

Direct Commands

L. = LIST
R. = RUN
N. = NEW

Error Reports

It is quite probable that you can have already seen some of the error reports generated by the BASIC Interpreter.

Although there are only three different error messages (WHAT? HOW? and SORRY) the BASIC will insert a question mark at the point where the error occurred.

WHAT? This means the interpreter has come across a command or expression that it can't interpret.

WHAT?
300 I? PUT A — INPUT is spelt wrongly.
WHAT?
40 A = 300/(B+C? — The close parenthesis is missing

HOW? This means the interpreter can not execute the command.

HOW?
60 A = 300*500? — The result is greater than 32767
10 A=5,B=0
20 C=A/B?
HOW? — You can't divide by zero
40 GOTO 37?
HOW? — Statement 37 is missing

SORRY This means that there is not enough memory. This can occur during typing in a programme or during the execution when the array is used — @( ). It is worth checking the variable or expression if the array is involved to make sure that it is a sensible value.

210 A = @(I*J+K)
SORRY

If this occurred during typing in of the programme then there is not enough memory.

If this occurred during execution (RUN) then either there is not enough memory for @ or the expression I*J+K may be incorrect.

To check this type
PRINT I,J,K,I*J+K
and the values of I J K and I*J+K will be printed. You can now check if the result is correct.

This shows how useful the direct command option is. If the result of the PRINT is OK then another check is
PRINT SIZE
This will give how much memory space (in bytes) is left.

CTI

microfile

Gary Evans has found himself a new home this month and reports on a way to save money and the latest in train controlers amongst other things.

OVER THE PAST FEW months the advertising pages of ETI have seen the inclusion of a number of American firms offering a wide range of components aimed in the main at the DIY computer hobbyist. The prices of many of the goods available, when converted into pounds, make very attractive reading. The snag — and there must be one — is just how do we go about getting the things over from the States.

The procedure is not as harrowing as one might suspect. The first thing to do is to identify exactly what it is you want to buy and the exact cost in dollars of the goods plus packing. Go along to your bank with the advert and tell them exactly what you want to buy and the cost in dollars. They will prepare a dollar draft, a document which, in conjunction with a sister bank in the States, will be as good as cash to the firm supplying the components. Note that your bank account will be debited at this stage.

Now its just a matter of sending off the draft plus your order — the things should arrive in the post within the next few days.

If the firm in the States 'does a bunk' with your hard-earned greenbacks, however, getting anything back will prove very difficult if not impossible. We would let you know of any companies that we know are not honouring their orders but it would be best to place a small order to try out a firm's credibility before parting with a large amount of money.

I might mention that an advert in last month's ETI, not even I've seen this month's ad pages, from an American firm, is advertising a TR5-80 16K conversion kit with information about which jumpers to change for a good bit under £100. When you compare this to the £200 plus Tandy want in addition to the fact that with the DIY way you keep your original 4K, you can see that shopping in the States can be very profitable.

Club Together

I've had a few, not a lot, but a few replies to my 'Club Call' a couple of months ago.

In the Midlands, a group of the ACC has been having successful bi-monthly meetings for about a year — contact John Diamond at 27 Loweswater Road, Binely, Coventry. Also in the midlands is the West Midlands Computer Club which has just held its first meeting in Brierly Hill. Contact Tony Bridgewood on 021-557 6709.

Now a plea for those interested in starting a branch of the ACC in Bristol, those interested contact Rex Godby at 16 Williamson Road, Ashley Down, Bristol.

Finally the Cambridge University Processor Group (they've got very nice notepaper) which despite the name is open to everyone and holds regular meetings during term time (that's about four months out of twelve from what I hear). Tim Hopkins is the man to contact at Magdaline College, Cambridge.

In all the above cases please enclose an SAE with any letter.

News of another firm generating games — initially for — you guessed it PET — the firm plan to expand into Z80 machine code programs — NASCOM, MICROS, RM 380Z with possibly games for KIM-1.

Mini micro are at 47 Queens Road, London, N11 2QP. Their catalogue is available — again send an SAE.

Shocking Story

It was my pleasure to build up one of the Triton prototypes. Enough has been said about the machine elsewhere in this issue, I'll just add my congratulations to the designer Mike Hughes for producing a really excellent project.

Before leaving the subject you might be interested to hear of an experiment I performed with the machine. It was designed to test the Triton under extreme conditions, namely applying high voltage AC the selected components via a high resistance. Needless to say I was the high resistance and the fact that I'm telling the tale show I'm OK, the Triton hardly twitched which could not be said for me.

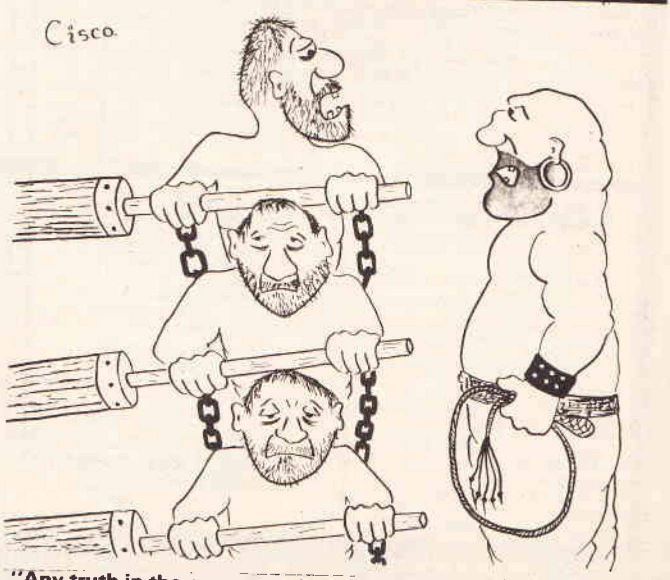
House Trained

Details are scarce, but the model train exhibition at the end of August saw the preview of an MPU controlled train system.

Designed by Hornby, who have designated it the Zero-1, the controller will enable up to 16 trains to be controlled on a layout, each being called up by a key pad. The trains will have programmable levels of inertia.

This is not a 'section' system, control being, presumably, by a pulse code system. The conversion of the train is simple, a small circuit block being inserted in the motor's power lines.

Due for launch late next year the Zero-1 should make Christmas '79 something to remember, as at a price of about £30/£40 it must be a must, to coin a phrase.



"Any truth in the rumour we're about to be replaced by an MPU boss."

COMPUTING AD INDEX

ETI MARKET PLACE

Digital Alarm

Size: 105mm wide 115mm deep x 55 mm high.

THIS IS THE THIRD digital alarm clock that we are offering (we regret the earlier versions are no longer available). We have sold thousands and thousands of these and our buying power enables us to offer a first rate branded product at a really excellent price.

The Hanimex HC-1100 is designed for mains operation only (240V/50Hz) with a 12 hour display, AM/PM and Alarm Set indicators incorporated in the large display. A switch on the top controls a Dim/Bright display function.

Setting up both the time and alarm is simplicity itself as buttons are provided for both fast and slow setting and there's no problem about knocking these accidentally as a 'locking' switch is provided under the clock. A 9-minute 'snooze' switch is located at the top.

£8·95

(Inclusive of VAT and Postage)

An example of this clock can be seen and examined in our reception at our Oxford Street offices.

DIGITAL ALARM

To:
Hanimex Alarm Offer
ETI Magazine
25-27 Oxford Street
London W1R 1RF

Please find enclosed my cheque PO for £8.95 (payable to ETI Magazine) for a Hanimex Digital Alarm Clock.

Name ....

Adress ....

....

....

Please allow 14 days for delivery

LCD Watch

New low price!

The enormous numbers involved in ETI offers has enabled us to arrange a real bargain — a full spec LCD watch with adjustable metal bracelet for under half the going rate.

This watch gives continuous display of hours and minutes press the button once and you'll get the date (American style). After a couple of seconds the display automatically reverts to time but if you press again you'll get a continuous seconds display.

Press another button and you get a back light, enabling you to see the display in the dark. Setting, or resetting is simplicity itself and a 'hold' facility allows you to set the watch spot on. The accuracy is magnificent, as with all the current range of digital watches and battery life is well in excess of a year.

£8·95

(Inclusive of VAT and Postage)

An example of this watch can be seen and examined in our reception at our Oxford Street offices.

LCD WATCH

To:
LCD Watch Offer
ETI Magazine
25-27 Oxford Street
London W1R 1RF

Please find enclosed my cheque/PO for £8.95 (made payable to ETI Magazine) for my LCD Digital Watch.

Name ....

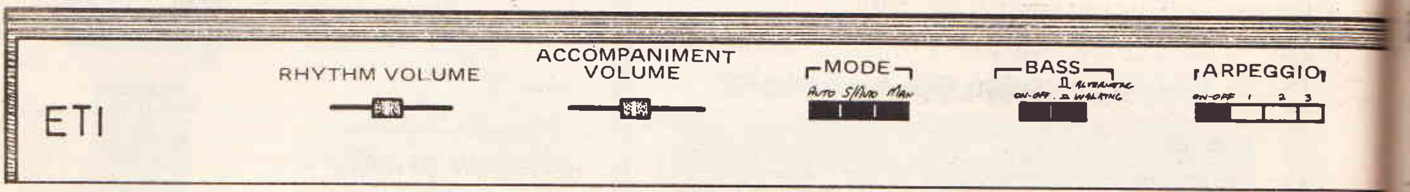
Address ....

....

....

Please allow 14 days for delivery

AUTOCHORD
PART ONE



WHILE NOT QUITE an instrument in its own right the auto chord is certainly more versatile than the common or garden rhythm generator.

The instrument is designed to be added to the lower two octaves of an organ and will provide a variety of accompaniment controlled by the mode selected.

The specification shows that the eights rhythms provided cover most requirements and gives some idea of the extra facilities offered by the auto chord.

The instrument will offer chords — major or minor third, fifth or diminished fifth and sixth of seventh. It will also provide a walking or alternate bass as well as arpeggios.

They say a picture is worth a thousand words, and at this moment we feel that at some time someone must have said much the same about sound. It's difficult to convey all the facilities offered by the auto chord on paper, so if you cannot visit Maplin's shop, where a unit will be on demonstration, you will just have to take our word that the auto chord provides everything that the solo musician could want.

The auto chord is designed to be incorporated within existing organs and is easiest to interface with a DC keyed organ although it is possible to use the auto chord with a direct keyed instrument.

Full constructional details plus a description of the auto chord in use will be presented next month.

SPECIFICATION

8 selectable rhythms	**Covering waltz, rock to Latin. Latin American rhythms can be combined. Non-Latin American rhythms can be combined.**
5 instruments	**Bass. Snare drum. Low bongo. Claves. Cymbals.**

CHORD ACCOMPANIMENT (with keyboard)

Three mode selection	**1. AUTO**
1	**Playing one note produces a chord structured around this note, and will play continuously.**
	SEMI-AUTO
3	**Individual notes or chords played are remembered and played continuously.**
	MANUAL
	Notes or chords played only continue whilst the keys are held operated.

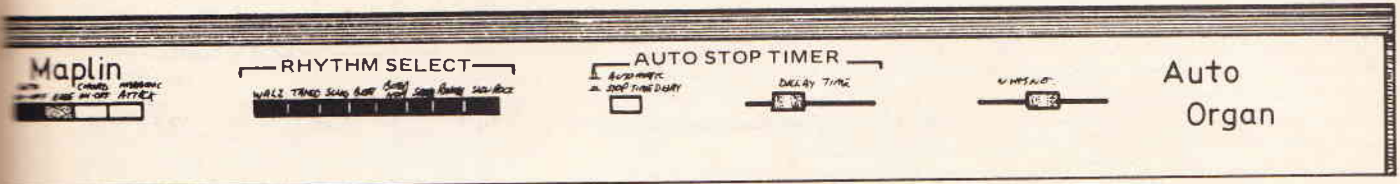
AUTO RESET
Variable bass. Delay-auto-stop and over-ride in all 3 modes. On/off.
Walking or alternating in modes 2 and 3. A minimum of three notes. Must be played for bass accompaniment.
Auto: On/off.
Chord accompaniment: On/off.
Two octaves progressive in modes 2 and 3. Selectable maj/min 3rd/7th.
Variable tempo

Harmonic attack	**Five tones added in short bursts**
Arpeggio	**Three selectable pitches**

Chord accompaniment volume
Rhythm volume

FRONT PANEL CONTROLS

SW1	Mains on/off	SW18	Auto/semi-auto/manual
SW2	Auto on/off	SW19	Auto-stop/continuous
SW3 to 10	Rhythm select	SW20	Auto reset
SW11	Chord on/off	SW21	Arpeggio. Off/1/2/3
SW12	Harmonic attack	R13	Tempo
SW13	Major/minor 3rd	R26	Auto-stop time delay
SW14	7th	R131	Auto-accom. volume
SW16	Bass on/off	R140	Rhythm volume
SW17	Bass — walking/alternating		



PARTS LIST

RESISTORS
½W

R126	47R
R24, 25, 155, 157, 159, 173, 181, 199, 216, 221, 234, 231	270R
R104	560R
R80	680R
R72, 88, 101, 115, 122, 143, 156	2k2
R55, 64, 71, 100	2k7
R154	3k9
R42, 56, 57, 58, 60, 162, 183, 238	4k7
R87	5k6
R116, 123, 125	6k8
R74, 75, 77, 117, 118, 124, 127, 131, 133, 135, 136, 140, 161, 182, 217, 222, 232, 235	10k
R15-20	12k
R76, 93	8k2
R28-49, 82, 95, 113, 158, 172, 208, 250	15k
R1-11, 14, 23, 73, 90, 168	22k
R106, 163, 170, 177, 191	27k
R54, 229	33k
R149-153	39k
R166, 167, 198, 203, 215, 239, 248	47k
R69, 70, 85, 86, 98, 99, 103	56k
R134, 230, 241	68k
R89, 102	82k
R62, 63, 66, 78, 79, 92, 120, 128, 132, 137, 160, 165, 169, 171, 174, 184, 186, 187, 200, 201, 204, 211, 212, 214, 219, 226, 227, 233, 236, 237, 240, 243, 245, 246, 249, 12, 21, 22 27 91	100k
R50-53, 67, 83, 96 189, 195	150k
R185, 188, 242, 244	180k
R129, 138, 209, 210, 220	220k
R176, 192, 193, 197, 205 206, 207, 225	270k
R81, 94, 179	330k
R65, 114, 121, 180, 223 224	470k
R105	820k
R107, 112, 119, 175, 178, 218	1M0
R196, 213, 228	2M2
R108	4M7

¼W

R141	39R
R110	100R
R146, 147	180R
R144	330R
R142, 145	820R
R148	1k5
R194	43k

POTENTIOMETERS

R111	1k0
R61, 247	47k
R164, 190, 202	100k
R109	470k
R68, 84, 97	1M0

CAPACITORS

C68, 72, 79, 86, 93, 94, 95, 101, 103, 110	10n polyester
C100, 111, 85	22n polyester
C21, 22, 23, 107	33n polyester
C5, 11, 17, 25, 31, 35, 70, 99, 105, 108	47n polyester
C10, 40, 71	68n polyester
C1, 12, 20, 28, 30, 47, 69, 76, 104, 109	100n polyester
C75	150n polyester
C9	220n polyester
C13-16	27n polycarbonate
C24	47n polycarbonate
C6, 7, 8	82n polycarbonate
C2, 66, 97, 106	1u0 polycarbonate
C3	1n0 ceramic
C19, 27, 29, 33, 38, 43	10n ceramic
C4	22p ceramic
C78, 80	220n mylar
C49, 52, 55	100p polystyrene
C44, 74, 88, 96	330p polystyrene
C73, 89	470p polystyrene
C91, 92	680p polystyrene
C39, 90	1n0 polystyrene
C32	1n5 polystyrene
C45, 87	2n2 polystyrene
C18, 26, 36, 41, 67, 82, 83, 84	3n3 polystyrene
C102, 77, 81	4n7 polystyrene
C34	6n8 polystyrene
C98	lu5 63 V electrolytic
C48, 50, 51, 53, 54, 56, 59, 60, 64, 65	10u25 V electrolytic
C37, 42	22u 10 V electrolytic
C58, 63	100u 25 V electrolytic
C61, 62	220u 16 V electrolytic
C57	470u 25 V electrolytic
C46	1000uV 16 V electrolytic

SEMICONDUCTORS

IC1	M254
IC2-5	4011
IC6	M251
IC7	M087
IC8	4069
IC9-11	741
IC12	4016
IC13	4013
Q1-4, 7, 8, 10, 11, 12, 13, 15, 16	BC548
Q9, 14	BC177
Q5	BFY51
Q6	BFX87
D1-86, 94, 105	1N4148
D87-90	1N4002
D91	12 V 400mW
D92	5V6 400mW
D93	12 V 400mW
LED1	TIL209

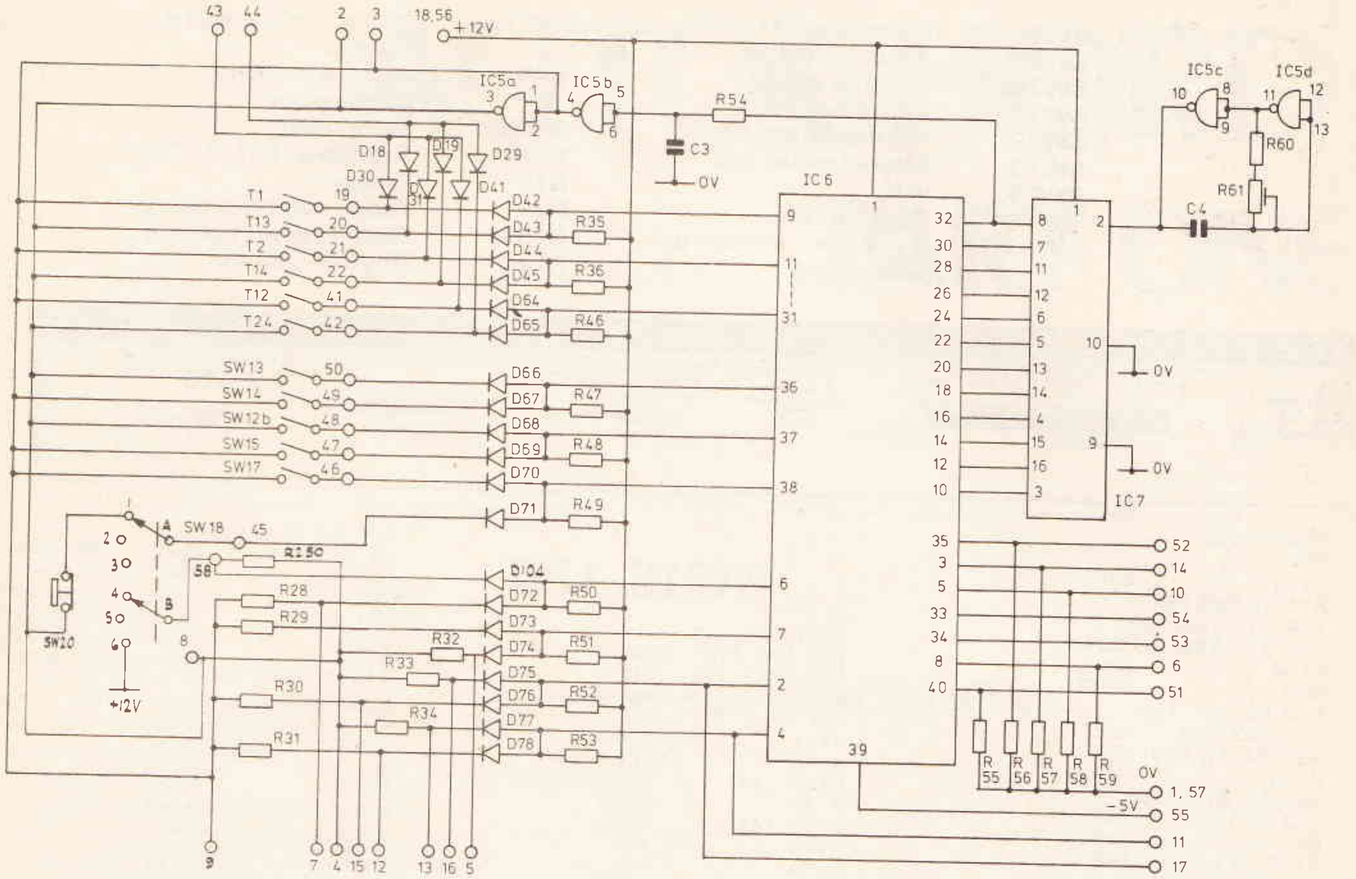
SWITCHES

SW1	Mains latchswitch
SW2	2 pole latchswitch
SW3 to 10	8, 2 pole latchswitch interdependent
SW11	2 pole latchswitch
SW12	2 pole latchswitch
SW13	2 pole latchswitch
SW14	2 pole latchswitch
SW16	2 pole latchswitch
SW17	2 pole c/over latch-switch
SW18	4p. 3W rotary
SW19	2 pole latchswitch
SW20	Push (break) sw
SW21	3p. 4W rotary

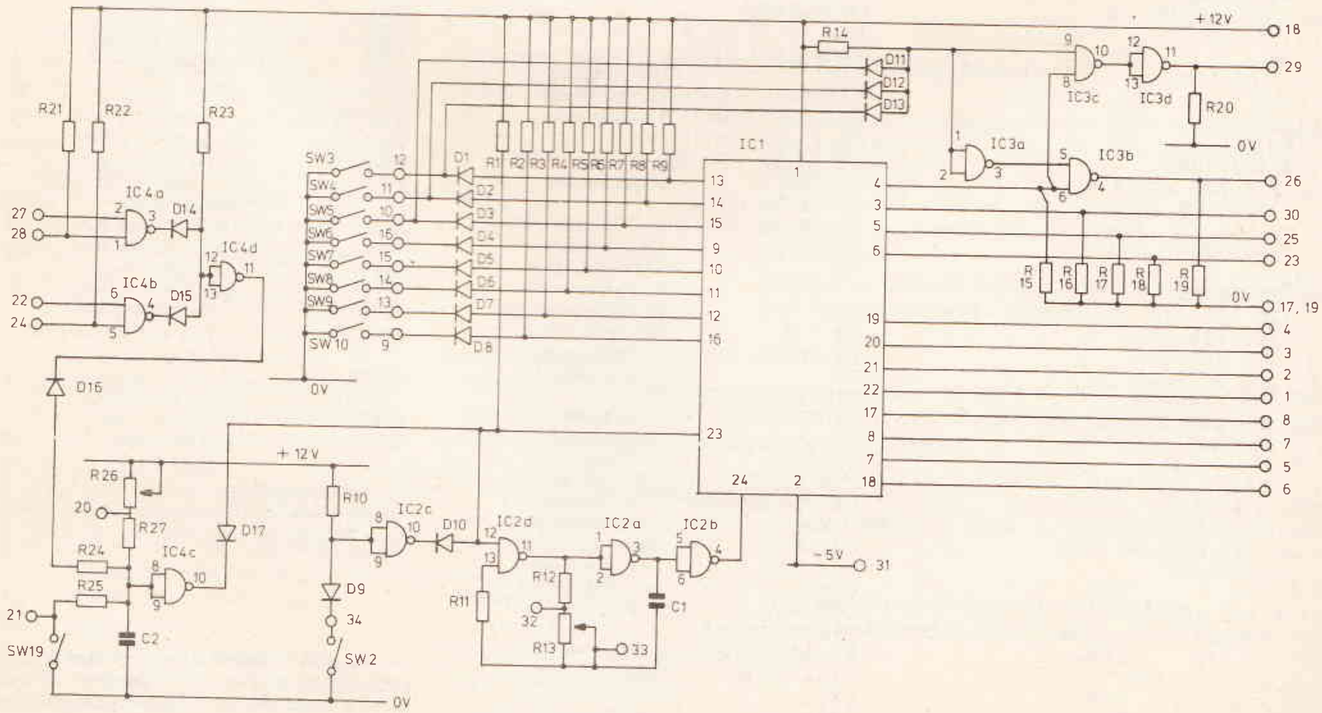
MISCELLANEOUS

PCBs, 15-0-15 250mA transformer, fuse plus holder, sockets, clip on heat sinks, cable, etc.

Production problems have meant that the circuit diagrams feor this project are without the usual component annotations.



Circuit diagrams of the generator and coder



HOW IT WORKS

PRE AMPLIFIER

The chord and rhythm outputs are amplified and filtered in ICs 9 and 11 respectively. The outputs from these devices are fed, via level control potentiometers to the input of IC10. This mixes the two signals and provides the final output of the instrument at a level suitable for feeding to a power amplifier.

POWER SUPPLY

The various ICs used in the auto chord require supplies of +12 V, +11 V, −5 V and −11 V. The +12 V line is derived from the rectified AC output of T1 by the series pass element Q5. The voltage at the emitter of Q5 is determined by D91, a zener diode. The +11 V supply is a simple shunt from the 12 V line.

The −5 V line is again a series pass circuit, this time the output voltage being set by D92.

The −11 V rail is simply stabilised by zener diode D93 as the current demanded from this rail is not enough to warrant the use of another series pass transistor.

The LED supply is taken from the negative voltage rail and is current limited by R148.

GENERATOR AND CODER

The rhythm generator section of the instrument is centered on IC1. This is the M254, a device that contains a ROM that will drive the sound generators with a selection of eight rhythms. To select a desired rhythm, the appropriate input must be taken to ground, via SW3-10, will the other inputs are held high by resistors R1-R9.

The M254 requires a clock signal to operate and this is generated by the CMOS oscillator formed by IC2. The frequency of this oscillator, and ultimately, the tempo of the rhythm, is controlled by R13.

The arpeggio, chord and bass accompaniment are generated by IC6, the M251.

The IC is fed with 12 input frequencies from the tone generator, IC7. This is clocked by the output of the CMOS astable based on IC5c and d.

The M251 is used in conjunction with the M254 which is responsible for the selection of the various notes in the arpeggio/chord/bass accompaniment.

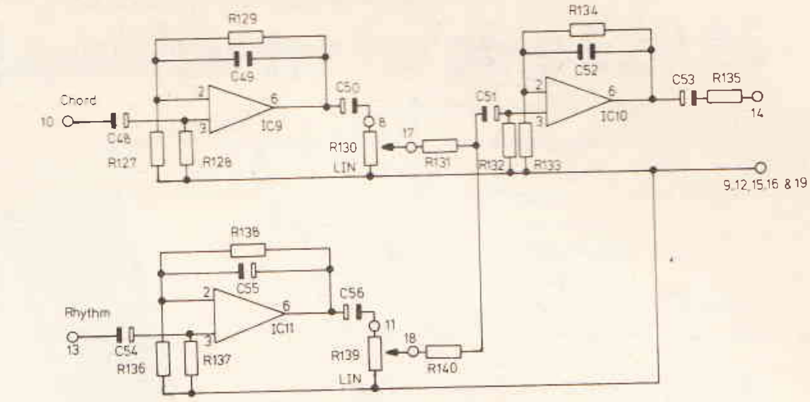
The M251 features a number of different modes of operation, in the automatic mode, when a number of keys in the two available octaves are played, the lowest note will be taken as a reference and memorised.

The memorized key, by means of an internal multiplexer, selects the corresponding tonic and all other notes programmed for arpeggio, chord and bass accompaniment.

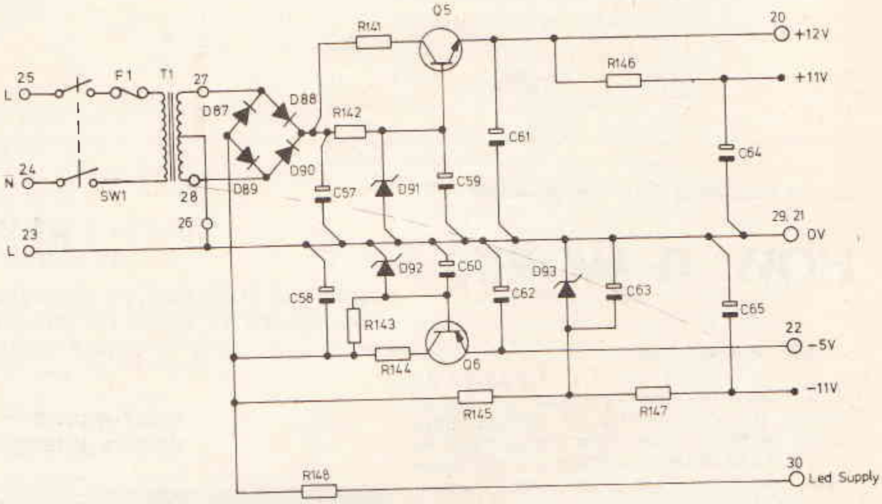
In the semi-automatic mode, the M251 will memorise the lowest four keys played together with the top note played. The circuit will then provide accompaniment until the mode is cancelled by selecting automatic mode briefly and returning to semi-automatic while no keys are played.

The semi-automatic mode can also be selected without memorization of keys.

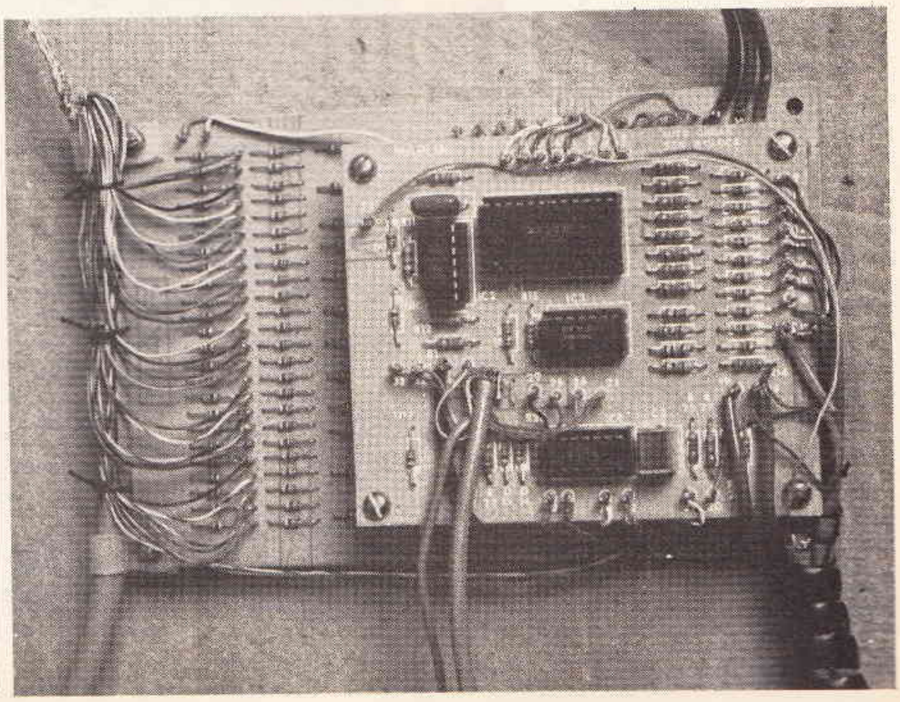
Due to the pin out restrictions of the 40 pin package a system of multiplexing has had to be adopted, this explains some of the complexity in this area of the circuit.

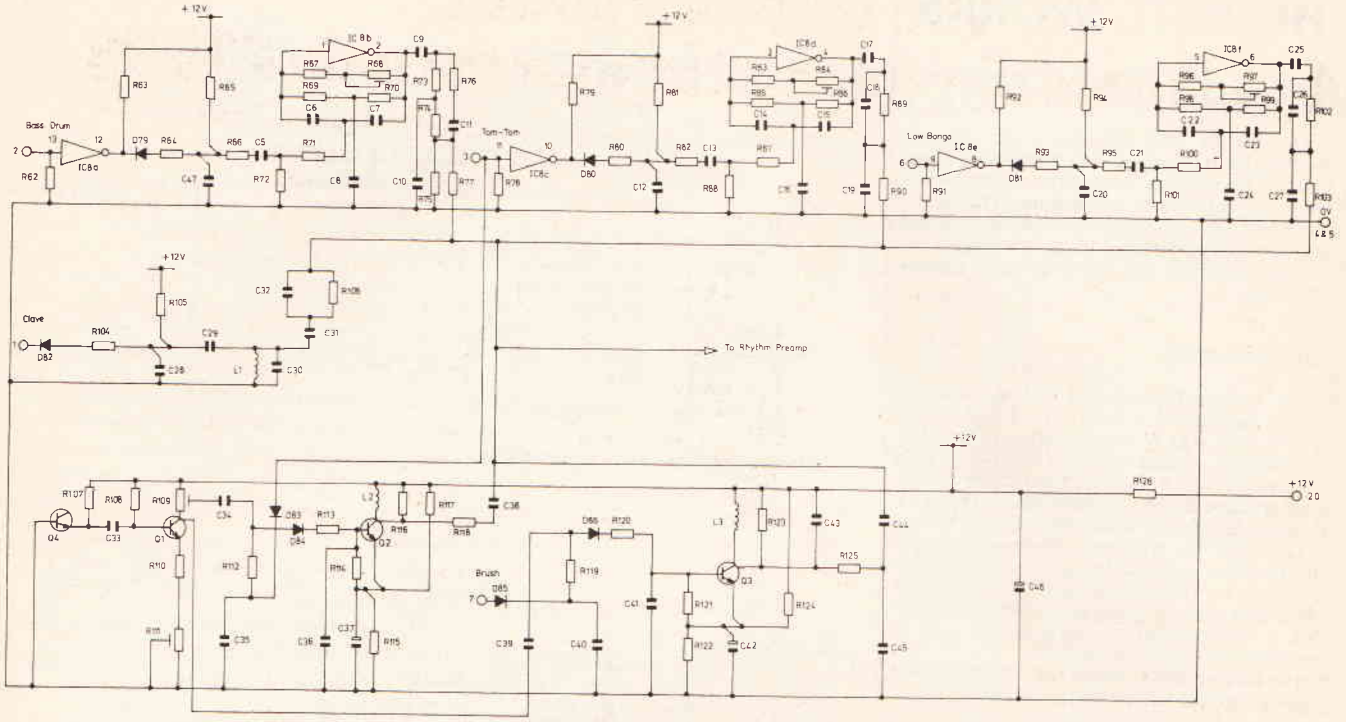


Circuit diagram of the preamplifier



Circuit diagram of the power supply





Circuit diagram of the voice generator

HOW IT WORKS

VOICE GENERATOR

THE bass drum, tom-tom and low bongo sounds are generated by the damped sinusoidal oscillators based upon the six invertors of IC8. Each of the oscillators are the same apart from the values of the timing capacitors which set the characteristic frequency of oscillation.

In each oscillator the variable resistor (R68, R84 and R97) will control the rate at which any oscillations will delay once triggered by the M254 rhythm generator.

The square wave output of the M254 is held low by a resistor, necessary because the M254's outputs are open drain, and fed via a differentiating network to the damped oscillator. A pulse from the output of the M254 will trigger the characteristic instrument sound.

In addition to the output of the damped oscillator based on IC8c and d the tom tom, to give it a more realistic sound, contains a white noise component.

The white noise is produced by the reverse biased zener effect of Q4 and after filtering and buffering, by Q1, with further filtering by Q2, is mixed with the oscillators output to provide a realistic tom-tom sound.

The brush sound consists of filtered white noise, the white noise again being generated by Q4 — the filtering this time being performed by Q3 and associated components.

The clave output is generated by the resonant circuit centered around L1 and C30.

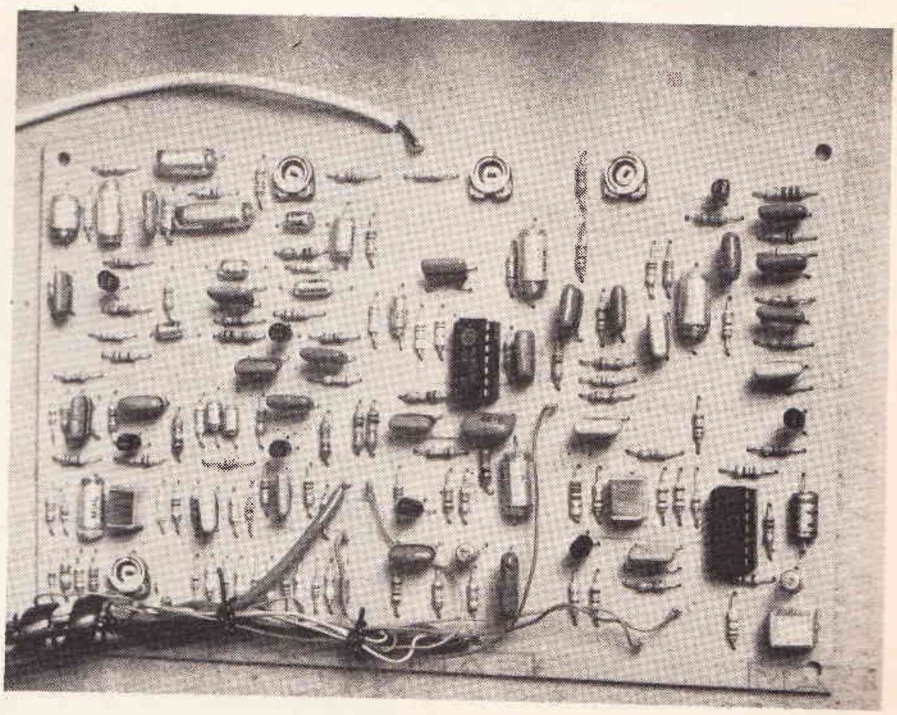
The outputs from the various voice generating circuits are summed and fed to the instruments pre-amplifier.

BUYLINES

Maplin Electronics will be supplying a complete kit of parts for the auto chord, including screened boards. Contact Maplin for details of price.

Full constructional details for the auto chord will follow next month.

Next month — full constructional details plus the auto stop board.



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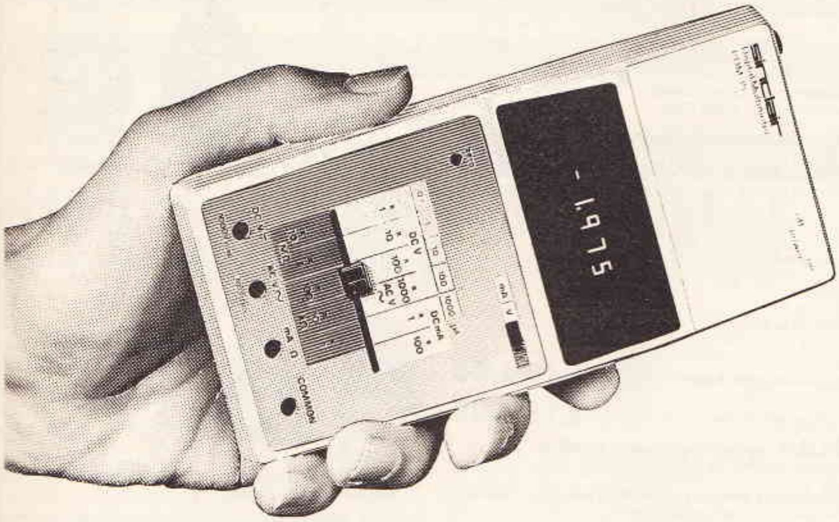

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Note: 10 MΩ input impedance.
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Accuracy of reading: 1.0% ± 2 counts.
DC Current (6 ranges)
Range: 1 nA to 200 mA.
Accuracy of reading: 1.0% ± 1 count.
Note: Max. resolution 0.1 nA.
Resistance (5 ranges)
Range: 1Ω to 20 MΩ.
Accuracy of reading: 1.5% ± 1 count.
Also provides 5 junction-test ranges.
Dimensions: 6 in x 3 in x 1½ in.
Weight: 6½ oz.
Power supply: 9 V battery or Sinclair AC adaptor.
Sockets: Standard 4 mm for resilient plugs.
Options: AC adaptor for 240 V 50 Hz power. De-luxe padded carrying wallet. 30 kV probe.

The Sinclair credentials

Sinclair have pioneered a whole range of electronic world-firsts – from programmable pocket calculators to miniature TVs. The PDM35 embodies six years' experience in digital multimeter design, in which time Sinclair have become one of the world's largest producers.

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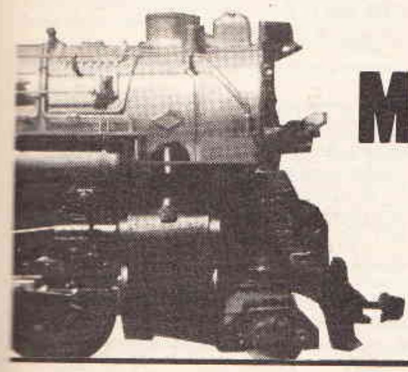
What to look for in the December issue: On sale Nov 3rd

ETI LIGHT SHOW

HANDS UP all those who've never been to a disco. None? Good — that means you've all seen sound-to-light units in action, although it's more than likely it was a normal three-channel affair. Usually boring, are they not?

Well ETI plans to change that next month; ours has five 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 straight sound to light, or have it strobe all lights. At a speed dependent upon music level (not volume — the unit is independent of that!) or hand over control to an internal digital circuit which produces some superb random effects. If you fancy a five colour manually controlled strobe unit it can do that as well!

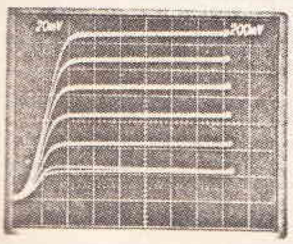
Each channel handles up to 500 W of lighting, and a complete kit of parts will be available from Powertran, who designed this project especially for ETI.



Electronics in Model Railways

An essential part of the education of any young man is his electric train (checking with ETI technical staff shows all eight had one — and five still have). Most of us however remember the controls as crude; today things are changing — sophisticated electronic controls are perfectly suited to model railways and the manufacturers are about to announce some dramatic advances. We take a look at what's happening.

CURVE TRACER



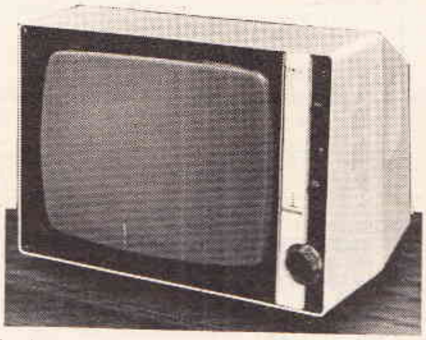
Explaining the shape of Voltage-Current characteristics of diodes, transistors and other non-linear devices is usually dull as it normally involves a tedious plot of static, experimental data.

A more elegant solution is available to anyone with a DC coupled scope capable of taking an external X-input. Next month we carry a project with the additional circuitry necessary to do this yourself.

Car Anti-theft System

A simple project to build but sophisticated in its operation. It is a comprehensive system that incorporates several features of large and expensive commercial systems and using state-of-art techniques it is extremely reliable. A kit will be available of the whole project.

How It Works



In the November issue we begin a new type of article. The idea came to us when discussions with experts in one area of electronics admitted to almost total ignorance of other areas — especially commercial circuitry. Mass-produced electronics use techniques which are not widely understood elsewhere — we hope to put that right. In the first of this occasional series we have asked Gordon King to discect a Thorn Monochrome TV; we shall show the complete circuit and explain the function of each stage. It's *not* done as a beginners series but to give those outside this field the true "Inside Story."

INDEX

A complete listing of all we've carried in ETI since our last Index (which was carried in April 1977) and went back to the first ever ETI). As our research shows that 96% of readers never throw away their copies it should be useful to most of you.

computing today No.2

Win a TRITON Computer

Want to get your hands on a Triton Computer Kit but can't afford it (yet)? In No. 2 of our new supplement Computing Today, we have a free-entry competition for one to be won. If you've read this far you'll probably know what it's worth — but in case you don't it's about £300.

Microprocessors by Experiment

Learn about microprocessors — not from some abstract description of a make believe MPU but by hands on experience with an MPU system. The series, based on the MK14 development kit, will take you through the operation of the SC/MP MPU and show you how to use it to do everything from control your heating system to land on the moon.

I/O for 6800

The microprocessor user rapidly arrives at the need to understand and apply input/output circuitry to interface peripheral equipment to the computer system. A standard choice, when using a 6800 microprocessor, is to employ a Peripheral Interface Adapter (PIA). Many engineers now buy ready-built systems then wish to utilise the PIA as straightforward outputs and inputs. When data sheets are consulted they are found to give concise yet complete hardware and software information. The user of a ready-built system needs help in simply getting the PIA to act as outputs and inputs without becoming involved in the intricate details needed by designers of microcomputer boards. This article aims to give this help.

Features mentioned here are in an advanced state of preparation as we go to press but circumstances may affect the final contents of the next issue.

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MICROPHONES. EM506 Condenser Mikes. Uni-directional. F.E.T. Amp. Dual imped., 50K/600ohms, 30-18KHz, on/off switch, £11.00. Miniature Tie Pin Condenser mike 1K imp., omni-directional, uses hearing aid battery (supplied) £4.95. Grundig Electret Inserts with built-in F.E.T. Preamp £1.50. Crystal Mike Inserts 37mm 45p. Electret Condenser Mikes 1KΩ Imp with std. Jack Plug £2.85. Cassette Condenser Mikes with 2.5 and 3.5 Jack Plugs £2.85. Standard Cassette Mikes 200 ohm Imped with 2.5 and 3.5 Jack Plugs £1.20.

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CRYSTALS. 300KHz HC6U 40p. 0.1" Edge Connectors, 64 way 65p. 32 way 40p.

RELAYS. Min. 220v AC Sealed Relay 2 pole C/O 45p. 240v AC Sealed Relay 3 pole C/O 5 amp Contacts 11-pin base 80p. 12 volt 4 pole N.O. Reed Relay 20p. Min. 24v DC Sealed 2-pole C/O relays 3-amp contacts. New 55p. 12v DC 4pc.o. open type, new 50p each.

MOTORS. 1.5 to 6v DC Model 20p. 115v AC min. 3 R.P.M. with Gearbox 30p. 240v AC Synch Motor 1/5th R.P.M. 65p. 240v AC Synch. Motor 1/24th R.P.M. 65p. Crouzet 115v AC 4 R.P.M. Motors, new 95p. 12v DC 5-pole 35p.

BOXES. Black A.B.S. Plastic with brass inserts and lid. 75 x 56 x 35mm 40p. 95 x 71 x 35mm 49p. 115 x 95 x 16mm 57p. 225 x 130 x 84mm £1.95.

TOOLS. Radio pliers, 5in. insulated handles £1.40. Diagonal side cutters, 5in. insulated handles £1.40.

MAINS TRANSFORMERS, all 240v AC primary. Postage shown in brackets per transformer.
6-0-6 100mA, 9-0-9 75mA, 12-0-12 50mA, 75p each (15p). 0-4-6-9 150mA, no mounting bracket, 65p (20p). 12-0-12 100mA, 95p (15p). 12v 500mA, 95p (22p). 12v 2 Amp, £2.25 (45p). 12v 4 Amp, £2.75 (54p). 15-0-15v 1 Amp, £2.10 (45p). 30-0-30v 1 Amp, £2.75 (54p). 0-12-15-20-24-30v tapped at 2 Amp, £4.50 (54p). 20-0-20v 2 amp, £3.50 (54p). 25v 1.5 Amp, £1.45 (45p). 18v 1.5 Amp rectified, £2.00 (45p). 35v, 2 Amp, 2.5v 2 Amp toroid, £2.95 (54p). 20v 2.5 Amp, £2.20 (54p). 1:1 Xenon/triac pulse transformer, 30p.

SWITCHES — Min. Toggle. SPST 8 x 5 x 7mm 45p. DPDT 8 x 7 x 7mm 60p. DPDT Centre Off 12 x 11 x 9mm 75p. DPDT C/O Sliders 20p. R.S. Single Pole C/O Push Buttons 45p. Roller Micro Switches 15p. Min. Micro Switches 13 x 10 x 4mm 20p. Min. Push to make or push to break Switches 16 x 6mm 15p.

SOLDER SUCKER. Plunger type, eye protection, replaceable nozzle, high suction, £4.95. Reed switches 28mm norm. open, 6p each.

TAPE HEADS — Cassette Stereo £3.00. BSR MN 1330 ½ Track Dual Impedance Rec./Playback 50p. BSR SRP90 ¼ Track Stereo Rec./Playback £1.95. TD10 Assemblies, two heads, ¼ Track Rec./Playback Staggered Stereo with built-in erase per head £1.20. Tape Head Demag 240v AC £1.95.

BUZZERS—GPO Type 6-12v 20p. Min. Solid State Buzzers 6-9-12 or 24v 15mA 75p. All Metal Buzzer, 30mm diam, 6-12 volts, high tone, 25p.

U.H.F. TV Transistorised Push Button Tuners (not Varicap), new and boxed, £2.50.

MURATA MA401L. 40kHz Transducers, rec/send, £3.25 pair.

METERS—Grundig Batt. Level Meter 1mA 40 x 40mm £1.10. Min. Level Meter 200μa 25 x 15mm 75p. Ferranti 600v AC Meter £3.95.

EDGE METER — Large scale 0-100, new £2.75.

POT CORE UNIT. Has 6-pot cores, including 1 FX2243 (45mm) and 2 FX2242 (35mm). 3 20mm Panel Fuseholders, 3 T03 SIL Power Transistors on heat sink, panel with various transistors and diodes with a 5-amp plastic S.C.R. New £1.75 + 75p P&P.

LA1230 adj. core 15mm dia. 14mH-18mH, HI Q, 10p each.

8 TRACK 12 volt motors new, £1.25
CASSETTE MOTORS 6 volt new, £1.25

SOLENOIDS—240v AC 45p. 12v DC H. Duty 75p. 240v 25lb pull, 2" travel £3.95.

12-WAY MOTORISED CAM UNITS. 50v AC low rev. motor driving 12 C/O micro switches, supplied with a capacitor for 240v AC use. Ex. equip. £1.95 + 35p P&P.

13 Amp rubber trailer extension sockets, 38p.

8 WAY RIBBON-CABLE, min solid core, 15p metre.

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GAIN CONTROL

PART 2

To conclude his survey of electronic gain control methods, Tim Orr presents us with more circuits which vary from a light bulb compressor to a markspace modulated universal filter unit, and a noise gate/expander.

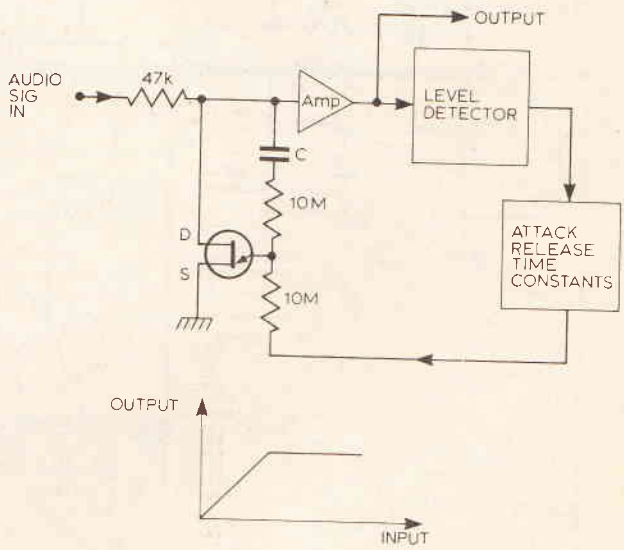
Basic Limiter Circuit

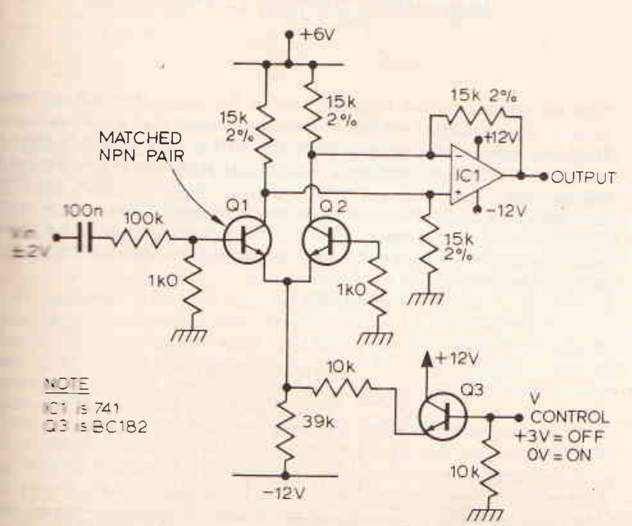
Most professional limiter circuits use a FET as the variable gain element. Relatively low distortion with a reasonable signal to noise ratio can be obtained. A basic limiter circuit is shown this being no different to previous circuits except for the variable gain element.

When a relatively small voltage (20 mV) is applied to the drain source of a FET, it acts like a fairly linear resistor. As the gate source voltage is varied, this resistor (RDS) also varies.

In fact the channel resistance RDS is inversely proportional to gate source voltage V_{GS}. When V_{gs} is oV, then RDS is at its generally minimum resistance (R_{ON}) which can be as low as 5R, but it is generally more like 100R. When V_{GS} exceeds the pinch off voltage (Vp or V_{GS} off) the channel resistance goes up to several hundred Megohms. So a junction FET can be used as a voltage controlled resistor, except that R_{ON} and V_{GS} (OFF) tend to vary widely from device to device. However with a bit of perseverance suitable devices can be selected and made to work.

One circuit trick that greatly reduces distortion is shown here. Half of the audio signal at the drain of the FET is presented to the gate. This is superimposed on top of the control voltage and produces a distortion cancelling effect. Distortion levels below 0.1% can be achieved using this technique.

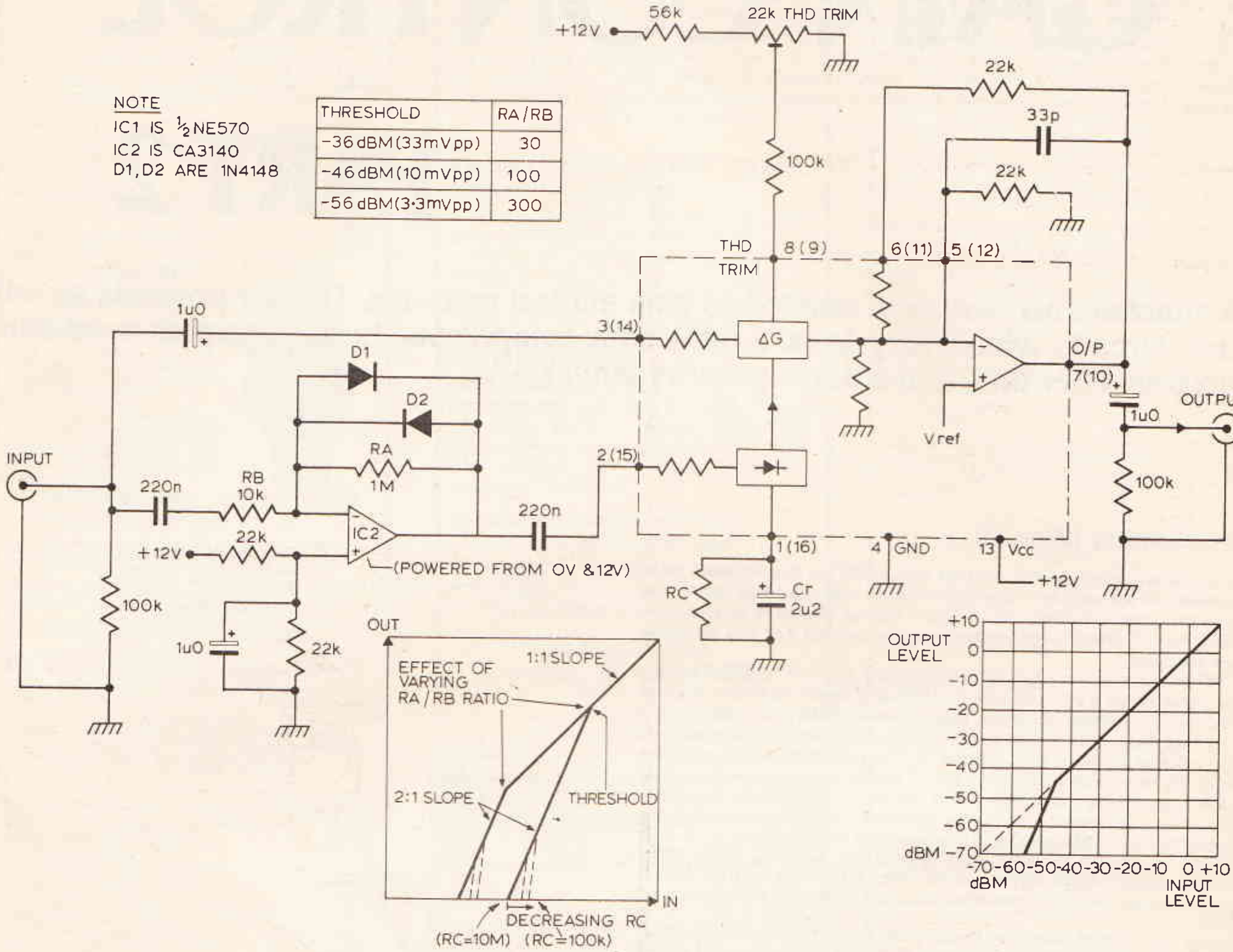




Transistor VCA

A circuit similar in operation to a CA3080 can be constructed with a matched pair of transistors and an op amp. Transistors Q1, 2 form a differential transistor pair which is used to steer whatever current is available between the two collectors, just as in the CA3080. the difference between the collector currents is equal to the product of the input voltage times the current I_{EE} times a constant. This difference is extracted by the differential amplifier IC1. The current I_{EE} is controlled by Qe. As the control voltage goes positive, Qe robs most of the current flowing down the 39k resistor, and hence I_{EE} and the output of IC1 decrease.

Two Channel Low Level Expander/Noise Gate



THRESHOLD	RA/RB
-36 dBM (33mVpp)	30
-46 dBM (10 mVpp)	100
-56 dBM (3·3mVpp)	300

It is often required that a rather noisy signal be cleaned up a bit. This is not possible to do continuosuly, but it is possible to clean up noise in what was initially the gaps. The results of this cleaning up process can quite often be heard when telephone conversations from "foreign correspondents" are broadcast.

By turning down the signal level in the gaps, (by performing a low level expansion) the perceived sound quality improves dramatically.

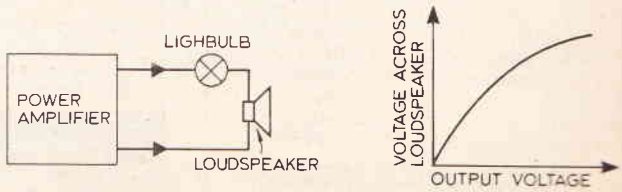
The circuit performs just such an expansion. The inputs signal passes through the variable gain cell and then appears at the op amp output. The gain of the gain cell is controlled by the signal coming from IC1. This is a high gain amplifier with diode clamping, so that the output swing is limited to about 1VO ptp. Therefore for input signals of 10 mV pp to 10 V pp, the output of IC1 remains at about 1VO ptp to 1V2 ptp.

So, for this range of input voltages the gain of the gain cell remains roughtly static. Now when the input level drops below 10 mV, the output of IC1 will start to fall and so will the gain of the gain cell. This produces a 2:1 downwards expansion curve, which means that the output then gets quieter at a rate faster than the input. To accentuate this effect, a bleed resistor can be placed in parallel with C.

The resistor robs some of the current that would have otherwise gone to the gain cell and causes the input output curve to roll off much more rapdily at low signal levels. Also, by varying the resistor ratio of RZ/RB, the expansion threshold level can be altered.

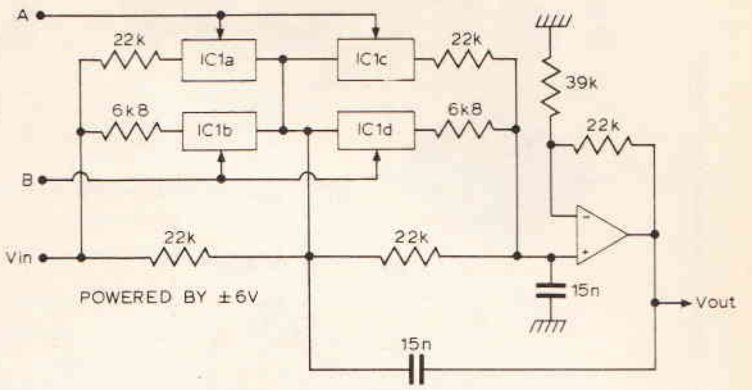
Incredibly Simple Compressor

Not all gain control systems need be complicated or indeed active. One product which I saw advertised was a compressor to help prevent loudspeakeroverloads. All it was was a lightbulb in series with the loudspeaker. When the power exceeds a certain level, the lamp will turn on, glow, its resistance increases dramatically and hence a bigger percentage of the power output is dissipated in the lamp. A nice, simple solution, but I think it would require some experimentation to find the right sort of car headlamp bulb!

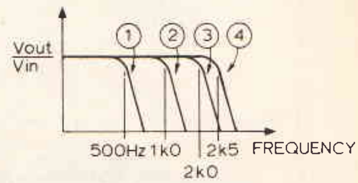


Switched Frequency Low Pass Filter

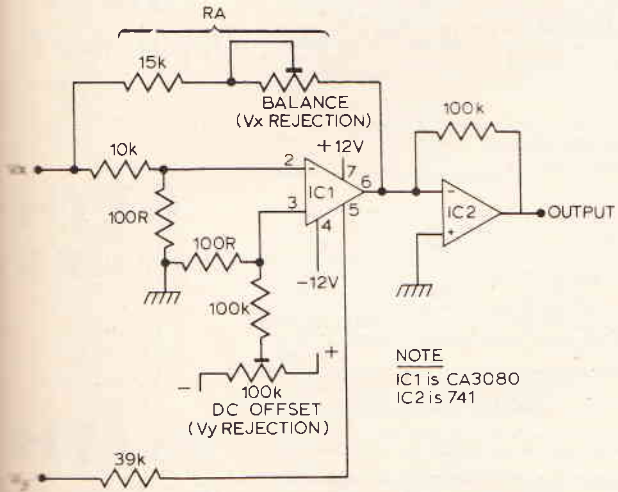
In this example the effective resistance is switched by using 4016 gates. The filter is a lowpass Butterworth and by turning gates A or B ON or OFF the cut off frequency can be altered. This allows the filter control to be physically remote or even to be computer controlled. Mark Space modulation of A and B would enable continuous control over the cut off frequency.

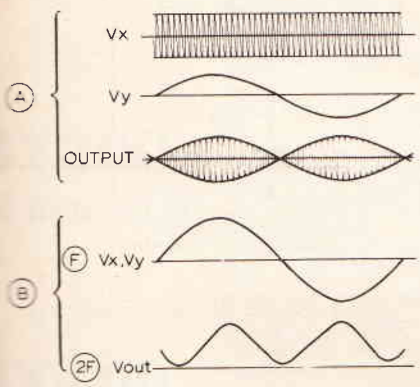


	①	②	③	④
A	OFF	ON	OFF	ON
B	OFF	OFF	ON	ON
Fc	500Hz	1kHz	2kHz	2·5kHz



Four Quadrant Multiplication

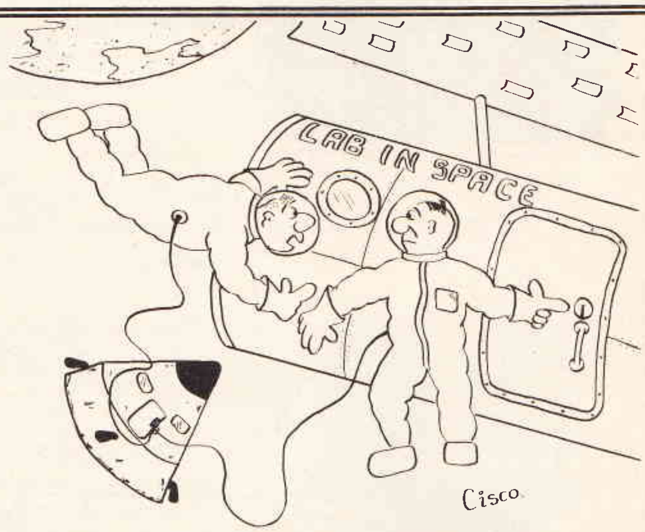




By using a few circuit tricks, the CA3080 can be made to perform 4 quadrant multiplication. In fact the CA3080 performs 2 quadrant multiplication and the trick is to move the axis on the multiplying graph. If we ignore the RA resistor chain then we have a 2 quadrant multiplier circuit similar to that shown previously. Imagine that V_x is a 1kHz sine wave. 1 Vptp and V_y is at 0V. The output of IC2 is a sine wave of fixed amplitude. Now if we connect RA, and adjust the balance control, it will be possible to cancel out the output, because the signal coming from IC1 is out of phase with that from the RA resistor chain. So with V_y set at 0 V there is no output for IC2. If V_y goes +ve, the output of IC1 will become greater than the current via the RA chain and the output if IC2 will grow.

If V_y goes—ve the current through the RA chain will exceed that from IC1 and the output of IC2 will grow, the phase being opposite to that when V_y was a sinewave from an oscillator, then this circuit could be used to generate ring modulation effects.

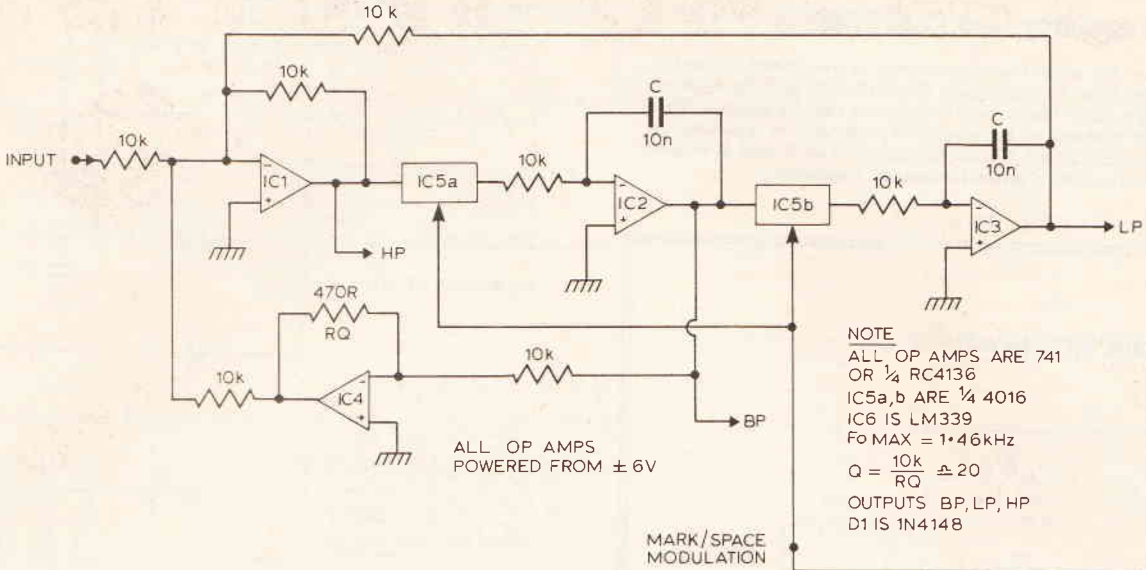
When V_x is set up 0V there may be some V_y breakthrough and this can be minimised by adjusting the V_y rejection preset.

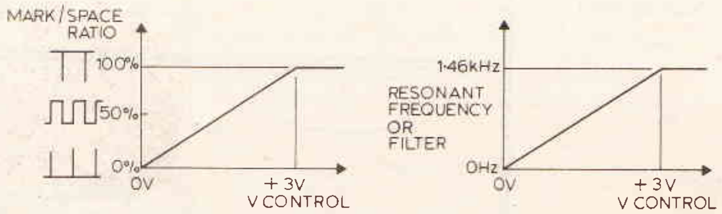


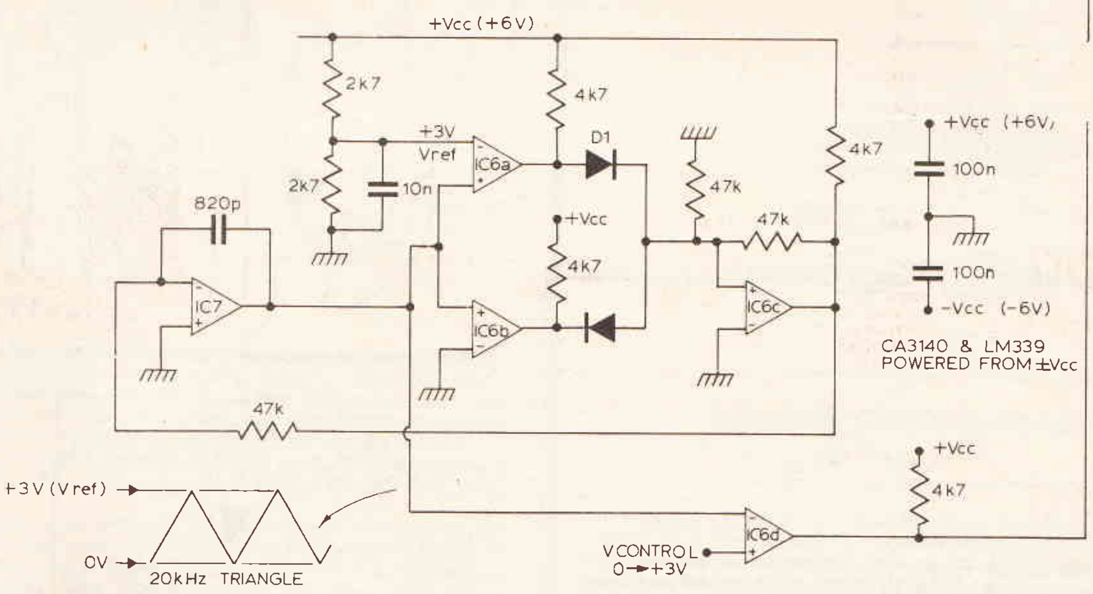
"No. I thought you were supposed to bring the key!"

"Forget about RAMS, ROMS AND PROMS, darling . . . we've got to talk about PRAMS!"

Markspace Modulated Universal Filter







It is possible to change the gain of an amplifier by effectively altering the input resistor. This can be done by markspace modulating a voltage controlled switch in series with the resistor.

When the markspace ratio is low, the switch is OFF most of the time and the effective resistance is large. When the markspace ratio is high the switch is ON most of the time and the effective resistance approaches that of the series resistor.

Having generated a markspace control waveform, it is possible to gang up together literally hundreds of voltage controlled switches. This enables large numbers of variables to be simultaneously changed.

The circuit is a markspace modulated universal filter (IC-6) and the markspace generator itself (IC-11).

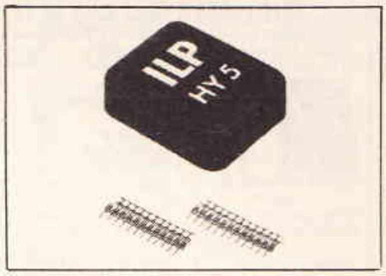
IC7-10 forms a triangle square wave oscillator. IC7 is an integrator whose outout ramps up and down between OV and a + 3 V reference. IC8-10 are all fast comparators. IC8 detects when the integrator outputs of IC8 & 9 are used to flip over a schmitt trigger IC10, which then drives the integrator. Thus the integrator output ramps up and down between OV and + 3 V at a rate of 20 kHz.

It is important that the frequency of the markspace oscillator be relatively high. As a rule of thumb it should be 2 ½ times the highest frequency components of the signals that you hope to process. The triangle output is fed into IC11's inverting input, the control voltage into the non inverting input. The output of IC11 is the markspace modulation which is used to drive the switches IC5,6. The filter resonant frequency is directly proportional to the mark space ratio that drives these switches.

The number of IC's used is a quad package, and so is the 4016 and so can be the op amps (use RC4136). Thus the whole circuit can be realised with only 4 IC's. Also the mark space oscillator canbe used to drive other independent comparators.

15 — 240 Watts!

HY5
Preamplifier



The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.); are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.
FEATURES: Complete pre-amplifier in single pack — Multi-function equalization — Low noise — Low distortion — High overload — two simply combined for stereo.
APPLICATIONS: Hi-Fi — Mixers — Disco — Guitar and Organ — Public address
SPECIFICATIONS:
INPUTS: Magnetic Pick-up 3mV; Ceramic Pick-up 30mV; Tuner 100mV; Microphone 10mV; Auxiliary 3-100mV; input impedance 47kΩ at 1kHz
OUTPUTS: Tape 100mV; Main output 500mV R.M.S.
ACTIVE TONE CONTROLS: Treble ± 12dB at 10kHz; Bass ± at 100Hz
DISTORTION: 0.1% at 1kHz; Signal/Noise Ratio 68dB
OVERLOAD: 38dB on Magnetic Pick-up; SUPPLY VOLTAGE ± 16.50V
Price £6.27 + 78p VAT. P&P free.
HY5 mounting board B1 48p + 6p VAT P&P free

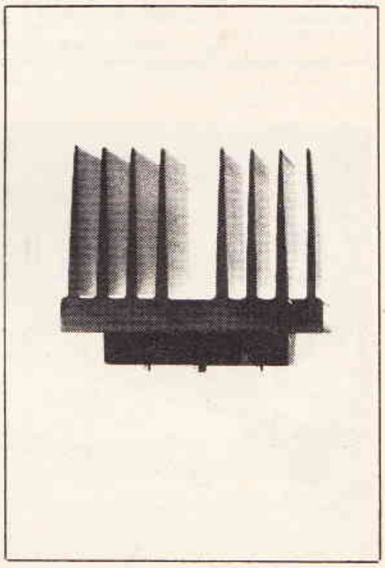
HY30
15 Watts into 8Ω

The HY30 is an exciting New kit from I.L.P.; it features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.
FEATURES: Complete kit — Low Distortion — Short, Open and Thermal Protection — Easy to Build
APPLICATIONS: Updating audio equipment — Guitar practice amplifier — Test amplifier — Audio oscillator
SPECIFICATIONS:
OUTPUT POWER 15W R.M.S. into 8Ω; DISTORTION 0.1% at 15W
INPUT SENSITIVITY 500mV; FREQUENCY RESPONSE 10Hz-16kHz — 3dB
SUPPLY VOLTAGE ± 18V
Price £6.27 + 78p VAT. P&P free.

HY50
25 Watts into 8Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.
FEATURES: Low Distortion — Integral Heatsink — Only five connections — 7 Amp output transistors — No external components
APPLICATIONS: Medium Power Hi-Fi systems — Low power disco — Guitar amplifier
SPECIFICATIONS: INPUT SENSITIVITY 500mV
OUTPUT POWER 25W RMS in 8Ω; LOAD IMPEDANCE 4-16Ω; DISTORTION 0.04% at 25W at 1kHz
SIGNAL/NOISE RATIO 75dB; FREQUENCY RESPONSE 10Hz-45kHz — 3dB
SUPPLY VOLTAGE ± 25V; SIZE 105.50.25mm
Price £8.18 + £1.02 VAT. P&P free.

HY120
60 Watts into 8Ω

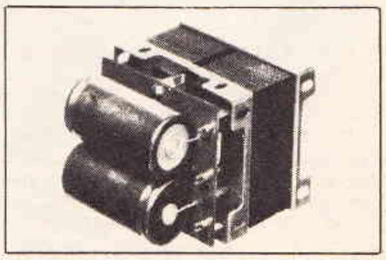


The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection, this amplifier sets a new standard in modular design.
FEATURES: Very low distortion — Integral Heatsink — Load line protection — Thermal protection — Five connections — No external components
APPLICATIONS: Hi-Fi — High quality disco — Public address — Monitor amplifier — Guitar and organ
SPECIFICATIONS:
INPUT SENSITIVITY 500mV
OUTPUT POWER 60W RMS into 8Ω; LOAD IMPEDANCE 4-16Ω; DISTORTION 0.04% at 60W at 1 kHz
SIGNAL/NOISE RATIO 90dB; FREQUENCY RESPONSE 10Hz-45kHz — 3dB; SUPPLY VOLTAGE ± 35V
Size: 114 x 50 x 85mm
Price £19.01 + £1.52 VAT. P&P free.

HY200
120 Watts into 8Ω

The HY200, now improved to give an output of 120 Watts, has been designed to stand the most rugged conditions, such as disco or group while still retaining true Hi-Fi performance.
FEATURES: Thermal shutdown — Very low distortion — Load line protection — Integral Heatsink — No external components
APPLICATIONS: Hi-Fi — Disco — Monitor — Power Slave — Industrial — Public address
SPECIFICATIONS:
INPUT SENSITIVITY 500mV
OUTPUT POWER 120W RMS into 8Ω; LOAD IMPEDANCE 4-16Ω; DISTORTION 0.05% at 100W at 1kHz
SIGNAL/NOISE RATIO 96dB; FREQUENCY RESPONSE 10Hz-45kHz — 3dB; SUPPLY VOLTAGE ± 45V
SIZE 114 x 100 x 85mm
Price £27.99 + £2.24 VAT. P&P free.

HY400
240 Watts into 4Ω



The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4Ω! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.
FEATURES: Thermal shutdown — Very low distortion — Load line protection — No external components.
APPLICATIONS: Public address — Disco — Power slave — Industrial
SPECIFICATIONS:
OUTPUT POWER 240W RMS into 4Ω; LOAD IMPEDANCE 4-16Ω; DISTORTION 0.1% at 240W at 1 kHz
SIGNAL/NOISE RATIO 94dB; FREQUENCY RESPONSE 10Hz-45kHz — 3dB; SUPPLY VOLTAGE ± 45V
INPUT SENSITIVITY 500mV; SIZE 114 x 100 x 85mm
Price £38.61 + £3.09 VAT. P&P free.

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7409	12p*	7491	75p*
7410	10p*	7492	35p*
7411	22p*	7493	35p*
7412	22p*	7494	75p*
7413	28p*	7495	75p*
7416	28p*	7496	85p*
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7447	82p*	74157	£1*
7448	£1*	74164	£1*
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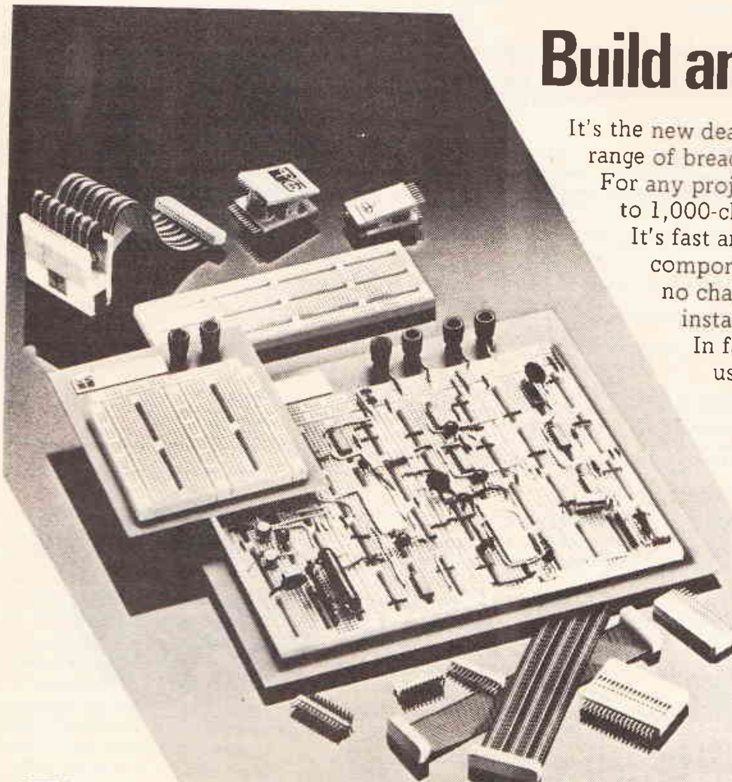

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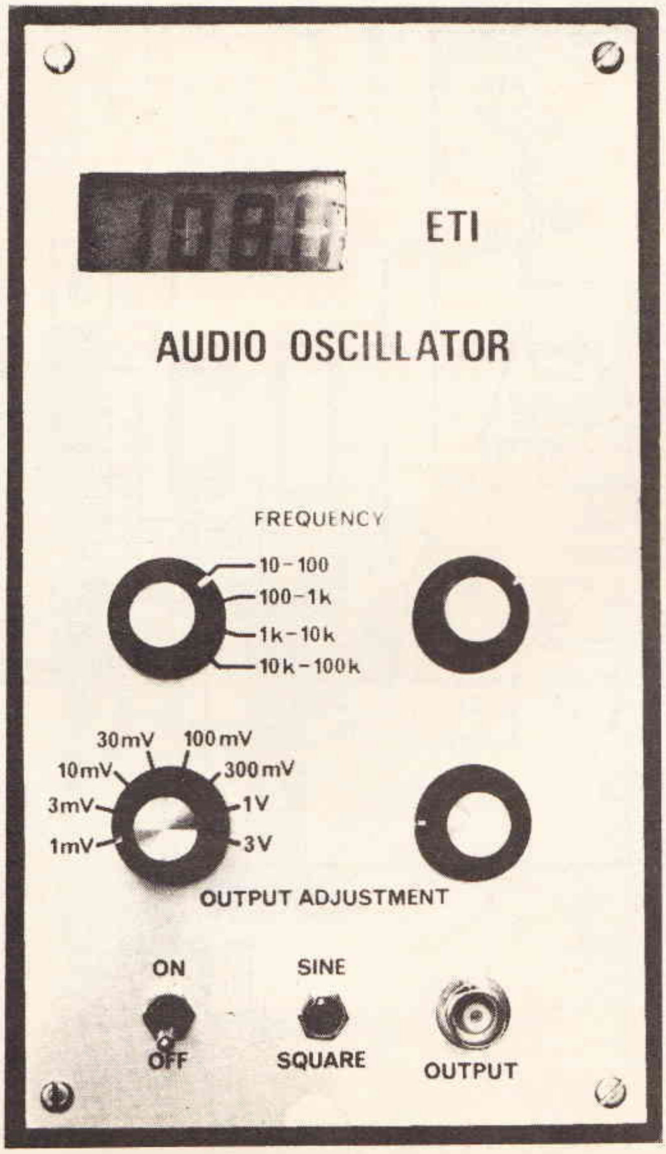
AUDIO OSCILLATOR
WITH LCD DFM OPTION

An audio oscillator combines with a new design in frequency meters that provides accuracy and fast reading rates.

Front view of the audio oscillator. Note that this is an early prototype and the 3V range has been deleted.



THE WEIN BRIDGE oscillator published in our June issue did not provide a performance of adequate standard for many test applications-one would not have expected so from such a simplified design. Since then we have had many requests to provide a high performance oscillator.

This oscillator started life as another wein bridge, started to evolve as a voltage controlled sweep oscillator but when it became too complex reverted to a simple wein bridge.

One major problem with all home made oscillators is that of scaling the frequency dial. This is not just a problem of positioning the knob but since normally available potentiometers have a tolerance of ± 20%, the scale length will also vary. In commercial units the use of an expensive wire wound potentiometer solves most of the problems giving reasonably accurate scaling.

We then decided to build in a frequency meter and the high power consumption and the poor resolution, especially at low frequencies, of previous designs led us to develop a completely new design.

This uses what is literally an analogue computer to convert a period measurement into frequency with some digital electronics controlling it and displaying the results. We based this on the Intersil ICL7106 IC which, due to its liquid crystal display drive circuitry, allows a low power consumption design. Due to the method of conversion from period to frequency the range is limited from about 50 to 1999 counts and therefore automatic range selection is used. As the oscillator itself has less range than this, this limitation is no problem.

To simplify wiring we initially used CMOS analogue switches to select the range changing capacitors in the oscillator but this unfortunately increased the second harmonic ▶

LCD FREQUENCY METER

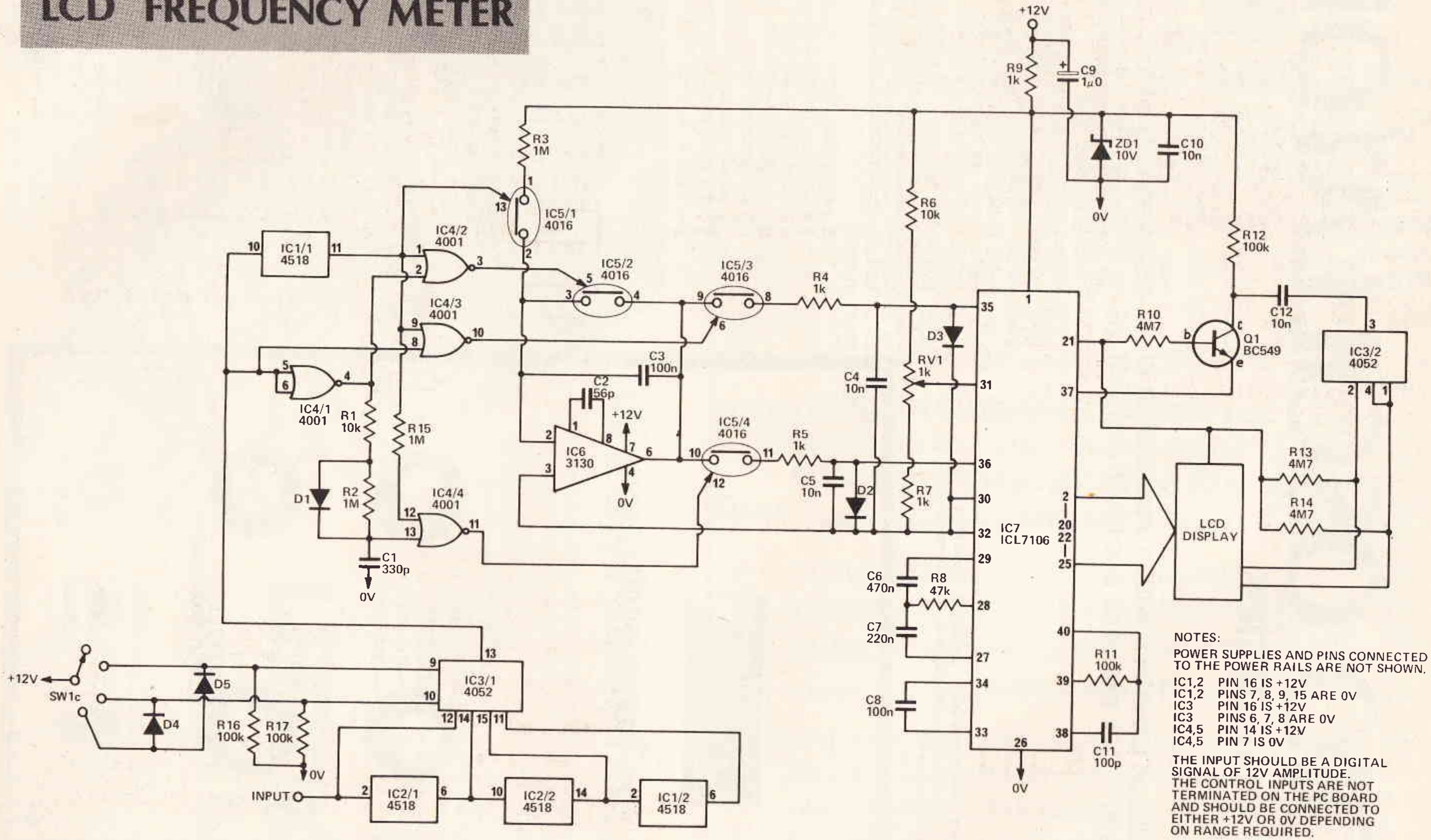
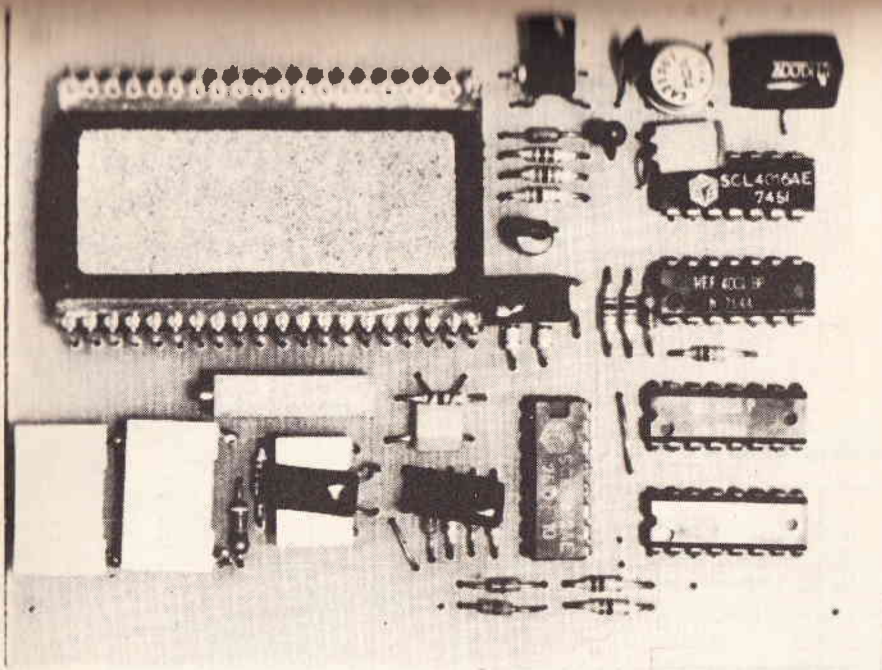


Fig. 1. The circuit diagram of the frequency meter section.

HOW IT WORKS

This section works by generating a voltage proportional to the period of one cycle and using this as the reference voltage for the Intersil voltmeter IC with a fixed voltage on the normal input. This gives the inverse function of normal operation and the display therefore is frequency.

and IC5/2 will turn on. This discharges C3 to zero volts. After a short delay to allow C3 to discharge IC5/4 is turned on transferring that voltage level onto C5. After a total of two cycles the process recommences. The voltage difference between the two capacitors is therefore the voltage change (pro-



To generate the reference voltage we use an integrator (IC6) which is controlled by IC5. Operation is as follows. Initially C3 is discharged and for one cycle of the input signal IC5/1 turns on. As the IC7 provides a stable voltage between pin 1 and pin 32 of about 2.8V the output of IC6 will fall linearly with time and as IC5/1 is on for exactly one cycle the voltage change will be proportional to that period.

After IC5/1 turns off the output of IC6 will stay fixed. IC5/3 is then turned on and C4 will change to that voltage. After half a cycle IC5/3 will turn off leaving C4 at that voltage portional to frequency) thus eliminating any offset errors in IC6. The pulses which control IC5 are derived from IC1/1 and IC4.

A reference voltage less than half the input voltage will result in the ICL7106 counting past 2000 (over ranging). The two inputs must also lie within the supply rails (less 1.5V). This limits the range of the instrument from 5 Hz to 200 Hz. For the higher frequency ranges, three decade drivers are provided and the necessary output selected by IC3. The correct decimal point is also selected by the other half of this IC.

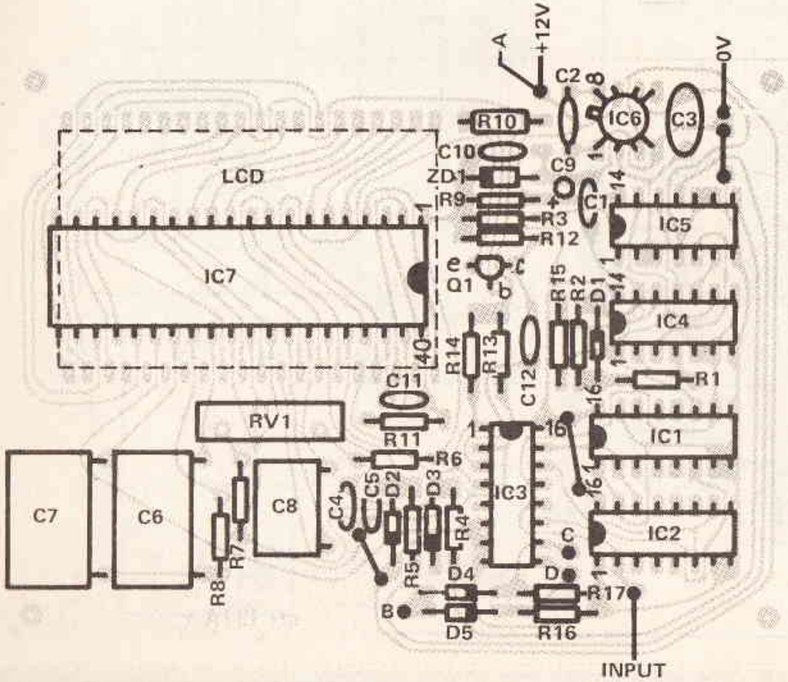
PARTS LIST

RESISTORS	all ¼W 5%
R1, 6	10k
R2, 3, 15	1M0
R4, 5, 7, 9	1k
R8	47k
R10, 13, 14	4M7
R11, 12, 16, 17	100k

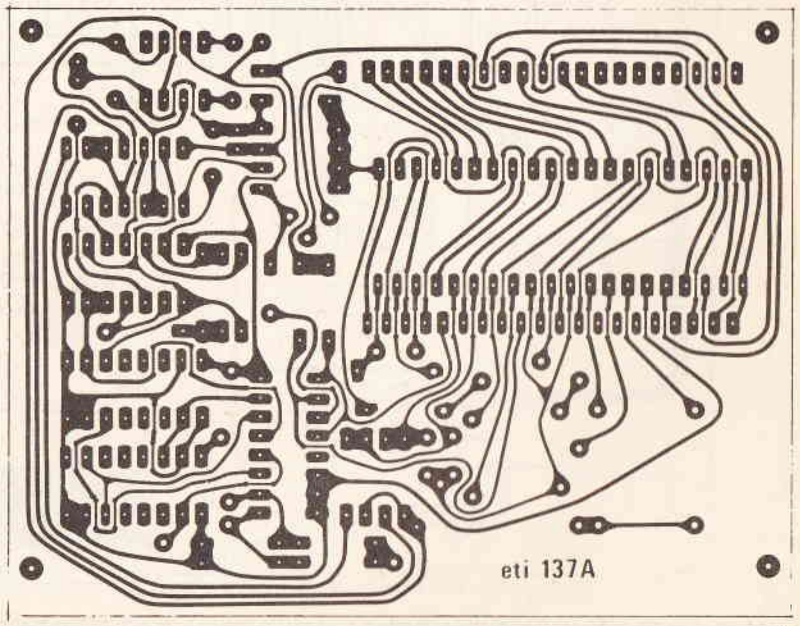
POTENTIOMETER	
RV1	1k ten turn trim

CAPACITORS	
C1	330p ceramic
C2	56p ceramic
C3, 8	100n polyester
C4, 5, 10, 12	10n polyester
C6	470n polyester
C7	220n polyester
C9	1u0 35 V tantalum
C11	100p ceramic

SEMICONDUCTORS	
IC1, 2	4518
IC3	4052
IC4	4001
IC5	4016
IC6	CA3130
IC7	ICL7106
Q1	BC549
D1-D5	1N914
ZD1	10 V 300mW Zener



Shown on this page are the foil pattern, overlay and photograph of the frequency meter section.



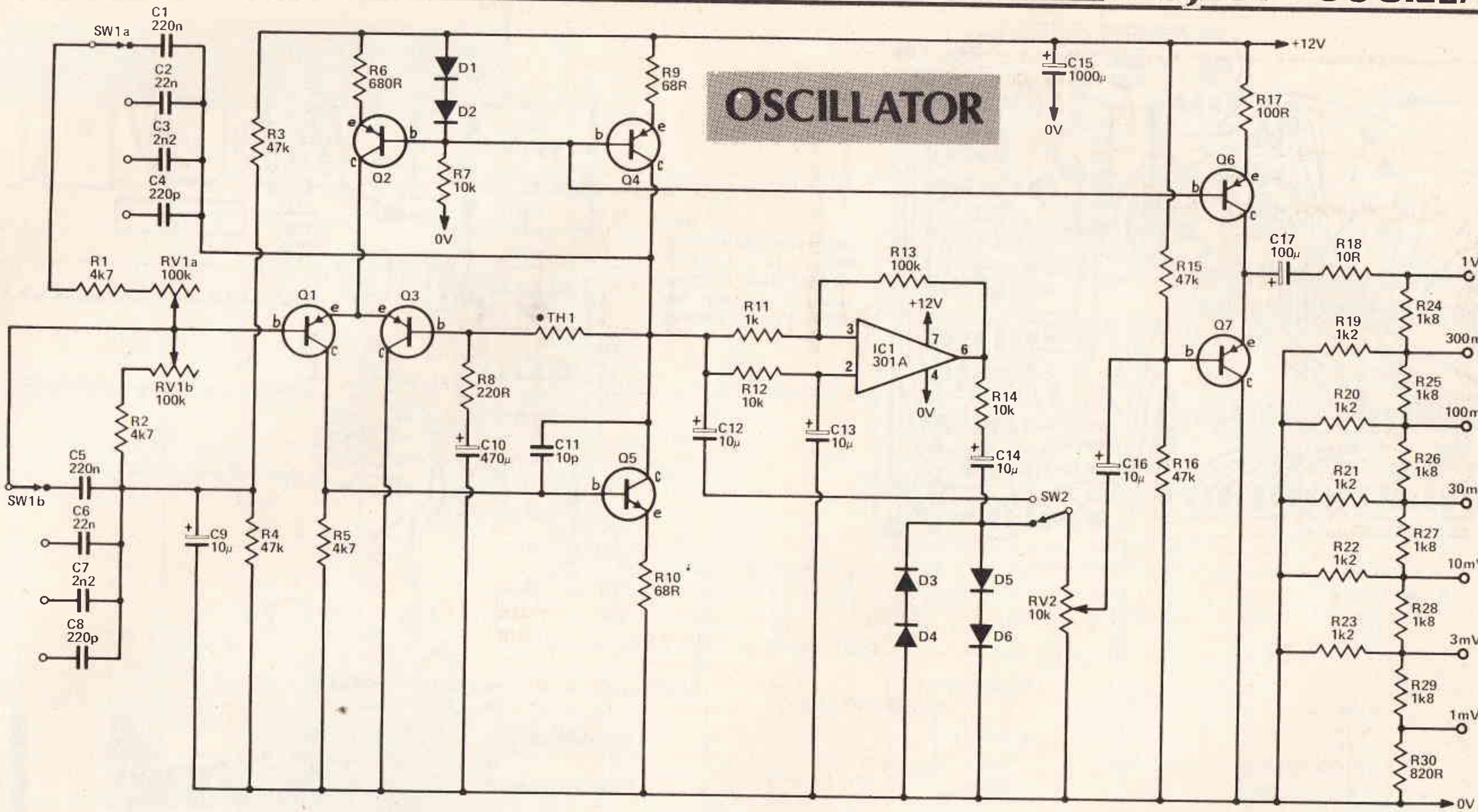


Fig. 2. The circuit diagram of the oscillator section.

PARTS LIST

Oscillator Board

RESISTORS all ½W 5%

R1, 2, 5	4k7
R3, 4, 15, 16	47k
R6	680R
R7, 12, 14	10k
R8	220R
R9, 10	68R
R11	1k
R13	100k
R17	100R
R18	10R
R19-R23	1k2
R24-R29	1k8
R30	[illegible]

CAPACITORS

C1, 5	220n polyester
C2, 6	22n polyester
C3, 7	2n 2 polyester
C4, 8	220p ceramic
C9, 12, 13, 14, 15	10u 25 V electrolytic
C10	470u 25 V electrolytic
C11	10p ceramic
C15	1000u 16 V electrolytic
C17	100u 25 V electrolytic

SEMICONDUCTORS

IC1	301A
Q1-Q4	BC559

HOW IT WORKS

The oscillator is of the conventional Wein bridge type with a differential amplifier made up by Q1-Q5. Gain stabilization is provided by the thermistor TH1. This type of circuit oscillates at the frequency where the impedance of the capacitors equals the resistors in the Wein bridge arms. With this feedback network the attenuation does not vary greatly like that of a twin tee but the phase shift does. The result is a sine wave oscillator with low distortion.

For frequency variation a two gang potentiometer is used to give a 20/1 continuous variation with switched capacitors giving four ranges each a decade apart.

The sine wave output is converted to square wave by IC1 with the amplitude stabilized by D3-D6.

BT106 1N914

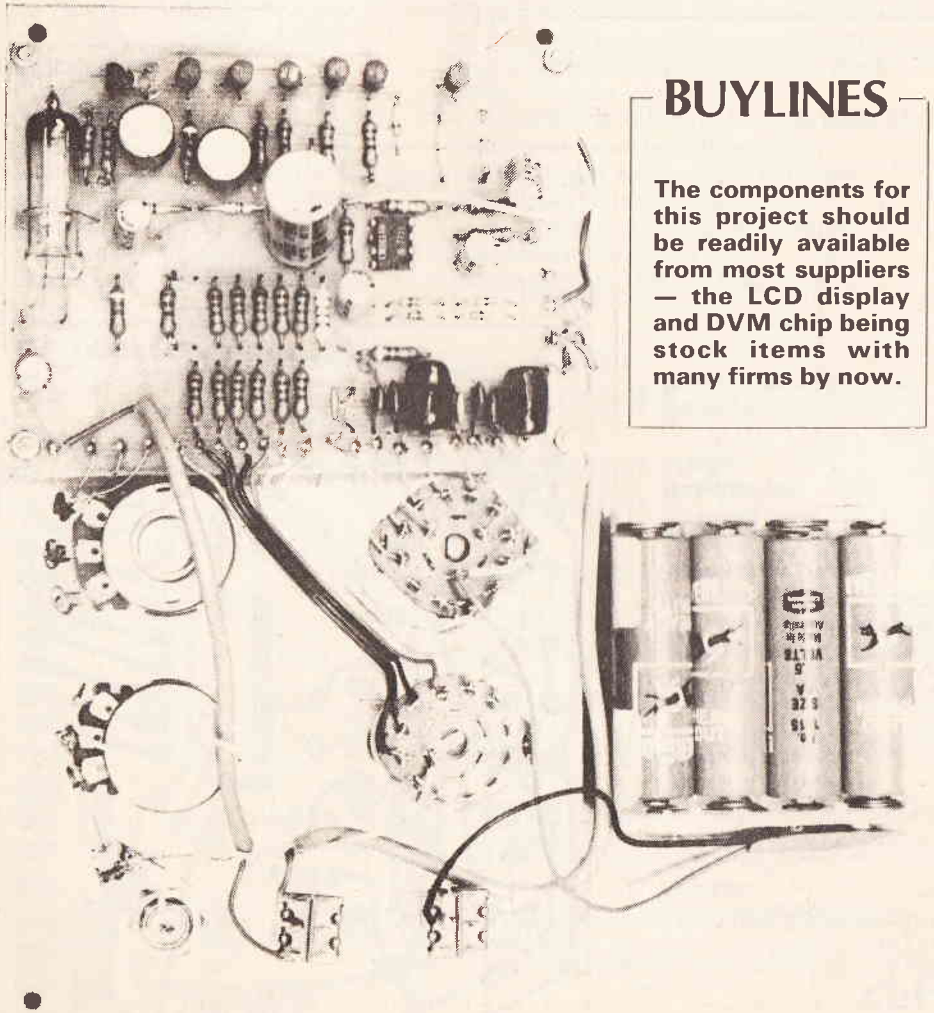
THERMISTOR
TH1 type R53

POTENTIOMETERS
*RV1 100k dual rotary
RV2 10k lin rotary

SWITCHES
SW1 Three pole four way rotary
SW2 SPDT

MISCELLANEOUS
PCB

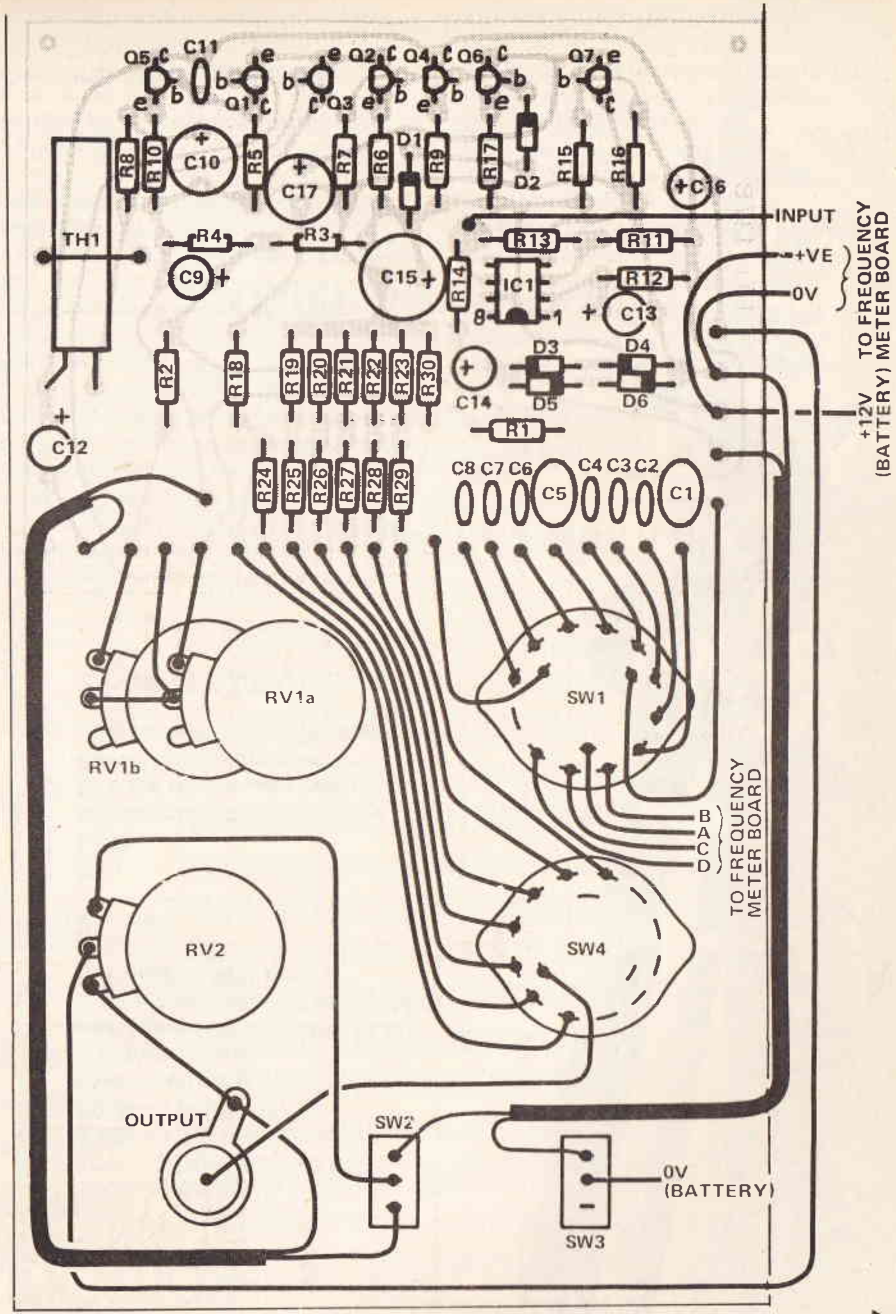
*RV1 — the preferred curve giving best resolution is antilog. If reverse rotation is acceptable log is as good. Otherwise use a linear curve.

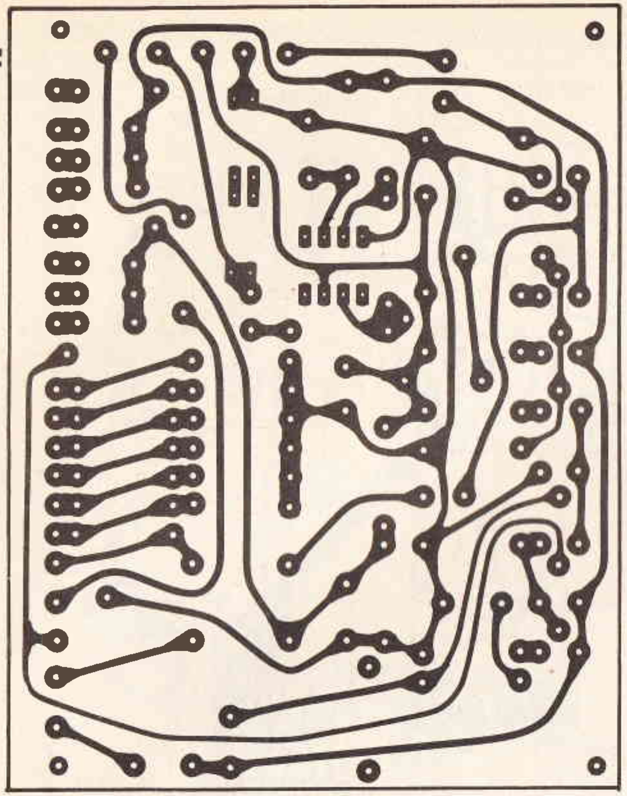


BUYLINES

The components for this project should be readily available from most suppliers — the LCD display and DVM chip being stock items with many firms by now.

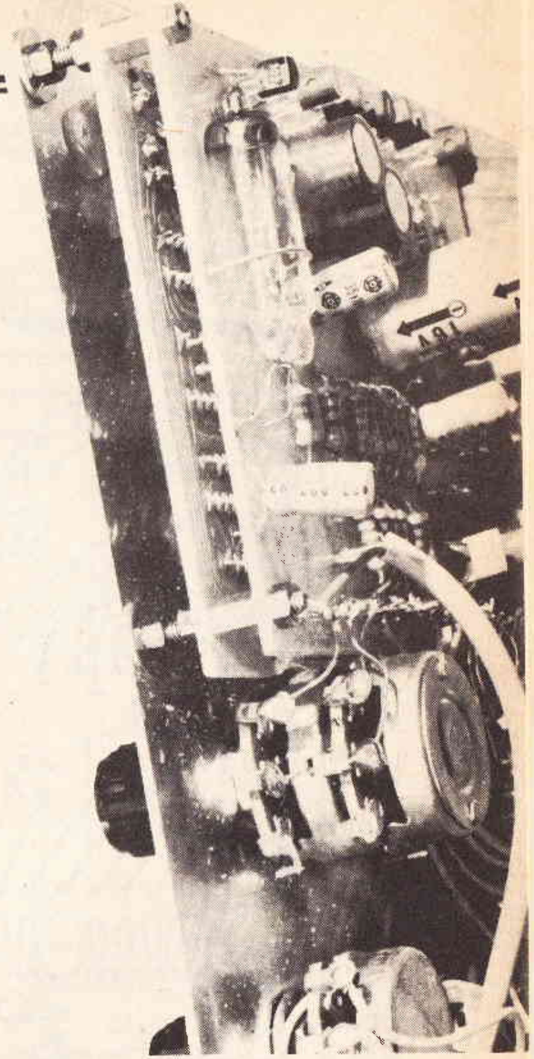
Fig. 3. Component overlay of the frequency meter board. Insert the LCD such that the +1 digit is on the left.





SPECIFICATION

Oscillator Section	
Ranges	**10.0—100.0 Hz** **100—1 000 Hz** **1.00—10.00 kHz** **10.0—100.0 kHz**
Outputs available	**sine or square**
Output level	**1 V maximum** **continuously variable plus** **10 dB steps down to 1 mV**
Output impedance	**nominally 600 ohms**
Sine wave distortion	**<0.1%**
Square wave risetime	**200ns**
Frequency Meter Section	
Number of digits	**3½**
Display	**LCD**
Reading rate	**5 per second**
Resolution	**0.1 Hz on lowest range**
Mode	**Period measurement** **computed to read frequency**
General	
Power consumption	**26 mA @ 12 V DC**



distortion when the supply voltage dropped below 12 volts. This is due to the non-linearity of the "on" resistance when the input voltage changes. We therefore reverted to the good old mechanical switch!

Construction

Assemble the frequency counter board first, following the overlay provided. As this board is mounted very close to the front panel (only the height of the LCD) the capacitors should have leads long enough to allow them to be laid on their side on top of the resistors, etc. Also the CA3130 and the transistor will have to be mounted close to the board. While it is not essential that a socket be used (we didn't) for the LCD, one is recommended. Be very careful with the display as it is glass and therefore fairly fragile.

The oscillator board can now be assembled following its overlay diagram. The thermistor should be tied down using a loop of tinned copper wire and pins should be used on all external wire terminating points. Cut all leads short on the back of the PCBs as the two are mounted back-back with only 6 mm spacing.

We built the units into a large box with all the components mounted on the front panel. The PCBs are secured by four 6BA c/s screws through the aluminium but hidden by the front panel. The frequency meter board is spaced using 6BA nuts to give just enough clearance for the display and is held in place using 6.4 mm long tapped spacers. Check that the spacers do not touch any track on the PCB and if so add pieces of insulation material under them.

The switches and potentiometers can now be mounted on the front panel and the wiring from the frequency counter board to the range switch done. Add wires from the two power connections and the input for later connections to the oscillator board.

The oscillator board can now be mounted onto the back of the frequency meter board ensuring that no leads short between the two boards. Also check that the spacers do not touch any tracks on the oscillator board. The wiring of the front panel can now be completed.

Checking and Adjustment

Switch on the check that the frequency meter and oscillator are working. Monitor the output of the oscillator with an accurate frequency counter and adjust the oscillator to the top end of one range. The frequency meter can now be calibrated by means of the 10 turn potentiometer on that board.

Check that the display range changes correctly and that the decimal point also moves. Each range while nominally having a 10-100 variation will be adjustable from about 7 to 150. Check the attenuator has 10 dB between steps.

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TRANSISTORS

				2N3393	0.17	2N4037	0.60	2N5192	0.80
2N696	0.39	2N2218	0.35	2N3394	0.17	2N4058	0.22	2N5193	0.75
2N697	0.31	2N2218A	0.38	2N3395	0.19	2N4059	0.17	2N5194	0.80
2N698	0.49	2N2219	0.38	2N3396	0.19	2N4060	0.22	2N5195	0.97
2N699	0.58	2N2219A	0.39	2N3397	0.19	2N4061	0.19	2N5245	0.37
2N706	0.30	2N2220	0.39	2N3438	0.85	2N4062	0.20	2N5246	0.38
2N706A	0.30	2N2221	0.25	2N3440	0.75	2N4064	1.35	2N5247	0.44
2N708	0.30	2N2221A	0.25	2N3441	0.92	2N4074	2.65	2N5248	0.44
2N718	0.30	2N2222	0.25	2N3442	1.45	2N4121	0.27	2N5294	0.44
2N718A	0.54	2N2222A	0.25	2N3638	0.17	2N4122	0.27	2N5295	0.44
2N720A	0.85	2N2369	0.27	2N3638A	0.17	2N4123	0.19	2N5296	0.44
2N722	0.45	2N2369A	0.27	2N3702	0.14	2N4124	0.19	2N5298	0.44
2N727	0.50	2N2646	0.80	2N3703	0.14	2N4125	0.19	2N5447	0.16
2N914	0.38	2N2647	1.55	2N3704	0.14	2N4126	0.19	2N5448	0.16
2N916	0.33	2N2903	1.60	2N3705	0.14	2N4284	0.38	2N5449	0.20
2N917	0.38	2N2904	0.31	2N3706	0.14	2N4286	0.22	2N5457	0.38
2N918	0.45	2N2904A	0.31	2N3707	0.14	2N4287	0.22	2N5458	0.35
2N929	0.37	2N2905	0.31	2N3708	0.12	2N4288	0.22	2N5459	0.32
2N929A	0.37	2N2905A	0.31	2N3709	0.12	2N4289	0.22	2N5460	0.65
2N930	0.37	2N2906	0.25	2N3771	2.16	2N4347	2.20	2N5484	0.37
2N930A	0.95	2N2906A	0.25	2N3772	2.20	2N4348	2.65	2N5485	0.40
2N1711	0.30	2N2907	0.25	2N3773	3.15	2N4918	0.65	2N5486	0.40
2N1889	0.30	2N2907A	0.25	2N3819	0.36	2N4919	0.70	2N5490	0.64
2N1890	0.30	2N2923	0.17	2N3820	0.39	2N4920	0.83	2N5492	0.64
2N1893	0.30	2N2924	0.17	2N3821	0.96	2N4921	0.54	2N5494	0.65
2N2102	0.50	2N2925	0.19	2N3900	0.28	2N4922	0.60	2N5496	0.67
2N2192	0.58	2N2926	0.17	2N3901	0.30	2N4923	0.75	2N6027	0.64
2N2193	0.50	2N3053	0.25	2N3903	0.20	2N4924	1.15	2N6107	0.45
2N2193A	0.52	2N3054	0.72	2N3904	0.18	2N5086	0.30	2N6108	0.55
2N2194	0.42	2N3055	0.75	2N3905	0.18	2N5087	0.30	2N6109	0.55
2N2194A	0.45	2N3390	0.50	2N3906	0.18	2N5088	0.30	2N6111	0.49
2N2195	0.40	2N3391	0.40	2N4031	0.55	2N5089	0.30	2N6121	0.41
2N2195A	0.40	2N3391A	0.45	2N4032	0.65	2N5190	0.65	2N6122	0.44
2N2217	0.55	2N3392	0.17	2N4036	0.72	2N5191	0.75	2N6123	0.48

2N6124	0.45	BC108A	0.16	BC178B	0.35			BC337	0.20
2N6125	0.47	BC108B	0.16	BC179	0.25	BC213L	0.17	BC338	0.23
40361	0.55	BC108C	0.17	BC179A	0.25	BC213LA	0.17	BC547	0.13
40362	0.55	BC109	0.16	BC179B	0.25	BC213LB	0.17	BC547A	0.13
40363	1.45	BC109B	0.17	BC179C	0.26	BC213LC	0.17	BC547B	0.13
40408	0.82	BC109C	0.18	BC182	0.12	BC214	0.17	BC548	0.13
40409	0.82	BC140	0.30	BC182A	0.12	BC214B	0.17	BC549	0.14
40410	0.82	BC141	0.32	BC182B	0.13	BC214C	0.17	BC549B	0.14
40411	3.10	BC147	0.13	BC182L	0.15	BC214L	0.18	BC549C	0.15
40594	0.87	BC147B	0.13	BC182LA	0.15	BC214LB	0.18	BC557	0.14
40595	0.98	BC148	0.13	BC182LB	0.15	BC214LC	0.18	BC558	0.13
40673	0.80	BC148B	0.13	BC183	0.12	BC237B	0.15	BC559	0.15
40669	1.30	BC148C	0.13	BC183A	0.12	BC238A	0.13	BCY70	0.21
AC126	0.48	BC149	0.15	BC183B	0.13	BC238B	0.13	BCY71	0.26
AC127	0.48	BC149C	0.15	BC183C	0.13	BC238C	0.13	BCY72	0.18
AC128	0.48	BC157A	0.15	BC183L	0.15	BC239B	0.16	BD115	0.88
AC151	0.43	BC158A	0.15	BC183LA	0.15	BC239C	0.17	BD131	0.55
AC152	0.54	BC158B	0.15	BC183LB	0.15	BC257A	0.18	BD132	0.75
AC153	0.59	BC159A	0.17	BC183LC	0.15	BC258B	0.19	BD135	0.40
AC153K	0.59	BC159B	0.17	BC184	0.12	BC259B	0.19	BD136	0.40
AC176K	0.70	BC160	0.38	BC184B	0.13	BC300	0.43	BD137	0.41
AC176	0.54	BC161	0.38	BC184C	0.13	BC301	0.43	BD138	0.41
AC187	0.59	BC167	0.13	BC184L	0.15	BC302	0.37	BD139	0.43
AC187K	0.65	BC167B	0.13	BC184LB	0.15	BC303	0.54	BD140	0.43
AC188	0.54	BC168A	0.13	BC184LC	0.15	BC307	0.16	BD181	1.90
AC188K	0.65	BC168B	0.13	BC212	0.15	BC307A	0.16	BD182	2.20
AD161	1.00	BC168C	0.13	BC212A	0.15	BC307B	0.16	BD183	2.35
AD162	1.00	BC169B	0.13	BC212B	0.15	BC308	0.16	BD187	0.95
AF106	0.60	BC169C	0.13	BC212L	0.18	BC308B	0.16	BD235	0.46
AF109	0.52	BC177	0.22	BC212LA	0.18	BC309A	0.16	BD236	0.44
BC107	0.16	BC177A	0.22	BC212LB	0.18	BC309B	0.16	BD237	0.44
BC107A	0.16	BC177B	0.25	BC213	0.15	BC309C	0.16	BD238	0.44
BC107B	0.16	BC178	0.22	BC213A	0.15	BC327	0.22	BD239A	0.44
BC108	0.16	BC178A	0.25	BC213B	0.15	BC328	0.20	BD239C	0.59

BD240A	0.49	BF160	0.33	BFR79	0.30	ME4001	0.16	TIP30C	0.70
BD240C	0.59	BF161	0.65	BFR80	0.30	ME4002	0.16	TIP31A	0.54
BD241A	0.49	BF167	0.37	BFR81	0.30	ME4003	0.16	TIP31C	0.72
BD241C	0.65	BF173	0.37	BFX29	0.34	ME4101	0.11	TIP32A	0.59
BD242A	0.55	BF177	0.27	BFX30	0.34	ME4102	0.11	TIP32C	0.82
BD242C	0.62	BF178	0.27	BFX84	0.30	ME4103	0.11	TIP41A	0.76
BD243A	0.65	BF179	0.33	BFX85	0.38	ME4104	0.11	TIP41C	0.97
BD243C	0.87	BF180	0.37	BFX86	0.30	ME6101	0.22	TIP42A	0.86
BD244A	0.70	BF181	0.37	BFX87	0.35	ME6102	0.22	TIP42C	1.08
BD244C	0.87	BF182	0.37	BFX88	0.30	MJ2955	1.35	TIP2955	0.70
BD245A	0.69	BF183	0.44	BFX89	1.37	MJE340	0.62	TIP3055	0.59
BD245C	0.85	BF184	0.41	BFY50	0.27	MJE370	0.62	TIS34	1.05
BD246A	0.72	BF185	0.37	BFY51	0.27	MJE371	0.86	TIS42	0.50
BD246C	0.93	BF194	0.16	BFY52	0.27	MJE520	0.50	TIS43	0.47
BD433	0.44	BF195	0.16	BFY90	1.35	MJE521	0.70	TIS90	0.22
BD434	0.46	BF196	0.16	BR101	0.55	MJE2955	1.65	TIS91	0.27
BD435	0.46	BF197	0.18	BRY39	0.55	MPF3055	1.05	TIS92	0.33
BD436	0.46	BF198	0.19	BSX19	0.35	MPF102	0.33	TIS93	0.36
BD437	0.55	BF199	0.19	BSX20	0.35	MPF103	0.44	ZTX300	0.17
BD438	0.55	BF224J	0.22	BSX21	0.35	MPF104	0.44	ZTX301	0.17
BD529	0.49	BF225J	0.27	BU104	1.80	MPSA05	0.44	ZTX302	0.27
BD530	0.55	BF244A	0.38	BU105	1.55	MPSA05	0.27	ZTX303	0.27
BD535	0.70	BF244B	0.33	BU126	1.08	MPSA06	0.27	ZTX304	0.27
BD536	0.70	BF245A	0.44	BU204	2.20	MPSA12	0.44	ZTX330	0.22
BD537	0.74	BF245B	0.44	BU205	2.40	MPSA14	0.33	ZTX500	0.16
BD538	0.77	BF257	0.35	BU206	2.70	MPSA55	0.27	ZTX530	0.25
BD539	0.60	BF258	0.35	BU208	2.70	MPSA56	0.27		
BD540	0.60	BF259	0.35	ME0401	0.22	R2008B	2.45		
BDX14	1.32	BF336	0.42	ME0402	0.22	R2010B	2.15		
BDX18	1.90	BF337	0.49	ME0404	0.17	TIP29A	0.49		
BDY20	1.10	BF338	0.52	ME0412	0.22	TIP29C	0.65		
BDY55	1.90	BFR39	0.30	ME0414	0.22	TIP30A	0.54		
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CA3028B	1.25	LM382N	1.32	MM5314	4.60	TBA550Q	3.80
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CA3080	0.85	LM70914	0.49	NE566	1.75	TBA810S	1.30
CA3080A	2.10	LM710	0.67	NE567	1.90	TBA820	0.80
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[illegible]	1.15	LM1351N	1.30	TAA5[illegible]2	2.10	TL080CP	1.25
[illegible]	1.15	LM1458N	0.45	TAA[illegible]50	0.48	TL081CP	0.90
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4011B	0.22	4035B	1.30	4066B	0.75	4096	1.30
4012	0.22	4037	1.20	4067	4.85	4097	4.65
4013B	0.52	4041B	0.85	4068	0.27	4098	1.00
4014	1.06	4042B	0.86	4069B	0.24	4510B	1.20
4015	1.05	4043	1.05	4070B	0.85	4511	1.75
4016	0.52	4044	1.00	4071B	0.24	4516	2.10
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4018B	1.05	4046B	1.50	4073B	0.24		
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74LS02N	0.26	74LS174N	1.33	7406N	0.56	74100N	1.40
74LS03N	0.26	74LS175N	1.26	7407N	0.55	74107N	0.35
74LS04N	0.29	74LS181N	3.95	7408N	0.22	74118N	0.95
74LS10N	0.26	74LS189N	3.74	7409N	0.22	74119N	1.40
74LS12N	0.26	74LS190N	1.00	7410N	0.20	74121N	0.28
74LS13N	0.58	74LS191N	1.00	7411N	0.26	74122N	0.55
74LS14N	1.43	74LS192N	1.98	7412N	0.20	74123N	0.55
74LS20N	0.26	74LS193N	1.98	7413N	0.36	74125N	0.45
74LS26N	0.39	74LS196N	1.28	7414N	0.60	74141N	0.86
74LS27N	0.50	74C00N	0.24	7416N	0.36	74148N	1.35
74LS28N	C.42	74C02N	0.24	7417N	0.36	74145N	0.86
74LS30N	0.26	74C04N	0.24	7420N	0.22	74150N	1.20
74LS37N	0.32	74C08N	0.24	7423N	0.32	74151N	0.76
74LS38N	0.32	74C10N	0.24	7425N	0.32	74153N	0.76
74LS40N	0.29	74C14N	1.41	7427N	0.32	74154N	1.20
74LS42N	1.07	74C20N	0.24	7430N	0.22	74155N	0.70
74LS47N	1.09	74C30N	0.24	7432N	0.30	74157N	0.78
74LS48N	1.09	74C32N	0.24	7437N	0.35	74160AN	1.10
74LS49N	1.09	74C42N	0.92	7438N	0.32	74161AN	1.10
74LS51N	0.26	74C48N	1.38	7440N	0.20	74162AN	1.10
74LS54N	0.26	74C73N	0.54	7441AN	0.84	74163AN	1.10
74LS73N	0.42	74C74N	0.56	7442N	0.76	74164N	1.36
74LS76N	0.42	74C76N	0.54	7445N	1.40	74165N	1.36
74LS78N	0.42	74C83N	1.30	7446AN	0.90	74167N	2.50
74LS83AN	1.20	74C85N	1.30	7447AN	0.80	74174N	1.60
74LS85N	1.10	74C86N	0.64	7448N	0.80	74175N	1.00
74LS90N	1.10	74C89N	4.39	7450N	0.22	74176N	0.90
74LS91N	1.20	74C90N	0.85	7451N	0.22	74177N	0.90
74LS92N	0.86	74C93N	0.85	7453N	0.22	74180N	1.00
74LS93N	1.10	74C95N	1.04	7454N	0.22	74181N	2.00
74LS95AN	1.10	74C107N	1.22	7460N	0.22	74182N	0.80
74LS96N	1.35	74C150N	4.14	7470N	0.46	74184N	1.50
74LS107N	0.42	74C151N	2.47	7472N	0.30	74185N	1.50
74LS109N	0.42	74C154N	3.68	7473N	0.44	74188N	3.25
74LS122N	0.80	74C157N	2.21	7474N	0.32	74189N	2.60
74LS123N	0.83	74C160N	1.11	7475N	0.80	74190N	1.40
74LS124N	2.70	74C161N	1.11	7476N	0.45	74191N	1.20
74LS125N	0.50	74C162N	1.11	7480N	0.60	74192N	1.20
74LS126N	0.50	74C163N	1.11	7481N	1.00	74193N	1.20
74LS136N	0.44	74C164N	1.04	7482N	0.90	74196N	1.20
74LS156N	1.20	74C193N	1.11	7483N	1.05	74197N	1.00
74LS158N	0.65	74C195N	1.04	7484N	1.20	74198N	2.00
74LS160N	1.43	7400N	0.17	7492N	0.45	74199N	2.00
74LS161N	0.85	7401N	0.17	7493N	0.45		
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INSIDE ULTRASONICS

Ultrasonic sound at very high frequencies is being used increasingly for medical diagnosis. Dr P. N. T. Wells of Bristol General Hospital reports.

THE IMPORTANCE OF ultrasonic diagnostic methods lies in the fundamental differences between them and other techniques such as radiology and radioisotope scanning. The symptoms of some diseases, and of natural conditions such as pregnancy, are best investigated by ultrasound. It maps out anatomical cross-sections, measures the performance of the heart and the flow of blood, and identifies many kinds of abnormality, including several types of cancer, all without encroaching into the body in any way.

Twenty-five years ago, doctors seeking to investigate the structures of the body had no alternative to X-rays and this often involved injections of substances to give better contrast to obtain information about soft tissues. Nowadays, ultrasonic methods have replaced radiology in helping to solve a number of clinical problems doctors depend on ultrasonic diagnosis, and patients demand this kind of investigation. The procedures are rapid and painless and nothing enters the body other than ultrasound waves. Unlike ionizing radiations, ultrasound at diagnostic exposure levels seems to be harmless.

Basic Principles

Most diagnostic applications of ultrasound depend on the reflection of ultrasonic waves at surfaces between tissue structures which differ in their so-called characteristic impedance. The characteristic impedance of a material is equal to the product of its density and the velocity of ultrasound within it. The densities of soft tissues, about 10^3 kg m^{-3} (kilograms per cubic metre), and the velocities of ultrasound within them, about 1500 m s^{-1} (metres per second), are similar to those for water. When an ultrasonic wave strikes the boundary between tissues that differ in characteristic impedance, a proportion of the energy in the wave is reflected in much the same way that light is reflected when it meets a change in reflectivity at a surface.

The characteristic impedances of soft tissues are similar, so the echoes from their boundaries are very small. For example, only about 0.5 per cent of the▶

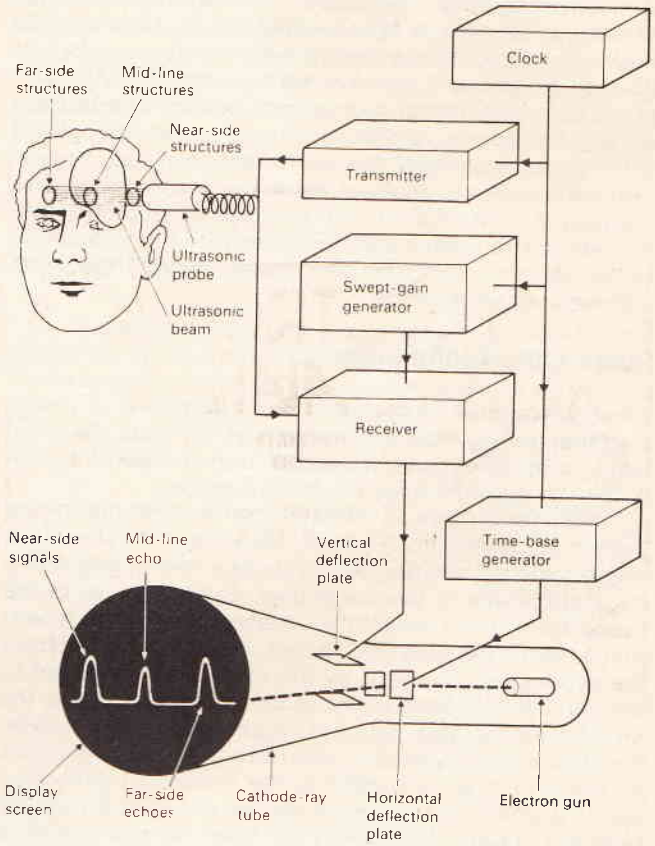

Fig. 1. Basic arrangement of the A-scope system, in use in this instance to show the mid-line structures of the brain in their relative position halfway between the sides of the skull, as indicated by symmetry of the deflections of the cathode-ray tube trace. Asymmetrical spacing of the deflections may mean that disease has brought about a physical change such as a tumour on one side of the brain. The swept-gain generator gradually increases the receiver amplification over each sweep of the time base to compensate for the attentuation of the deeper echoes by intervening tissues.

energy striking the boundary between kidney and fat is reflected. However, such echoes are large enough to be detected by a sensitive receiver, but almost all the energy crosses the boundary and is available for reflection by deeper structures.

Much larger reflections occur at boundaries between soft tissues and either bone or gas, because of large differences in characteristic impedance. These large reflections restrict the use of ultrasound in medical diagnosis. Moreover, it is necessary to exclude air from between the probe and the patient. This may be done either by examining through a water bath or through a film of oil smeared on the patient's skin.

Resolution

Ultrasonic echo-ranging techniques depend on the measurement of the time interval between the transmission of a brief pulse of energy and the reception of its echo, just as in radar. In any imaging system, whether using light, ultrasound or any other kind of radiation, the resolution is limited by the wavelength of the radiation. It is for this reason that ultrasound, as opposed to sound, is used in medical diagnosis. We need to visualise structures of only a few millimetres in size, so that wavelength has to be around a millimetre or less. In soft tissues, it is about 1.5 mm at a frequency of 1 MHz and proportionately less at higher frequencies. The highest audible frequency, about 20 kHz, has a wavelength of 75 mm. In principle, the performance might appear likely to improve as the frequency is increased, but ultrasound is attenuated as it travels through tissues and the rate of attenuation also increases with the frequency, so we have to compromise between better resolution and reduced penetration.

Pulse-Echo Techniques

In an ultrasonic instrument for diagnosis, a probe containing a piezoelectric transducer converts electrical signal into ultrasound waves for transmission into the patient. It does the opposite for the echoes.

The simplest type of ultrasonic pulse-echo diagnostic system is called the A-scope. (See Fig. 1). The clock triggers the transmitter, which feeds a brief pulse with a large amplitude to the transducer. Echoes return to the probe from those reflecting surfaces inside the patient that lie along the ultrasonic beam. Electrical signals from the echoes are amplified by the receiver and applied to the vertical deflection plates of the cathode-ray tube; the time-base generator, which is triggered into operation by the clock at the instant the ultrasonic pulse is transmitted by the probe, is connected to the horizontal deflection plates to drive the spot on the display at a constant speed from left to right. In this way the beam sweeping across the display is deflected vertically at intervals along the horizontal axis, corresponding in distance from the start of the sweep, to echo-producing surfaces at various distances along the ultrasonic beam. A special circuit in the receiver increases the amplification of the deeper echoes to compensate for theit attentuation by intervening tissues. The clock operates at a repetitin rate fast enough to give a flicker-free trace on the display.

The A-scope has clinical applications in neurology, ophthalmology and internal medicine. It allows the depths of echo-producing surfaces to be measured, and the characteristics of echoes from within structures to be studied.

Echoes from moving structures, such as the valves of the heart, oscillate in position along the horizontal axis, or time base, of the display. In cardiology particularly patterns of movement can give diagnostic information. They can be studied by making recordings with the aid of a B-scope display (see Fig. 2).

In the B-scope, the time-base sweep is normally visible, but it is brightened by returning echoes to

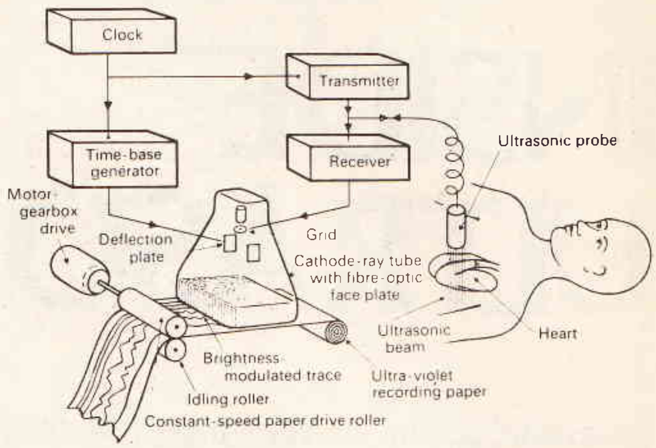

Fig. 2. Time-position recording system based on the B-scope display, shown in use for echocardiography. The fibre-optic face plate of the cathode-ray tube collects enough light to produce a self-developing trace on ultra-violet recording paper.

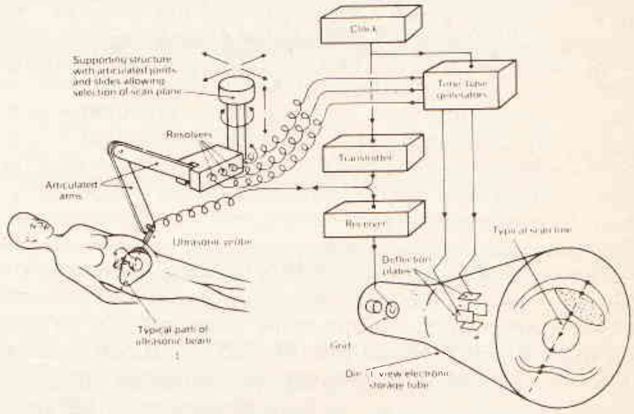

Fig. 3. Two-dimensional scanner and B-scope display system studying a foetus. The time-base generators are driven by electrical outputs from a series of resolvers that measure the position of the ultrasonic beam as it moves across the patient. Horizontal and vertical time-bases combine to deflect the spot in such a way that its movement across the display corresponds to the movement of the beam. Echoes received as the probe moves over the patient produce a cross-sectional image in a plane corresponding to that of the scan. In this example, the image is built-up on the screen of an electronic storage tube for direct viewing.

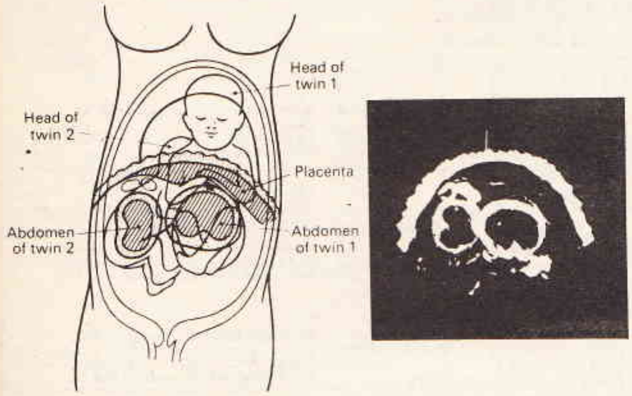

Fig. 4. A two-dimensional scan reveals twins at about 25 weeks of pregnancy. The placenta on the anterior wall of the uterus is clearly defined while the abdomens of the twins, identified in the explanatory diagram, appear in section.

produce spots of light on the display in places where, on an A-scope, there would be deflections of the beam. The positions of the spots of light correspond to echo-producing structures in the patient, and the pattern of their movement can be permanently recorded.

Cross-Sectional Images

The B-scope forms the basis of another display method, the two-dimensional ultrasonic scanner (see Fig. 3). The ultrasonic probe, instead of being held in the hand, is mounted on a scanner. It can be moved to any position in a two-dimensional plane. In this way it is possible to arrange for the beam to pass through structures lying in a chosen plane within the patient, while the position of the probe and the direction of the beam are measured continuously by 'resolvers' mounted in the scanner. The electrical signals from the resolvers control two time-base generators, driving the vertical and horizontal beam deflection plates of a cathode-ray tube. The direction and position of the ultrasonic beam across the patient controls the position of the cathode-ray beam showing up on the display, related to the positions of the echo-producing surface.

A cross-sectional image of the surfaces can be built up photographically by a camera with an open shutter that records the bright spots on the display while the patient is being scanned. The echo information can also be stored electronically.

Two-dimensional scanners in which the probe is moved in contact with the patient produce individual images in scanning times of about 10 seconds, images can be produced at a much faster rate by moving the probe mechanically. Images in rapid succession allow physiological movements to be studied; their main importance is in cardiological diagnosis. But although these rapid mechanical scanners produce so-called real-time images, they lack flexibility. This difficulty can be overcome by using ultrasonic probes containing many separate transducer elements, operated separately or in groups, which can produce ultrasonic scans made up of parallel lines or or lines arranged in a fan shape, at frame rates of tens per second.

As well as making it possible to study rapidly moving structures, real-time scanners can also be used to explore large volumes of anatomy in a short time. A doctor using one can examine a patient in about a quarter of the time it takes with a 'conventional' two-dimensional scanner.

Doppler Effect

The frequency of an ultrasonic wave reflected from a stationary structure is equal to that of the incident wave. If the beam is reflected by a surface which is moving ▶

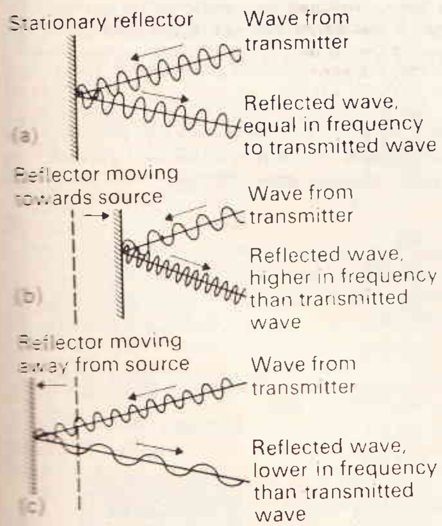

Fig. 5. The Doppler effect occurs when a wave is reflected from a moving surface, giving an upward or downward 'shift' in frequency as in (b) and (c).

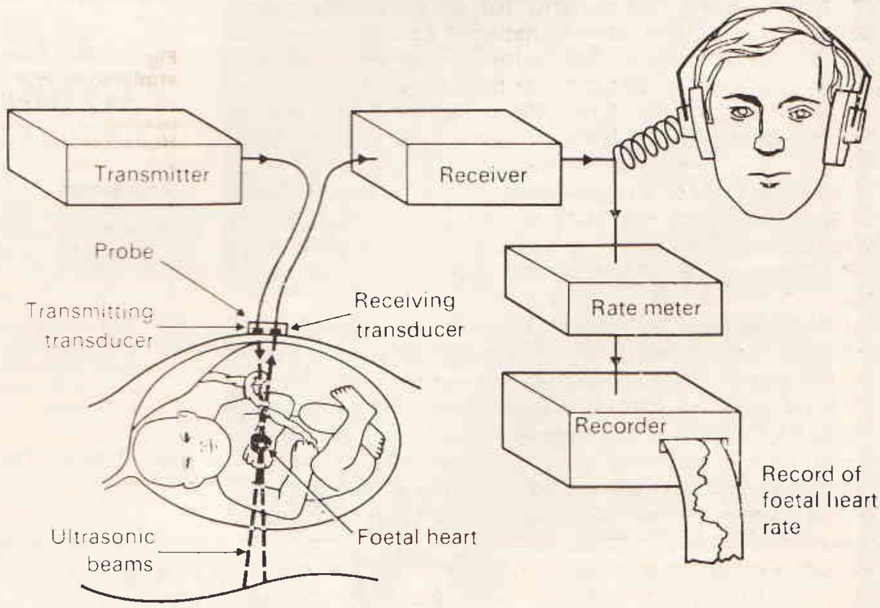

Fig. 6. One use of the Doppler 'shift' is to monitor the foetal heart. The echoes usually fall in the range of audible frequencies.

towards the ultrasonic source, the reflected wave is compressed into a shorter space. This means that the wavelength is reduced. It shows as an upward 'shift' in its frequency. Reflection by a surface moving away from the source gives a downward shift. This phenomenon, the well-known Doppler effect, conveniently gives shift frequencies that fall in the audible range when ultrasound is reflected by moving structures in the body such as heart valves or flowing blood. A simple instrument based on this makes it possible to detect the movement of the foetal heart. Similar instruments to measure blood flow allow peripheral arterial disease to be assessed.

Because Doppler shifted signals are received only from structures that move, two-dimensional maps of them can be built up by using a Doppler probe to scan the patient. In this way the distribution vessels close to the surface can be studied. Such information may obviate the need for X-ray angiography, which is a dangerous and expensive procedure.

It can also be combined with other information about structure position obtained by the pulse-echo method, making it possible to map out blood vessels within the body and measure the rate of blood flow at the same time.

The clinical value of ultrasonic techniques has already been proved, but their spread into general, everyday service will depend on the development of instruments that are simple to use. These, paradoxically, may be more complicated than the ones we already have. It will also mean training doctors and technicians to obtain and interpret results. But it is clear that ultrasonic diagnosis is, in many instances, the best and most economical way of getting the information essential to proper care of the patient.

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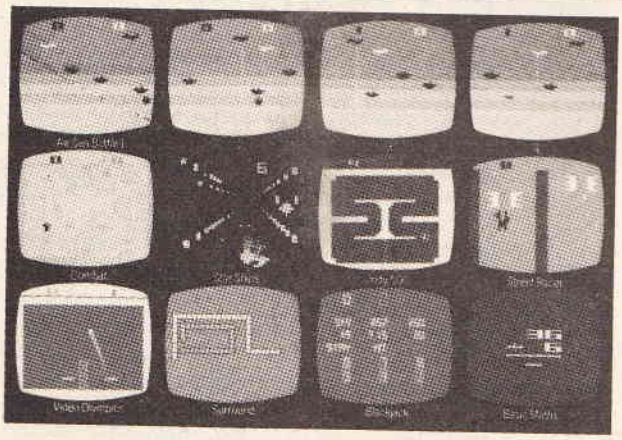

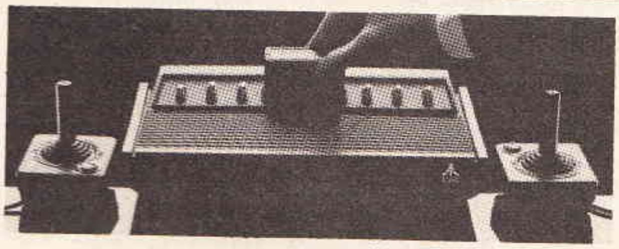

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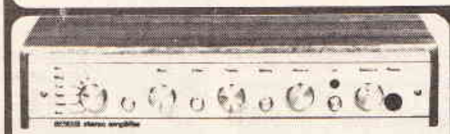

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audiophile

A woeful tale of the pre-amp to make you red in the face this month. Crimsons CPR1 considered by Ron Harris who recovered enough to visit Sony's launching of sixty new models!

MEANWHILE back at the Crimson pre-amp, I shall begin this month by finishing what I began last, and furnishing details of the CPR1 module. To begin with, quoting specs would be largely superfluous in this context, but as I know there are some of you out there high on numbers, try these for size:

SENSITIVITY: 3.4 mV RMS (1kHz) — mag
70 mV RMS 1kHz all others

for 770 mV RMS output

SIGNAL/NOISE: —70dB unweighted 10kHz bandwidth mag
—86dB unweighted 10kHz bandwidth others

CROSSTALK: —80dB 20 Hz-20 kHz
THD: .008% any level below clipping

There are pages of figures in the leaflets Crimson issue for free, so if you've at all interested get after one of those. The nice thing about these specs is their completeness — nothing hidden away here in shrouds of triviality. All the parameters are given as test results under very precise conditions. I could find no reason to argue with any of them and as I'm usually mean and nasty about such things Crimson should take that as praise indeed.

Building Up To It

Power requirements are simply 15-0-15 at under 100mA, and mine measured in the region of 40mA per channel while in full flow. Crimson naturally produce a PSU for this, and it is termed not unreasonably REG1.

The pre-amp arrives as an assembled PCB with set of application notes, and as such cannot be considered a kit by any but the most stretched imagination. Not for the beginner this, as a fair bit of experience comes in most handy — although the notes are very good (but poorly produced) and if you're feeling brave by all means get stuck in — I shan't say 'I told you' — not too loud anyway.

After a few minutes fussing around with pen and paper I decided to house pre-amp and PSU in separate boxes — with appropriate nod in direction of Meridian — for reason of neatness and hum foiling. Let me say now that these circuits are good enough to merit such attention.

As there are no tone controls, metalwork is simplified I'm glad to say, and for a basic system should be very easy indeed.

Crimson make out a very good case in their design notes for doing things their way, but nonetheless there are a few things I would like to disagree with.

Firstly they feed straight into the volume control with auxiliary inputs via the selector switch. This presents the equipment driving into the amp with a varying load, and I would personally prefer to see a high impedence buffer in there, with a lower sensitivity, than the 70 mV now prevailing, and a higher input impedance. A small point perhaps, but under music conditions a constant load is to be preferred I feel.

Secondly the magnetic input is 'fairly' standard although better than most. I would differ from Crimson philosophy enough to prefer the idea of buffering the cartridge input at a constant value, say 47k//200p with unity gain in the first stage, picking up equalisation over two further stages both run at lower gain than usual. This configuration results in a cleaner sound with better transient performance providing the capacitance of each stage is carefully designed for.

I'm offering up these ideas for perusal, not criticising Crimson in particular, its just that the Crimson approach encourages you to drag out your personal theories and give 'em a good airing. I'd be very interested to hear from any of you out there with your ideas on how audio design should be done — we'll print the best we get.

Back To Wires

Anyway to return to the point the CPR1 auditioned very well indeed. Mind you our first sample gave me a hard time for a while. It kept doing things it couldn't do and doing them when I least expected it. After a few bottles of Vallium and several hair pulling sessions with Crimson we discovered I'd been given a non-production board. A quick GPO job and we're back in business. Sanity is saved.

I still don't know what the odd sample was up to — and don't intend to to find out any further that way lies madness. I suspect Crimson save that board to assassinate reviewers in the most fiendish way possible. Who'd believe it was murder?

The production model has never given the slightest problem and has behaved impeccably throughout. I compliment Crimson on the attentive way they panicked along with me over the rogue PCB, several poor unsuspecting boards now on soak test because of my nervous breakdown.

Inputting Pickups

To use this input, you add a passive network to the input to optimise loading for the particular device in use. Crimson themselves recommend adding several networks and switches to increase flexibility. I don't. Switches at this signal level are a menace — if you don't believe me, see Stan Curtis's article elsewhere in this issue. Leave out the switches and hardware for your choice of pickup — how often do you change anyway?

With the switches added a thickening of detail occurs, and transients don't transient nearly as well.

Other inputs are straightforward, although perhaps a little low on input impedance. Noise and hum were commendably low on all inputs, and the separate boxes earn their worth on first power-up. The ten second switch-on blank period to eliminate 'clunks' is a great idea, although on both my samples the delay was so long I almost had time to go make a cup of tea before power came through.

It can be most detrimental to confidence to be left standing there, soldering iron still smoking, poised over the completed unit hand on power switch counting off seconds wondering why the b. . . .y hell it hasn't come on yet. Smiles fade rapidly like that.

Listen In

On magnetic input the Crimson CPR1 produced a very nice sound indeed, of very high quality with good detail and fair extension into the bass registers. On a quick A-B with a very highly priced integrated amp the CPR1 surprised me by showing itself clearly superior! OK wiseguy — wheel out the heavies.

Now my personal idol amongst pre-amps is the Lecson AC1 which I feel has never been approached for quality of reproduction, at any price. As such it makes an excellent reference against which to judge lesser machines. However not everyone agrees, and a champion of the Naim offered up his favourite to give the Crimson a run.

You can see from the opposition how seriously the CPR1 managed to get itself taken. Against the Lecson it was frankly outclassed. The AC1 had better depth, and better bass control. Treble came out smoother from the Lecson showing up the Crimson as slightly hard in this register. Mind you the Lecson costs nearly ten times as much and the Crimson gave a very good account of itself.

Comparing it with the Naim unit nearly lost me a friend. I preferred the CPR1! There was not much in it mind you, and Crimson can be justly proud to have produced a home build design capable of this level of performance.

grumbles

A few niggles. The balance control is very limited in operation. More so than is even trendy, never mind useful, and a little extra swing would do no harm. I'm not at all happy about those auxiliary inputs really, but they seemed to cause no problems so I'll shut up about them.

In order to obtain the level of performance the design can offer very careful construction is required. All cables screened. All as short as possible. Good soldering. Good earthing. Isolated PSU and sound routing of cables carrying HT — away from anywhere at signal level. Leave the on-off switch on the PSU box so that mains need not even enter the case.

Also the subjective quality, although of a very high quality, is a little hard, and judged against the best designs around slightly lacking in detail. Still none of this detracts from the fact that here we have a DIY amplifier that can compete with the very best commercial units, and make mincemeat of many far higher priced designs. Highly recommended.

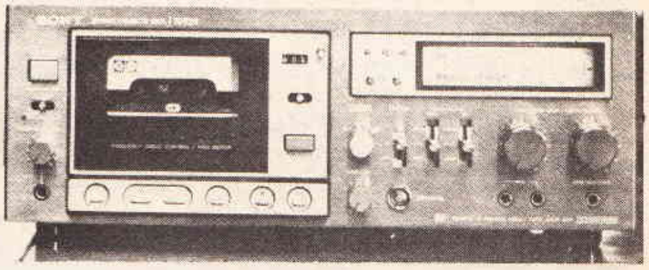
Outlook: Warm and Sony

Sony have gone berserk. Only gone and scrapped practically their entire hi-fi range they have and launched no less than 60 new models if you please. Its enough to give leaflet collectors a heart attack. There is some very clever gadgetry in amongst the flock, and scattered here before you are some of the gems.

The TA-E88 looks very, very interesting indeed, representing as it does the state-of-the-art for Japanese pre-amp design. I'm at present still on my knees to Sony (and my trousers are wearing out fast) to get a closer look so hopefully more details on that one later (Please Mr Sony? . . . Sir?).

The G1 and G7 speakers came as a surprise too, they're better than any oriental offering previously to assail my ear drums, and are capable of giving any competitor a good run for its cones.

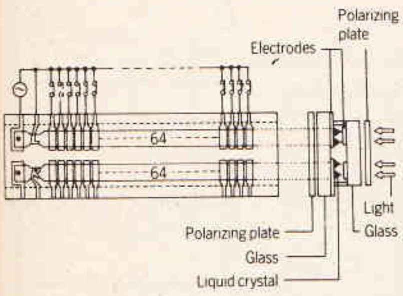
They have divided up the dealers too, creating a new super-fi franchise. This basically means that only the best dealers can sell the best of the range, although the division looks to be a bit unsure in places. ETI

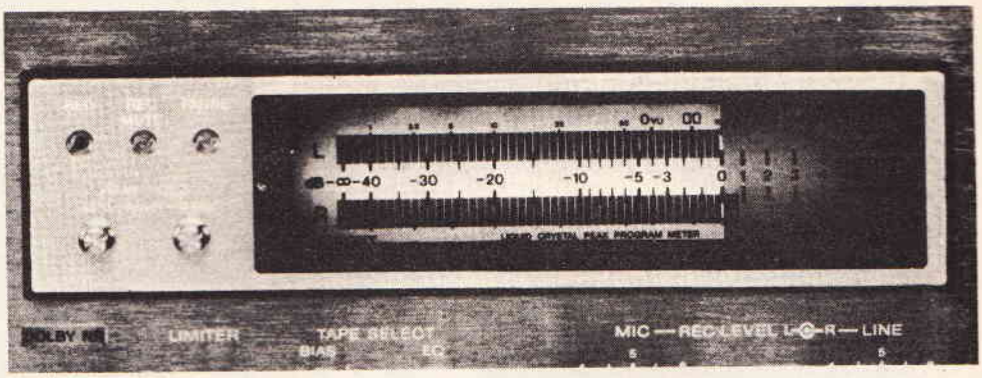


And here we have the TC K8B the new £469 cassette deck released as part of the super-fi Sony range. It incorporates that magnificent LCD display (details on the right) and on the short listen so far gave an excellent audio account of itself.

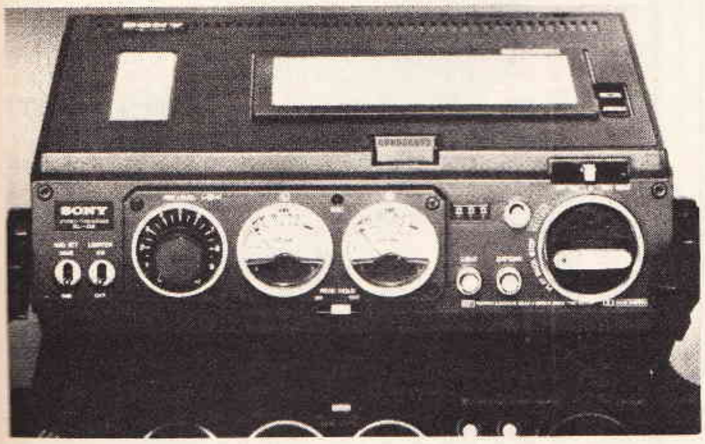
Below: the G1 speakers. Very good indeed for the price (circa £190 the pair) and deserving of none of the usual anti-Japanese speaker bias. Give them a listen if you get the chance.

LCD Peak Programme Meter



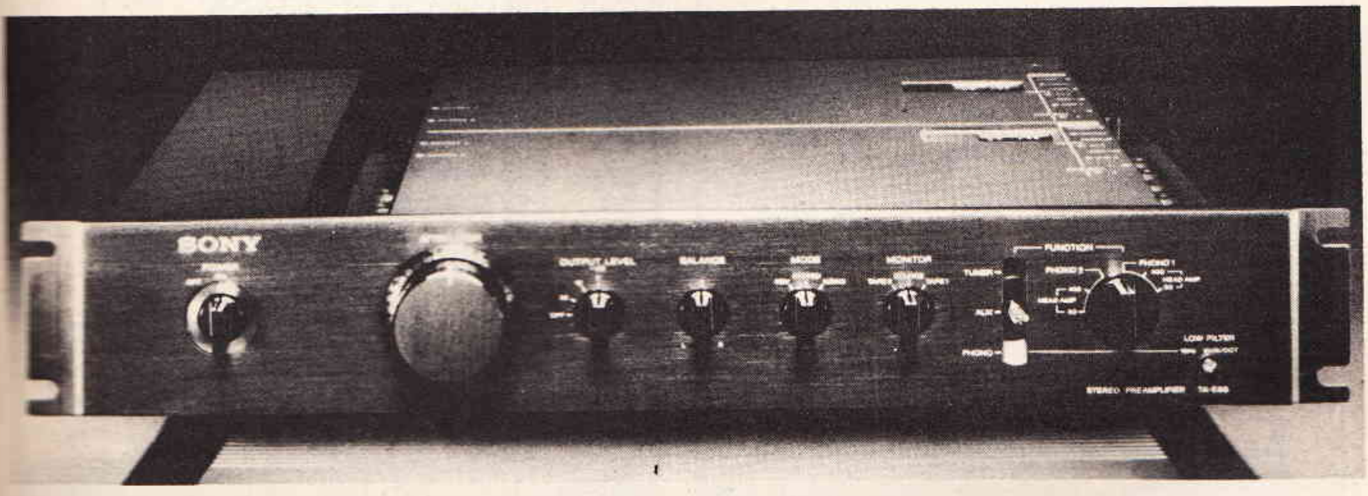


Above: the LCD level meter as used in the TCK8B in close-up. This uses 64 segments to indicate signal level, and has red settable stops to hold peak values. The colours are nice too!



This is a nice touch. A portable Elcaset machine. Gives really nice reproduction and is quite easy to cart around. All the controls are mounted so as to be accessible when in mid-carry. The format would seem to be ideal for this usage. All the quality of a reel-to-reel and no fiddling about while rapidly unspooling tape in a gale! Priced sensibly at £459 and called the EL D8 for the wandering rich amongst you.

Not that I'm obsessed with cassette decks or anything, but here's another one. The TC K6B this time. It's main little gimmick is the MPU program selector. That little LED display in the centre can be stepped to read the number of the track you wish to hear. The machine will promptly go and find it and play it for you. Again LCD level meters, although not as good as the TC K8Bs obviously less segments. Below: The incredible TAE8B. The unit has two COMPLETELY separate channels inside its box. Selectable phono load on one input, and one straight in for people who don't like switches in line (Like me) at this low level. Moving coil pre-pre amp is standard of course. Price £699 (What did you expect?)



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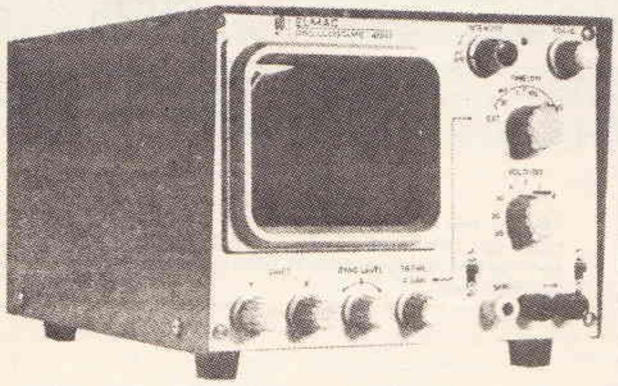

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Input Impedance
Input Voltage — Max
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Deflection Sensitivity
Bandwidth (between 3dB points)
Gain Control
Input Impedance
Input Voltage — Max
TIME BASE
Sweep Range (calibrated)
FINE Control

Blanking
SYNCHRONIZATION
Selection
Synchronization Level
POWER SUPPLY
— 115/220V AC ± 10% at 50/60Hz
Power Dissipation

CRT DATA

PHYSICAL DATA
Dimensions
Weight
Stand
Case
Front Panel

— 100m V/division
— DC — 5MHz
— 9 step 0.1, 0.2, 0.5, 1, 2, 5, 10.20 50V/div
— 1 Meg/40 pf in shunt
— 600V P.P
— 0-400mV/division
1Hz-350KHz
— Continuous, when time base in EXT position
— 1 Meg
600V P.P
— 100msec/div to 1μ sec/div in 5 steps
— Variable between steps — includes timebase calibration position
— Internal — on all ranges

— Internal, external
— Continues from positive to negative
Input Voltage
— 18W
— 4in. — flat face, single beam
— Maximum high voltage — 1.5kV
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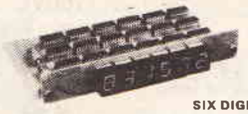

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(ETI project 560 — Aug/Sept/Oct '76)

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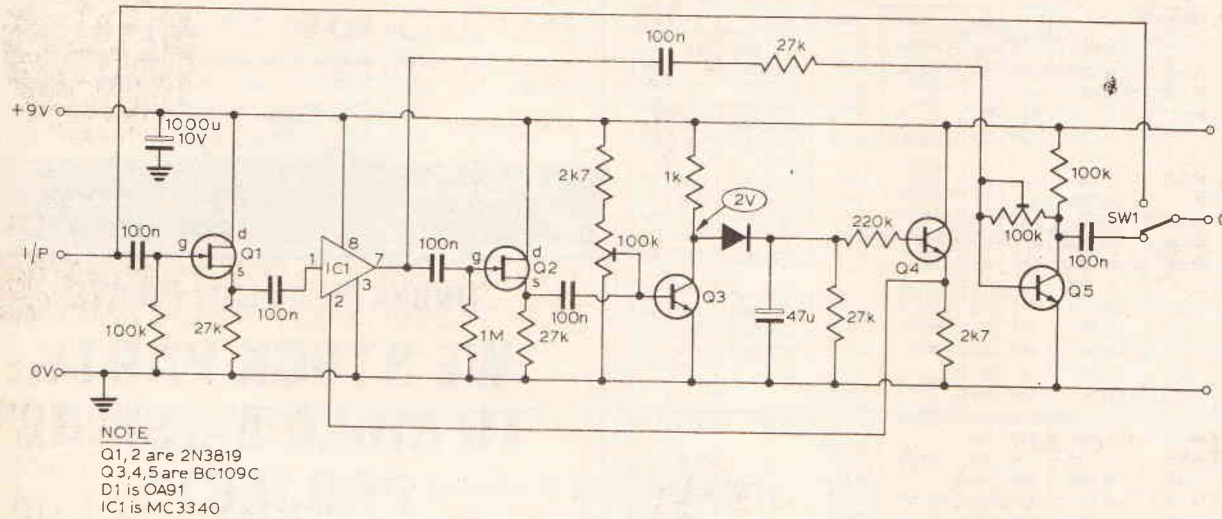
Guitar Sustain Unit

S. D. Maistre



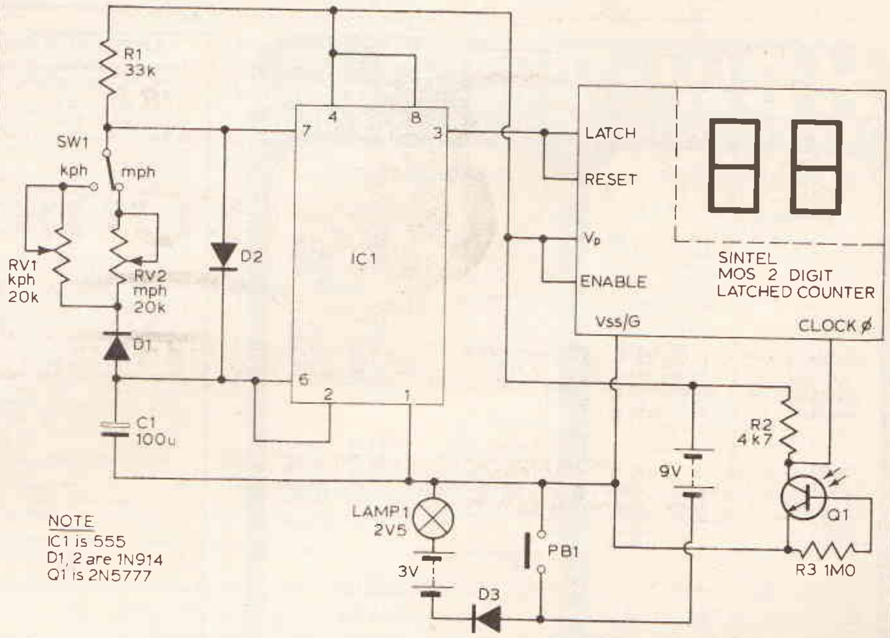
The sustain to be described here holds the output at a constant level over a wide range of input levels. It was designed for use with electric guitars and has a maximum effect with the guitar pick-up volume full up.

The principle employed is that of an AGC, whereby the circuit output is monitored by a DC voltage follower which controls the gain of the VCA through which the signal passes. The advantages of this circuit are that, unlike many such devices, it does not use opto-coupling which draws too much current for battery powered equipment; it produces no audible distortion; components are easily obtained — and cost is low.

Construction method is not critical.

Digital Bike Speed

B. Lemming



This unit provides push-bike speed measurement between zero and 100 km hr or 100 mph! The circuit is based on the Sintel MOS counter block, which counts the pulses from the photo transistor Q1.

These pulses are provided by fixing 18 aluminium 'barriers' to the wheels. Q1 was an unmarked type in the prototype, in a TO 18 package. This mounts in an old felt-tip pen case opposite the lamp so that the barriers interrupt the beam in operation. The counter operates whilst PB1 is pressed, but latches after a time determined by RV1 or RV2. IC1 and associated components. IC1 forms a square-wave oscillator with variable mark-space ratio. The time for which pin 3 is taken low is determined by RV1/RV2 — this enables the counter.

The speedo accuracy is determined by the accuracy of setting of controls RV1 and/or RV2.

Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items.

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 25-27 Oxford St., London W1R 1RF.

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					12FE20	20+20	0.25A EACH	2.0	60p
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50FE15	15+15	1.6A EACH	3.10	70p	08FE09	9+9	0.5A EACH	1.80	50p
50FE20	20+20	1.2A EACH	3.10	70p	08FE10	10+10	0.4A EACH	1.80	50p
50FE28	28+28	0.9A EACH	3.10	70p	08FE12	12+12	0.3A EACH	1.80	50p
50FE30	30+30	0.8A EACH	3.10	70p	08FE15	15+15	0.25A EACH	1.80	50p
20FE06	6+6	1.6A EACH	2.60	65p	06FE06	6+6	0.5A EACH	1.50	50p
20FE09	9+9	1.0A EACH	2.60	65p	06FE10	10+10	0.35A EACH	1.50	50p
20FE12	12+12	0.8A EACH	2.60	65p	06FE12	12+12	0.25A EACH	1.50	50p
20FE15	15+15	0.6A EACH	2.60	65p	06FE15	15+15	0.20A EACH	1.50	50p
20FE20	20+20	0.5A EACH	2.60	65p	30FE30	0-12-15-20-24-30	1A	2.95	1.00
60FE52	26-0-26	1A EACH	3.60	75p	60FE30	0-12-15-20-24-30	2A	4.70	1.00
60FE60	30-0-30	1A EACH	3.60	75p	100FE30	0-12-15-20-24-30	3A	5.60	1.00
80FE52	26-0-26	1.5A EACH	4.50	75p					
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CMOS Gate Identifier

C. Ching

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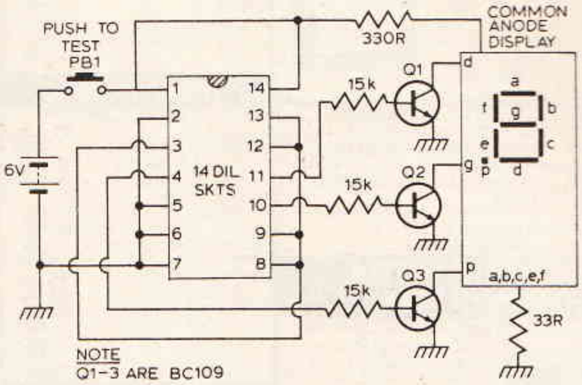
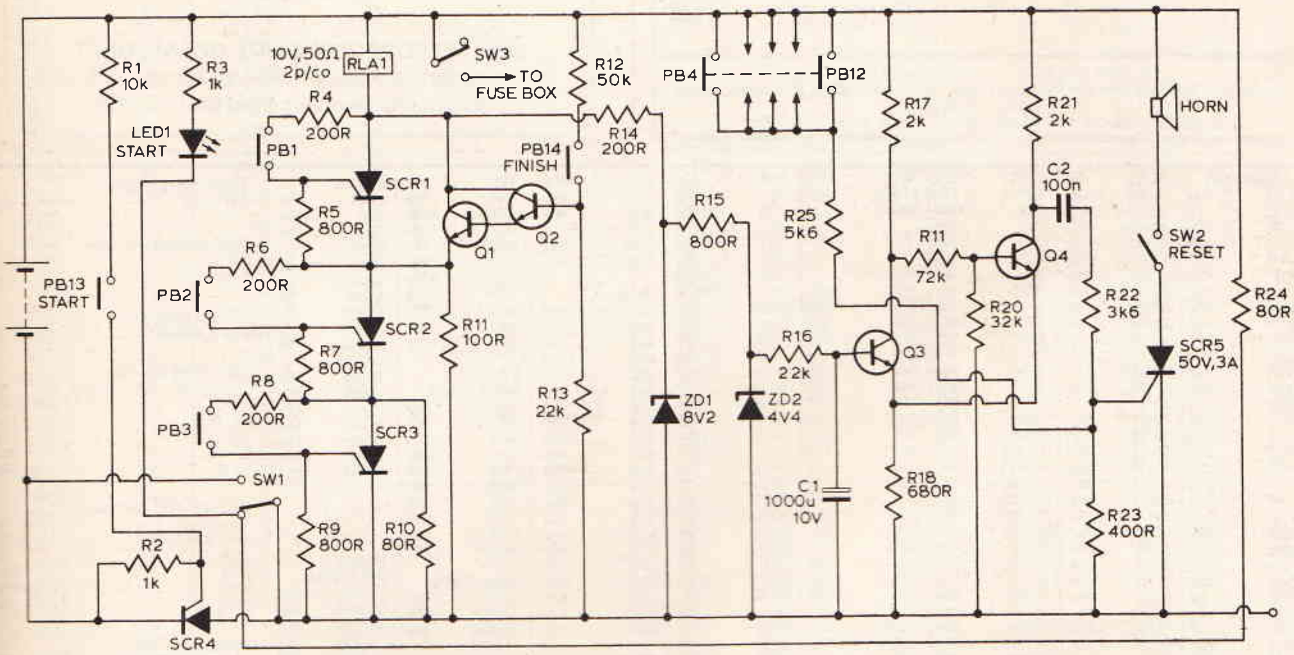


Electronic Ignition Switch

K. A. Last



NOTE
Q1 is BFY50
Q2,4 are BC108
Q3 are BC108C
SCR1-4 50V,1A TYPES
SCR5 50V,3A
LED1 is TIL 209
RLA1 is 10V,50R COIL WITH 2p/co CONTACTS

When used with a calculator type keyboard, this circuit provides a 'combination lock' ignition switch which only activates if the correct sequence of three numbers is keyed in. The keyboard has 14 keys numbered 1 to 12, 'START' and 'FINISH'. To start the car, the 'start' key is pressed and the start LED will light. The correct sequence of 3 numbers is then keyed in. If the sequence is wrong, the cars horn will be sounded. If the right sequence is entered, the 'START' LED will extinguish and the ignition will be energised. The correct sequence will be PB1, PB2, PB3, but these can be arranged amongst the other keys in the keyboard, and given any numbers.

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*Please note that OSTS prices exclude VAT at 8% throughout this side of the page. Most ambit items are at 12½% except those marked *. Please keep orders separately totalled, although a single combined payment, and 25p postage charge, will be sufficient.*

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4017	80p	4076	90p	4543	174p
4018	80p	4077	20p	4549	399p
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4024	76p	4089	150p	4559	388p
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4027	55p	4096	105p	4562	530p
4028	72p	4097	372p	4566	159p
4029	100p	4098	110p	4568	291p
4030	58p	4099	122p	4569	303p
4031	250p	4160	90p	4572	25p
4032	100p	4161	90p	4580	600p
4033	145p	4162	90p	4581	319p
4034	200p	4163	90p	4582	164p
4035	120p	4174	104p	4583	84p
4036	250p	4175	95p	4584	63p
4037	100p	4194	95p	4585	100p
4038	105p	4501	23p		
4039	250p	4502	91p		
4040	83p	4503	69p		
4041	90p	4506	51p		
4042	85p	4507	55p		
4043	85p	4508	248p		
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4045	150p	4511	149p		
4046	130p	4512	98p		
4047	99p	4513	206p		
4048	60p	4514	260p		
4049	55p	4515	300p		
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4051	65p	4517	382p		
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[illegible]
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LM318H	279p	748CN	36p
LM318N	224p	NE531T	120p
		NE531N	105p

OPTO 7 seg displays

0.43" High Efficiency HP:
5082- 7650 red CA
5082- 7653 red CC
5082- 7660 yellow CA
5082- 7663 yellow CC
5082- 7670 green CA
5082- 7673 green CC
} 233p

0.3" Standard HP
5082- 7730 red CA
5082- 7740 red CC
} 147p

0.5" Fairchild
FND500 red CC 150p
FND507 red CA 150p

TTL: Standard AND LP Schottky

All prices listed in pence *

	'N'	'LSN'		'N'	'LSN'		'N'	'LSN'		'N'	'LSN'
7400	13	20	7455	35	24	74126	57	44	74185	134	
7401	13	20	7460	17		74128	74		74188	275	
7402	14	20	7463			74132	73	78	74190	115	92
7403	14	20	7470	28		74133		29	74191		
7404	14	24	7472	28		74136		40	74192	105	180
7405	18	26	7473	32		74138		60	74193	105	180
7406	38		7474	27	38	74139		60	74194	105	187
7407	38		7475	38	40	74141	56		74195	95	137
7408	17	24	7476	37		74142	265		74196	99	110
7409	17	24	7478			74143	312		74197	85	110
7410	15	24	7480	48		74144	312		74198	150	
7411	20	24	7481	86		74145	65		74199	160	
7412	17	24	7482	69		74147	175		74248		90
7413	30	52	7483A			74148	109		74251		90
7414	51	130	7484	97		74150	99		74253		105
7415		24	7485	104	99	74151	64	84	74257		108
7416	30		7486		40	74153	64	54	74279		52
7417	30		7489	205		74154	96		74283		120
7420	16	24	7490	33	90	74155	54	110	74290		90
7421	29	24	7491	76	110	74156	80	110	74295		120
7422	24	24	7492	38	78	74157	67	55	74298		100
7423	27		7493	32	99	74158		60	74258		110
7425	27		7494	78		74159	210		74260		26
7426	36	27	7495A	65	99	74160	82	130	74365		49
7427	27	29	7496	58	120	74161	92	78	74366		49
7428	35	32	7497	185		74162	92	130	74367		43
7430	17	24	74100	119		74163	92	78	74368		49
7432	25	24	74104	63		74164	104		74375		60
7433	40	32	74105	62		74165	105		74379		130
7437	40	24	74107	32	38	74166			74399		150
7438	33	24	74109	63	38	74167	20		74445		92
7440	17	24	74110	54		74168			74447		90
7441	74		74111	68		74169		200	74490		140
7442	70	99	74112	88		74170	230	200	74668		110
7443	115		74113		38	74172	625				
7444	112		74114		38	74173	170				
7445	94		74116	198		74174	87	120			
7446	94		74118	83		74175	87	110			
7447	82		74119	119		74176	75				
7448	56	99	74120	115		74177	78				
7449		99	74121	25		74180	85				
7450	17		74122	46		74181	165	350			
7451	17	24	74123	48		74182	160				
7453	17		74124			74183		210			
7454	17	24	74125	38	44	74184	135				

ICM7217 - count & display £9.50
ICM7207 - clock pulse IC £4.95
ICM7208 - count & display £14.95
ICL7106CP - LCD DVM IC £9.55
KIT £24.80
LED DVM with ICL7107 £20.65

Ambit overspill

the remainder of the column is not OSTS

Varicap diodes VAT 12.5%............

BA102	30p
BA121	32p
ITT210	30p
BB105B	40p
BB104B	45p
3xBB104B	200p
MVAM2	148p
MVAM115	105p
MVAM125	105p
matching to a max of 6 diodes	25p
per diode (1%)	
KV1210	275p

PIN & switching VAT 12.5%...........

BA479 pin	35p
tda1061 pi-network attenuator	95p
BA182 bandswitch diode	21p
10 for	150p

MISCELLENY

NE555	30p
NE556	78p
NE558	180p
LM3909	72p
11C90DC	1400p

8629 divide by 100 to 150MHz 4.20p
95H90DC 320MHz divide by ten 7.80p

Requests for the next issue of the catalogue now being "booked" for despatch immediately it is ready (about November). Please send 45p to reserve a copy.

From the World's leading radio innovation source:

Apart from the MC3357, mentioned alongside, Ambit has the first easy-to-use low noise, low cost UHF dual gate MOSFET - the BF960 from Siemens. With a gain of 18dB, and a noise figure of only 2,8dB at 800MHz, you will see what we mean. At 200 MHz, the gain is 23dB, and NF only 1.6dB. Combine these figures with the famous ease of use of a dual gate MOSFET, and you have the easiest and most effective front end device yet. £1.60 each

Moving Coil Meters

Ambit offers a very wide range of low cost meters, together with the unique 'Meter Made' scale system for professional grade scale customizing:

Series	Scale Area	illumination	cost*
900	14x31mm	internal 12v	250p
920	30x50mm	from behind	275p
930	36x63mm	internal 12v	375p
940 twin	35x45mm	from behind	350p
950	55x45mm	from behind	300p

Stock movement 200uA/750Ω. The 930 series is 5% linear, others are 77uA at 50% FSD. These and many others available in quantity for OEMs
SAE for full scale details please. (Not in cat.)

Radio; Audio; Comms ICs:

Only the very best quality - and only types we have used in our own laboratory tests

Radio frequency + mixers + oscillator(s)		
TDA1062	DC to VHF front end system	1.95
TDA1083/ULN2204	am/fm/audio in one IC	1.95
TDA1090/ULN2242	am/fm hifi tuner system	3.35
HA1197	LF/30MHz am receiver system	1.40
CA3123E/uA720	LF/30MHz linear system	1.40
TBA651	LF/30MHz linear system	1.81
SD6000	DMOS RF/Mixer pair	3.75
IF amplifiers		
CA3089E/KB4402	famous FM IF system	1.94
HA1137W/K	4420 as 3089 + deviation mute	2.20
CA3189E	update with deviation mute	2.75
TBA120a/SN76660N	FM if and detector	0.75
TBA120S	hi gain version TBA120	1.00
MC1350P	agc IF amp	1.20
MC1330P	synch AM demodulator	1.35
MC1495L	precision 4 quad multiplier	6.86*
MC1496P	popular double balanced mixer	1.25
Communications circuits		
KB4406	differential amplifier	0.50
KB4412	2 bal.mixers/agc/gain/doub. conv	2.55
KB4413	am/fm/ssb det. AGC, ANL, mute	2.75
KB4417	3mV mic processor preamp	2.55
KB4423	FM noise blanker system	2.55
Audio preamps		
LM381	stereo high gain/low THD	1.81
LM1303	stereo audio optimized OA	0.99
TDA1054	high quality with alc option	1.95
KB4417	see above	
Audio Power amps		
TBA810AS	7W RMS overload protected	1.09
TDA2002	8W/2Ω in pentawatt package	1.95
TDA2020	15W RMS hifi power dc coupled	2.99
TCA940	10W higher voltage 810	1.80
ULN2283	1W 2.5 to 12 v supply capability	1.00
LM380N8	1W power	1.00
LM380N14	2.5W power	1.00
HA1370	HiFi 15w in easy heatsink pack	2.99
Stereo Decoder Devices		
MC1310/KB4400	original pll decoder	2.20
CA3090AQ	RCA's pll decoder	3.25
uA758	Buffered version of 1310	2.20
LM1307/uA707	non pll type	1.55
HA1196	advanced adj.sep pll low thd	3.95
HA11223	newpilot cancel low thd/imd	4.35

All ambit decoders are supplied with the LED beacon of your choice. Please state colour.

Discrete semiconductors

Some of the biggest stocks of specialist MOS and FET transistors for radio in the UK.

BF900	80p*	40673	55p*	40822	43p*
40823	51p*	MEM680	75p*	BF256S	34p*

Most types for most RF circuitry, inc. new UHF T package types etc. See price list

Hitachi VMOS 100W power devices:

Hitachi 2SK134 /2SJ48 100W comp. VMOS. Data and circuit info £1, and the devices themselves for £14.00 a pair *

DISCRETE LEDs from Telefunken, square sided and round, AMBIT has the best value.....

LED size (mm)	2.5x5	5 dia	2.5dia
RED	17p	14p	14p
Yellow	20p	15p	15p
Green	20p	16p	16p
Orange	24p /he	29p/he L	17p

he= high efficiency L= lens end

10% disc for 10 / 25% per 100 mix

Switch Systems: Check our combinations !

A very wide selection of BOTH Alps SUB series units, (Schadow/AB/Oreor compatible) & the miniature Dialistat units. Available in DIY systems for maximum flexibility and low cost.

And Finally

Further details of these, and many more of the wonders of the world of wireless in the new Ambit catalogue - with magazine supplement. 45p inc pp etc.
Phone (0277) 216029/227050 9am-7pm, callers welcome anytime

Coils & Filters by TOKO

After a period of relative price stability, please note that some prices are increased as a direct result of the failure of £ versus stronger trading currencies. (Mainly Yen)

7 & 10mm IFTs for AM/FM - 1000s es		
455/470kHz	most types of appcns	30p
10.7MHz		33p
Short Wave Coils sets		
Now two ranges of impedance/coupling ea		33p
TV video and sound IFs/detectors		
Another new range in 10mm		33p
6MHz ceramic IF sound filter		80p
Molded VHF coils full catalogue 15p		
Ultra stable coils for 30 - 200MHz from		20p
Chokes - biggest range/biggest stocks		
Most E12 values ex stock, any to order		
7BA series	1uH to 1mH	16p
8RB series	100uH to 33mH	19p
10RB series	33mH to 120mH	33p
FM IF FILTERS ceramic and linear phase		
CFSE/SFE10.7	stereo ceramic IF 10.7MHz filters in 5 groups	50p
CFSB10.7	mono/roofing IF filter	50p
BBR3125N	4pole linear pahe 10.7MHz	150p
BBR3132A	6pole linear phase 10.7MHz	250p
MPX pilot tone filters for 19 & 38kHz		
BLR3107N	Stereo 4k7 impedance	215p
BLR2007	Stereo 3k3 impedance	220p
BLR3152	Mono 4k7 impedance	100p
BLR3157	Mono 4k7/3k0 imp	100p
AM/FM/SSB IF FILTERS		
MFL series	2.4kHz ssb /455kHz carrier	1195p
MFH series	4/5/7kHz BW on 455kHz	195p
MFK series	7/9kHz BW on 455kHz	165p
LFY455D	12kHz 4 ele ladder on 455kHz	125p
CFM2455	6kHz micro mechanical ..	65p
SFD455/470kHz	murata IF filter	85p
CFT455B/C	6/8kHz min + 2IFTs	60p
CFU470C	6kHz on 470kHz	65p
Ratio Detectors for FM/NBFM		
1A651/7	455kHz ratio det	135p
KAN1508/9	10.7MHz ratio detector	66p
94ACS15106/7	10.7MHz ratio detector	66p
Quadrature detectors for CA3089E etc		
KACSK586HM	single	33p
KACS34342/3	double	66p
Polyvaricon tuning capacitors + trimmers		
2A20ST7	2x266pF AM	95p
CY22217Z	2x335p AM, 2x20pF FM	175p
CY23217PX	2x335pF AM, 3x20pF FM (2 trimmers)	245p

Tuner Modules

From the biggest and best range.................

TUNERHEADS for 88-108MHz band 2 (varicap)		
EF5803	6 cct, 3 MOSFETs, amp. osc.	19.75
EF5801	6 cct, 2 MOSFETs, osc op	17.45
EF5600	5cct, MOSFET RF, by TOKO	14.95
EF5400	4cct balanced mixer/pin agc	9.75
EC3302	3cct FET input miniature	8.25
TUNERSETS by LARSHOLT (head+IF)		
7252	Dual MOS head/low dist IF	26.50
7253	FET head, mpx decoder inc	26.50
IF AMPLIFIERS all with deviation mute, agc, afc, meter drives etc		
7020	HiGain dual ceramic filter	6.95
7030	Mos preamp, linear phase filter	10.95
7 130	2 mos preamps, 3 lpfilters	16.25
NBFM1	455/470kHz NBFM module	9.95
MPX decoders, all with pilot tone filters and buffer amplifiers for min 300mV RMS		
92310	1310 based system	6,95
93090	3090AQ based system	8.85
91196	HA1196 based + birdy filter	1299
91196B	HA1196 based + birdy filter + 2 x LM380 audio monitor amps	16.45
911223	HA11223 based system	12.50
AM RADIO -		
91197	The original MW/LW varicap tuner with electronic switch	11.85
9122	The uniband tuner module	13.22
AM FM RADIO UNITS		
71083	Using TDA1083, provides a complete MW/LW/FM portable radio chassis for clock radio etc	12.95
71083D	Drive/dial system for 71083	1.75

SPECIALS: TUNERHEADs in the range 40-200MHz to special order
The EF5803 and EF5400 are available to cover bands in the region described. The costs depend on quantity and actual mods required to cover the desired band. Max coverage approx. 20% of centre frequency selected. Also, please allow 3-5 weeks delivery for these items.

2 Gresham Road, Brentwood, Essex.

7400 TTL

7400	.12
7401	.12
7402	.12
7403	.12
7404	.13
7405	.13
7406	.28
7407	.28
7408	.14
74S08	.40
7409	.14
7410	.13
7411	.18
7412	.21
7413	.25
7414	.54
7416	.27
7417	.27
7420	.13
7421	.28
7422	.17
7423	.25
7425	.20
7426	.25
7427	.25
7428	.34
7430	.13
74S30	.30
7432	.24
7433	.32
7437	.24
7438	.24
7440	.13
7441	.52
7442	.55
7443	.90
7444	.90
7445	.70
7446	.70
7447A	.64
7448	.60
7450	.13
7451	.13
7453	.13
7454	.13
7460	.13
7470	.28
7472	.22
7473	.26
7474	.26
74S74	.50
7475	.30
7476	.26
7480	.45
7481	.90
7482	.80
7483	.72
7484	.90
7485	.88
7486	.26
74S86	1.50
7489	2.00
7490	.35
7491	.65
7492	.44
7493	.40
7494	.80
7495	.54
7496	.60
7497	2.38
74100	.94
74104	.40
74105	.40
74107	.28
74109	.45
74110	.46
74111	.70
74116	1.60
74118	.82
74119	1.30
74120	.82
74121	.25
74122	.40
74123	.53
74125	.44
74126	.45
74128	.62
74132	.68
74135	.68
74136	.75
74137	.94
74141	.58
74142	2.00
74143	2.00
74144	2.00
74145	.64
74147	1.30
74148	1.18
74150	.99
74151	.60
74153	.60
74154	1.05
74155	.63
74156	.63
74157	.63
74159	1.70
74160	.80
74161	.80
74162	.80
74163	.80
74164	.89
74165	.89
74166	.99
74167	2.70
74170	1.58
74172	4.00
74173	1.18
74174	.89
74175	.68
74S175	4.70
74176	.88
74177	.88
74178	1.20
74179	1.10
74180	.90
74181	1.92
74182	.75
74S182	2.30
74H183	.99
74184	1.20
74185A	1.20
74186	7.20
74188	2.70
74190	1.05
74191	.99
74192	.99
74193	1.05
74194	.90
74195	.84
74196	.90
74197	.90
74198	1.48
74199	1.48
74221	1.50
74273	2.15
74279	1.25
74283	1.70
74284	6.85
74293	1.35
74298	1.92
74390	1.92
74393	2.12

74LS TTL

74LS00	.19
74LS01	.19
74LS02	.19
74LS03	.19
74LS04	.20
74LS05	.20
74LS08	.19
74LS09	.19
74LS10	.19
74LS11	.19
74LS12	.19
74LS13	.46
74LS14	1.10
74LS15	.19
74LS20	.19
74LS21	.19
74LS22	.19
74LS26	.24
74LS27	.40
74LS30	.19
74LS32	.25
74LS37	.27
74LS38	.27
74LS40	.19
74LS42	.53
74LS47	.97
74LS48	.97
74LS49	.97
74LS51	.19
74LS54	.19
74LS55	.20
74LS73	.30
74LS74	.34
74LS75	.45
74LS76	.32
74LS78	.32
74LS83	.78
74LS85	.90
74LS86	.35
74LS93	.95
74LS95	1.10
74LS107	.36
74LS109	.36
74LS112	.38
74LS113	.36
74LS114	.36
74LS123	.82
74LS124	2.45
74LS125	.44
74LS126	.44
74LS132	.69
74LS136	.40
74LS138	.53
74LS139	.53
74LS151	1.05
74LS153	.50
74LS154	1.20
74LS155	.86
74LS156	.86
74LS157	.47
74LS158	.53
74LS160	1.22
74LS161	.69
74LS162	1.22
74LS163	.69
74LS164	1.20
74LS168	2.00
74LS169	2.00
74LS170	1.78
74LS173	1.05
74LS174	1.12
74LS175	1.05
74LS189	2.85
74LS190	.81
74LS191	.81
74LS192	1.80
74LS193	1.80
74LS195	1.12
74LS196	1.20
74LS197	1.20
74LS221	1.12
74LS247	.97
74LS248	.97
74LS249	.97
74LS251	1.00
74LS253	1.05
74LS257	1.05
74LS258	1.05
74LS266	.39
74LS273	2.50
74LS279	.50
74LS283	1.00
74LS289	2.85
74LS293	.90
74LS298	1.60
74LS352	.92
74LS353	1.05
74LS365	.50
74LS366	.50
74LS367	.50
74LS368	.50
74LS386	.37
74LS670	2.00

CMOS

4000	.14
4001	.15
4002	.16
4006	.92
4007	.16
4008	.92
4009	.45
4010	.48
4011	.15
4012	.16
4013	.42
4014	.80
4015	.77
4016	.42
4017	.77
4018	.87
4019	.42
4020	.92
4021	.82
4022	.82
4023	.15
4024	.66
4025	.15
4026	1.28
4027	.50
4028	.67
4029	.86
4030	.48
4031	2.34
4033	1.25
4034	2.00
4035	1.00
4036	2.40
4037	.99
4038	1.00
4039	2.80
4040	.88
4041	.77
4042	.72
4043	.82
4044	.82
4045	1.40
4046	1.32
4047	.95
4048	.60
4049	.42
4050	.42
4051	.84
4052	.84
4053	.84
4054	1.10
4055	1.00
4060	.98
4066	.48
4067	3.50
4068	.24
4069	.17
4070	.17
4071	.17
4072	.17
4073	.17
4075	.17
4076	1.05
4077	.46
4078	.22
4081	.17
4082	.20
4085	.72
4086	.76
4089	1.55
4093	.65
4094	1.80
4095	1.10
4096	1.10
4097	3.50
4098	1.12
4099	1.90
4404	1.00
4410	.30
4412	.80
4428	1.50
4445	.30
4449	.17
4501	.88
4502	.50
4507	[illegible]
4508	2.25
4510	1.05
4511	.98
4512	.92
4514	2.85
4515	2.80
4516	1.02
4518	.99
4519	.50
4520	1.05
4521	2.00
4522	1.35
4527	1.60
4528	.92
4529	1.10
4536	3.56
4563	4.20
4555	.85
4556	.85
4558	1.25
4566	1.40
4583	.75
4585	1.03

LINEAR

TAA550B	.35
TAA661B	1.40
TBA120S	.68
TBA641A	1.88
TBA800	.90
TBA810S	1.16
TCA270SQ	2.21
TDA2020	3.56
ZN414	1.20
380-14	.90
381-14	1.30
555-8	.30
556-14	.80
702-14	.50
710-14	.32
711-14	.32
1310-14	1.78
2501B-14	2.20
3045-14	.45

OP AMPS

301A-8	.35
709-8	.42
709-14	.46
709 T099	.60
741-8	.22
741-14	.20
741 T099	.48
747-14	.70
1458	.55
3130-T099	1.00
3900-14	.50

VOLTAGE REGS

300 T099	1.00
309K T03	1.30
723 14DIL	.46
7805 T0220	1.10
7812 T0220	1.10
7815 T0220	1.10
7824 T0220	1.10
7905 T0220	1.55
7912 T0220	1.55
7915 T0220	1.55

LOW PROFILE DIL SOCKETS

8 pin	.11
14 pin	.12
16 pin	.13
18 pin	.23
20 pin	.27
22 pin	.29
24 pin	.32
28 pin	.44
40 pin	.60

400mW ZENER DIODES

2.7V-33V .09 each .80 for 10: 3.50 for 50: 6.50 for 100 (Any mix).

S.C.R's

1Amp 200V	.30
4Amp 200V	.40
4Amp 400V	.50
7Amp 100V	.50
7Amp 400V	.65
10Amp 200V	.80
16Amp 100V	.75

LEDs

	.125in	.2in
Red	.09	.10
Green	.20	.20
Yellow	.20	.20
LED clip	.03	.04

Transistors and diodes

AC128	.14
AD161 / AD162	.80
BAX13	.04
BAX16	.05
BC107	.09
BC107B	.10
BC108	.09
BC108B	.10
BC109	.10
BC109B	.11
BC109C	.12
BC142	.25
BC143	.25
BC147	.09
BC148	.09
BC149	.09
BC157	.10
BC158	.11
BC159	.11
BC171	.10
BC172B	.11
BC177	.15
BC182	.11
BC182L	.11
BC183	.11
BC183L	.11
BC184	.11
BC184L	.11
BC187	.18
BC208	.12
BC212	.12
BC212L	.12
BC213	.11
BC213L	.11
BC214	.13
BC214L	.13
BC237B	.16
BC261B	.15
BC549	.12
BCY42	.25
BCY70	.17
BCY71	.18
BCY72	.15
BD115	.50
BD131	.40
BD132	.41
BD133	.50
BD135	.44
BD139	.46
BD140	.48
BD189	.60
BF241	.25
BF258	.24
BFX34	.85
BFX85	.23
BFX86	.24
BFX87	.22
BFX88	.22
BFY50	.20
BFY51	.20
BFY52	.18
BFY64	.20
BR100	.25
BRY39	.45
BSX19	.18
BSX21	.20
BSY25	.38
BY127	.12
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BYX10	.14
BYX36-150	.08
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ME3001	.12
ME8002	.10
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MJE371	.66
MJE521	.60
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MJE3055	.65
MPF102	.32
MPS5172	.14
MPS6522	.20
MPSA-06	.22
MPSA-13	.24
MPSA-56	.22
MPSA-93	.28
MPSU-01	.35
MPSU-51	.38
OA47	.08
OA79	.08
OA81	.08
OA90	.07
OA91	.075
OA202	.085
OC20	1.00
OC28	.95
OC35	.95
OC36	.95
OC71	.25
OC84	.65
TIL31	1.70
TIL111	1.00
TIP29A	.42
TIP29B	.50
TIP29C	.60
TIP30A	.50
TIP30B	.55
TIP30C	.65
TIP31A	.50
TIP31B	.52
TIP31C	.55
TIP32A	.55
TIP32B	.61
TIP32C	.70
TIP41A	.67
TIP41B	.70
TIP41C	.80
TIP42A	.72
TIP42B	.78
TIP42C	.86
TIP3055	.50
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ZTX304	.20
ZTX450	.20
ZTX502	.20
ZTX504	.25
ZTX550	.20
1N821	.28
1N823	.30
1N914	.06
1N916	.07
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1N4002	.055
1N4003	.06
1N4004	.075
1N4005	.08
1N4006	.085
1N4007	.09
1N4148	.04
1N5400	.13
1N5402	.16
1N5404	.17
1S44	.05
1S020	.11
1S920	.06
1S921	.07
1S922	.08
1S923	.09
1S951	.10
2N438	.50
2N696	.15
2N697	.15
2N706	.20
2N929	.20
2N1306	.35
2N1307	.35
2N1613	.21
2N1711	.24
2N2219	.20
2N2221	.17
2N2222	.18
2N2222A	.20
2N2368	.20
2N2369	.22
2N2646	.42
2N2904	.20
2N2904A	.22
2N2906	.18
2N3053	.17
2N3054	.42
2N3055	.42
2N3440	.50
2N3702	.08
2N3704	.07
2N3705	.07
2N3706	.08
2N3707	.08
2N3710	.07
2N3771	2.20
2N3773	3.10
2N3819	.20
2N3904	.12
2N3905	.12
2N3906	.12
2N4058	.12
2N4062	.12
2N4124	.16
2N4126	.16
2N5133	.16
2N5136	.16
2N5142	.18
2N5458	.28

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1A 200V	.30
1A 600V	.35
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6A 200V	.78
25A 100V	1.50
25A 200V	1.80

DIAC

BR100 .26

MIXED CAPACITOR PAK

50 caps. Mxd. values of volts and capacitances. Assorted polyester, polystyrene, ceramic, polycarbonate, mica, electrolytic, etc.

1.00 PER PAK

ELECTROLYTIC PAK

1lb weight. Approx. 50 capacitors. Mixed values of capacitances and voltages.

1.25 PER PAK

1 WATT ZENER DIODES

3.3V-100V .16

ELECTROLYTICS

uF	16v	25v	40v	63v
1	.045	.05	.055	.06
2.2	.045	.05	.055	.06
3.3	.045	.05	.055	.06
4.7	.045	.05	.055	.06
6.8	.05	.055	.06	.07
10	.05	.06	.07	.09
22	.06	.07	.09	.13
33	.07	.085	.10	.15
47	.08	.10	.12	.19
68	.09	.12	.16	.23
100	.10	.13	.18	.26
150	.11	.15	.20	.28
220	.12	.16	.22	.32
330	.14	.18	.26	.36
470	.16	.20	.29	.40
680	.18	.24	.35	.48
1000	.20	.29	.41	.56
2200	.38	.46	.65	.95
4700	.47	.60	.90	

POLYESTER 100V Radial lead

.001, .0012, .0015, .0018, .0022, .0027, .0033, .0039, .0047, .0056, .0068, .0082, .01, .04; .012, .015, .018, .022, .045; .027, .033, .039, .047, .05; .056, .068, .06; .082, .1, .12; .15, .07; .18, .22, .27, .08; .33, .10; .39, .11; .47, .12; .68, .16.

BEAD TANTALUM

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ASTRA-PAK

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WHYTELEAFE
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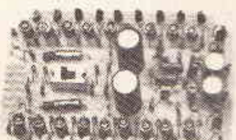
TOTAL AMPLIFICATION FROM CRIMSON ELEKTRIK

WE NOW OFFER THE WIDEST RANGE OF SOUND PRODUCTS

STEREO PRE-AMPLIFIERS

MC 1



CPR 1

CPR 1—THE ADVANCED PRE-AMPLIFIER

The best pre-amplifier in the U.K. The superiority of the CPR 1 is probably in the disc stage. The overload margin is a superb 40dB, this together with the high slewing rate ensures clean top, even with high output cartridges tracking heavily modulated records. Common-mode distortion is eliminated by an unusual design. R.I.A.A. is accurate to 1dB; signal to noise ratio is 70dB relative to 3.5mV; distortion < .005% at 30dB overload 20kHz. Following this stage is the flat gain/balance stage to bring tape, tuner, etc., up to power amp. signal levels. Signal to noise ratio 86dB; slew-rate 3V/uS; T.H.D. 20Hz — 20kHz < .008% at any level. F.E.T. muting. No controls are fitted. There is no provision for tone controls. CPR 1 size is 138 x 80 x 20mm. Supply to be ± 15 volts.

MC 1 PRE-PRE-AMPLIFIER

Suitable for nearly all moving-coil cartridges. Sensitivity 70/170uV switchable on the p.c.b. This module brings signals from the now popular low output moving-coil cartridges up to 3.5mV (typical signal required by most pre-amp disc inputs). Can be powered from a 9V battery or from our REG 1 regulator board.

REG 1 — POWER SUPPLY

The regulator module, REG 1 provides 15-0-15v to power the CPR 1 and MC 1. It can be used with any of our power amp supplies or our small transformer TR 6. The power amp kit will accommodate it.

POWER AMPLIFIERS

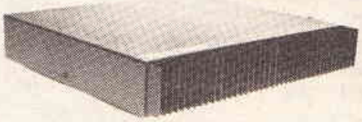
It would be pointless to list in so small a space the number of recording studios, educational and government establishments, etc., who have been using CRIMSON amps satisfactorily for quite some time. We have a reputation for the highest quality at the lowest prices. The power amp is available in five types, they all have the same specification. T.H.D. typically .01% any power 1kHz 8 ohms; T.I.D. insignificant; slew rate limit 25V/uS; signal to noise ratio 110dB; frequency response 10Hz-35kHz, —3dB; stability unconditional; protection drives any load safely; sensitivity 775mV (250mV or 100mV on request); size 120 x 80 x 25mm.

POWER SUPPLIES

We produce suitable power supplies which use our superb TOROIDAL transformers only 50mm high with a 120-240 primary and single bolt fixing (includes capacitors/bridge rectifier).

POWER AMPLIFIER KIT

The kit includes all metalwork, heatsinks and hardware to house any two of our power amp modules plus a power supply. It is contemporarily styled and its quality is consistent with that of our other products. Comprehensive instructions and full back-up service enables a novice to build it with confidence in a few hours.



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CPRI	£29.49	CPRIS	£39.98
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POWER SUPPLY:

REGI	£6.75	TR6	£1.75

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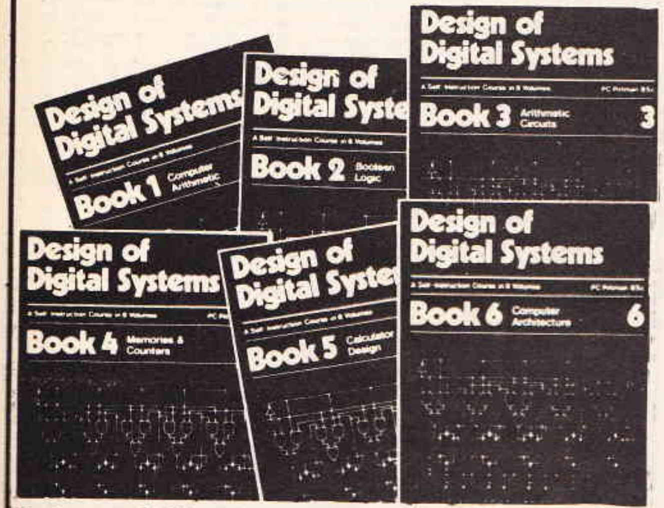

Design of digital Systems is written for the engineer seeking to learn more about digital electronics. Its six volumes — each A4 size — are packed with information, diagrams and questions designed to lead you step-by-step through number systems and Boolean algebra to memories, counters and simple arithmetic circuits, and finally to a complete understanding of the design and operation of calculators and computers.

The contents of Design of Digital Systems include:

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Book 2 OR and AND functions; logic gates. NOT, exlusive OR, NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.
Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.
Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).
Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
Book 6 Central processing unit (CPU); memory organisation; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.

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ELECTROVALUE Buying Guide

Section 5

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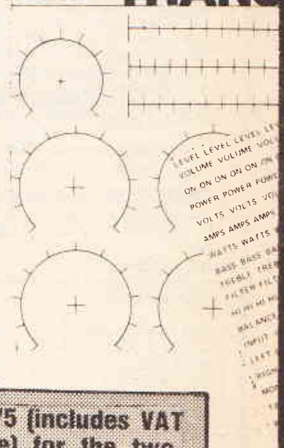

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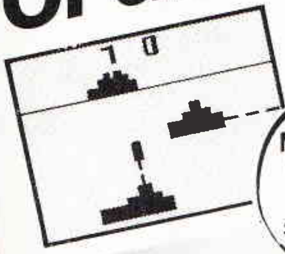
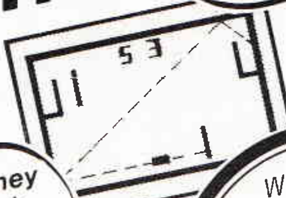
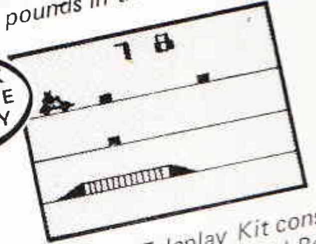
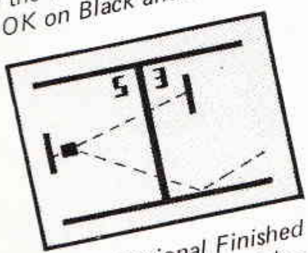

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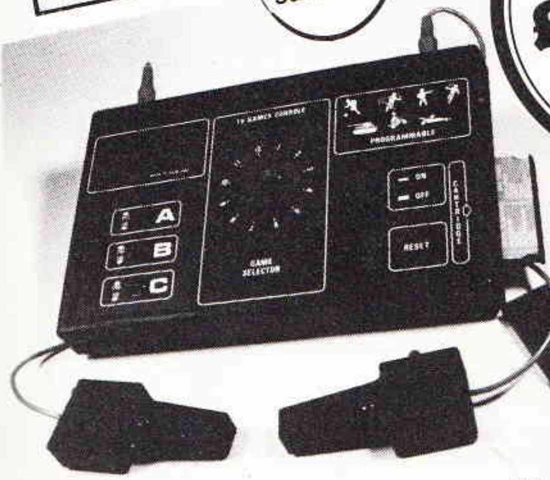

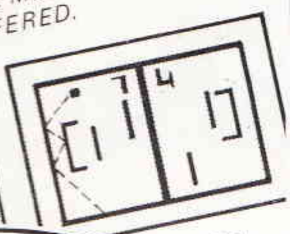

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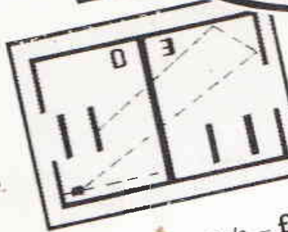


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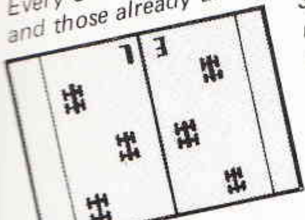

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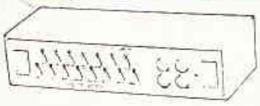

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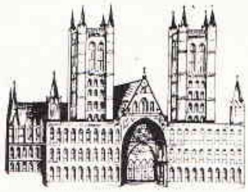

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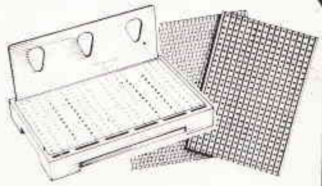

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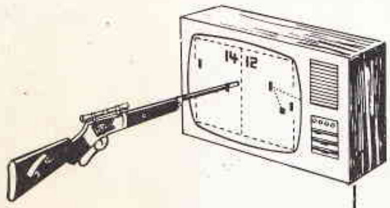

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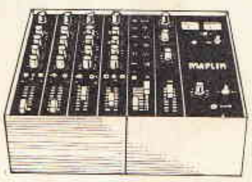

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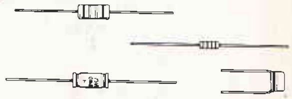

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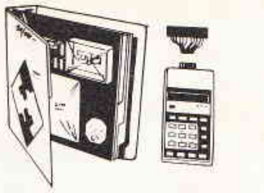

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