electronics today INTERNATIONAL

NOVEMBER 1978

45p

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

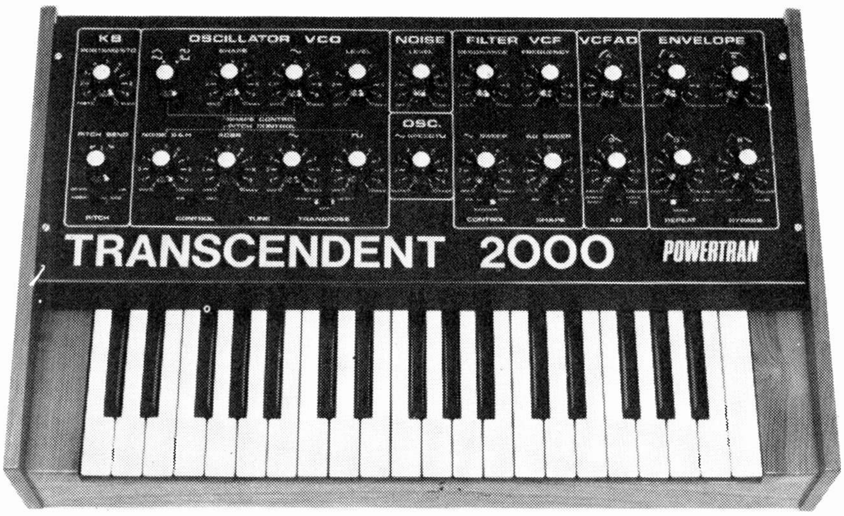
LCD DFM/Oscillator

. . . 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 ½% metal film!) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality 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!



STILL ONLY £172.00 + VAT FOR COMPLETE KITS!

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

Due to the fantastic success in the launching of this superb new kit, instead of **£186.50** we are able to continue the special introductory offer of **£172.00** + VAT!

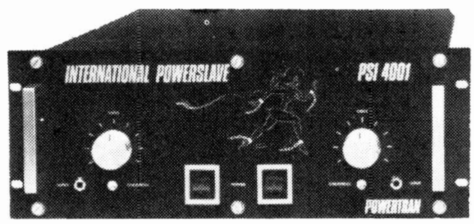
200 + 200 watt AMPLIFIER

As featured in Electronics Today International

400W rms continuous — 800W peak!
0.03% THD at FULL power!
PLUS all the following features too!

- ★ Each channel totally independent with its own stabilised power supply driven by custom designed TOROIDAL transformers!
- ★ Inherent reliability — monster heat sinks for cool running at the hottest venues — electronic open and short circuit protection!
- ★ Ultra low feedback (an incredible low 14dB overall!), super high slewing rate (20V/μs). 200W rms continuous to 4 ohm from EACH channel, input sensitivity 0 775V (0dB)
- ★ Professional quality components, sturdy 19 rack mounting chassis complete with sleeve and feet for free standing work too
- ★ Easy to build — plenty of working space with ready access to all components, minimal wiring, extensive instruction suitable for both experience constructors and newcomers to electronics
- ★ Value for money — quality and performance comparable with ready-built amplifiers costing over £600!

PSI 4001 SLAVE MODEL



PSI 4002 STUDIO MODEL

SUPER NEW LOW PRICES!

PSI 4001
COMPLETE KIT ONLY £187.50 + VAT
PSI 4002
COMPLETE KIT ONLY £196.90 + VAT

The kits shown on this page are available as separate packs Prices are given in our FREE CATALOGUE

PRICE STABILITY: Order with confidence irrespective of any price changes we will honour all prices in this advertisement until November 30th, 1978 if ETI October 1978 issue is mentioned with your order Errors and VAT rate changes excluded
EXPORT ORDERS: No VAT Postage charged at actual cost plus 50p handling and documentation
U.K. ORDERS. Subject to 12% surcharge for VAT* (i e add ⅛ to the price) No charge is made for carriage. * or at current rate if changed
SECURICOR DELIVERY: For this optional service (U K. mainland only) add £2 50 (VAT inclusive) per kit
SALES COUNTER: If you prefer to collect your kit from the factory, call at Sales Counter (at rear of factory) Open 9 a m -4 30 p m Monday-Thursday

OUR CATALOGUE IS **FREE!** WRITE OR PHONE **NOW!**

POWERTRAN ELECTRONICS

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ANDOVER
(STD 0264) 64455

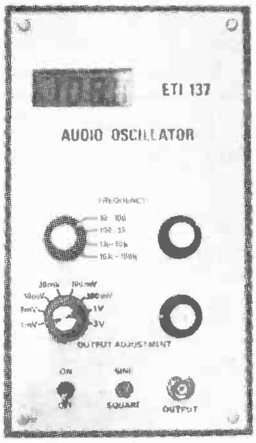
electronics today INTERNATIONAL

NOVEMBER 1978 VOL 7 NO 11

what a display p.16

FEATURES

PROJECTS



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INFORMATION

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

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High quality audio modules for Stereo and mono

S450

STEREO
FM TUNER
Fitted with
phase lock-loop

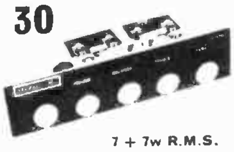
£22·30
+ 40p p&p
+ 12½% VAT

FREQUENCY RANGE	88–108 Mhz
SENSITIVITY	3·0 μV
BANDWIDTH	250 kHz
SPURIOUS REJECTION	50 dB
SELECTIVITY ± 400 kHz	55 dB
AUDIO OUTPUT (22·5 kHz deviation)	100 mV
STEREO SEPARATION	30 dB
SUPPLY REQUIREMENTS	20 to 30V (90mA max)
AERIAL IMPEDANCE	75 ohms
DIMENSIONS	240mm × 110mm × 32mm

The 450 Tuner provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, simply by changing the settings of the pre-set controls. Features include FET input stage. Vari-Cap diode tuning. Switched AFC LED Stereo indicator.

Stereo 30

COMPLETE
AUDIO
CHASSIS



7 + 7w R.M.S.

£18·95
+ 40 p&p
+ 12½% VAT

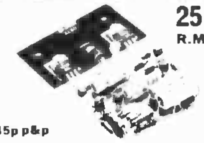
OUTPUT POWER	7 Watts RMS
LOAD IMPEDANCE	8 ohms
TOTAL HARMONIC DISTORTION	Less than ·5% (Typically ·3%)
FREQUENCY RESPONSE	50 Hz to 20 kHz ± 3dBs
TONE CONTROL RANGE	± 12 dBs at 100Hz and 10kHz
SENSITIVITY	190 mV for full output
INPUT IMPEDANCE	1 M ohms
TRANSFORMER REQUIREMENTS	22 V.A.C. rated at 1A
DIMENSIONS (Less controls and panel)	200mm × 130mm × 33mm

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, main switch, fuse and fuse holder and universal mounting brackets.

AL60

25w
R.M.S.

AUDIO
AMPLIFIER
MODULE
25 Watts RMS



£4·55 + 35p p&p
+ 12½% VAT

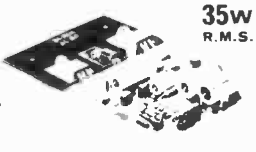
OUTPUT POWER	25 Watts RMS
SUPPLY	30–50 V
LOAD IMPEDANCE	8–16 ohms
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz × 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

This high quality audio amplifier module is for use in audio equipment and stereo amplifiers and provides output powers up to 25 RMS with distortion levels below 0·1%.

AL80

35w
R.M.S.

AUDIO
AMPLIFIER
MODULE



£7·15*
+ 35p p&p
+ 8% VAT

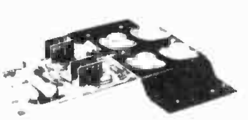
OUTPUT POWER	35 Watts RMS
SUPPLY	40–60 V
LOAD IMPEDANCE	8–16 ohms
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz × 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

The AL80 is similar in design to the AL60 above and is of the same high quality but provides output powers up to 35W with distortion levels below 0·1%.

AL250

125w R.M.S.

POWER
AMPLIFIER



£17·25* + 40p p&p + 8% VAT

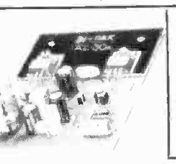
OUTPUT POWER	125 Watts RMS continuous
OPERATING VOLTAGE	50–80 V
LOADS	4–16 ohms
FREQUENCY RESPONSE	25 Hz 20 kHz measured at 100 Watts
SENSITIVITY FOR 100 WATTS O/P AT 1 kHz	450 mV
INPUT IMPEDANCE	33 K ohms
TOTAL HARMONIC DISTORTION	
50 WATTS into 4 ohms	0·1%
50 WATTS into 8 ohms	0·06%

This unit, designated AL250, is a power amplifier providing an output of up to 125W RMS, into a 4 ohm load.

AL30A

10w
R.M.S.

AUDIO
AMPLIFIER
MODULES



£3·75 + 35p p&p
+ 12½% VAT

MAXIMUM SUPPLY VOLTAGE	30 V
POWER OUTPUT for 2% THD	10 Watts RMS
TOTAL HARMONIC DISTORTION	Less than ·25%
LOAD IMPEDANCE	8–16 ohms
INPUT IMPEDANCE	100 K ohms
FREQUENCY RESPONSE	50 Hz–25 kHz ± 3 dBs
SENSITIVITY	75 mV for full output
DIMENSIONS	74mm × 63mm × 28mm

These low cost 5 and 10 watt modules offer the utmost in reliability and performance, whilst being compact in size.

SPM80

STABILISED
POWER SUPPLY

£4·25 + 35p p&p
+ 12½% VAT

INPUT A.C. VOLTAGE	33–40V
OUTPUT D.C. VOLTAGE	33 V nominal
OUTPUT CURRENT	10 mA–1·5 amps
OVERLOAD CURRENT	1·7 amps approx.
DIMENSIONS	105mm × 63mm × 30mm

Designed to power two AL60s at 15 Watts per channel simultaneously. Circuit Techniques include full short circuit protection.

PA100

STEREO
PRE-AMPLIFIER

£15·80
+ 40p p&p
+12½% VAT

FREQUENCY RESPONSE	20 Hz to 20 kHz × 1 dB	
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·07%)	
SENSITIVITY INPUTS 1. TAPE	100 mV/100 K ohms	For an output 250 mV
2. RADIO TUNER	100 mV/100 K ohms	
3. MAGNETIC P.U.	3·5 mV/50 K ohms	
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz	
BASS CONTROL RANGE	± 15 dBs at 75 Hz	
TREBLE CONTROL RANGE	+ 10–20 dBs at 15 kHz	
SIGNAL/NOISE RATIO	Better than 65 dBs (All inputs)	
INPUT OVERLOAD	Better than 26 dBs (All inputs)	
SUPPLY	20 to 40 V	
DIMENSIONS	300 · 90 · 33mm (less controls)	

A top quality stereo pre-amplifier and tone control unit, the PA100 provides a comprehensive solution to the front end requirements of stereo amplifiers or audio units. The six push button selector switch gives a choice of inputs together with two filters for high and low frequencies.

MPA30

MAGNETIC CARTRIDGE
PRE-AMPLIFIER

£2·95
+ 35p p&p
+ 12½% VAT

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the MPA 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.

SENSITIVITY	3·5 mV for 100 mV output
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
INPUT IMPEDANCE	50 K ohms
SUPPLY	18 to 30 V—re earth
DIMENSIONS	110 × 50 × 25mm (inc DIN socket)

PA12

STEREO
PRE-AMPLIFIER

£7·10
+ 30p p&p
+ 12½% VAT

The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL 20/30 Audio Amplifier Modules, the PS12 power supply and the T538 Transformer. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.

FREQUENCY RESPONSE	20 Hz–20 kHz (—3dB)
BASS CONTROL	± 12 dB at 60 Hz
TREBLE CONTROL	± 14 dB at 10 kHz
INPUT IMPEDANCE	1 Meg. ohm
INPUT SENSITIVITY	300 mV
CROSSTALK	—60 dB
SIGNAL/NOISE RATIO	—65 dB
OVERLOAD FACTOR	± 20 dB
TAPE OUTPUT IMPEDANCE	25 K ohms
DIMENSIONS	152mm × 84mm × 25mm

PS12 POWER SUPPLY

Designed for use with the AL30A S.450 and MPA30 in conjunction with transformer T538.

INPUT VOLTAGE	17–20v AC
OUTPUT VOLTAGE	27–30v DC
OUTPUT CURRENT	800mA
SIZE	60mm × 43mm × 26mm

£1·30
+ 35p p&p
+ 12½% VAT

GE 100 NINE CHANNEL MONO-GRAPHIC EQUALIZER

The GE100 has nine 1 octave adjustments using integrated circuit active filters. Boost and Cut limits are ± 12dB. Max. Voltage handling 2 V RMS, T.H.D., 0·05%, input impedence 100K. Output impedence less than 10 K. Frequency response 20 Hz -20 KHz (3dB). The nine gain controls are centred at 50, 100, 200, 400, 800, 1,600, 3,200, 6,400 and 12,800 Hz. The suggested gain controls are 10 K LIN sliders (not supplied with the module) See Paks S31 and 16192.

£22·00
+ 35p p&p
+ 12½% VAT

SG30 POWER SUPPLY BOARD for GE100 15-0-15 VOLT £5·50 + 12½% VAT + 35p p&p

SIREN ALARM MODULE

American Police screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer breakdown and other security purposes. Order No. S15. No. BP124.
Only £3·50 + 8% VAT + 25p p&p

MA60 HI-FI AMPLIFIER KIT

Build you own top quality amplifier, save yourself pounds. The MA60 kit comprises the following BI-kits modules, 2 × AL60 amps, 1 × PA100 pre-amp, 1 × SPM80 stab. power supply, 1 × BMT80 transf. giving 17 watts RMS per channel STEREO. All modules covered by the BI-PAK satisfaction or money back guarantee. Details of the above modules are in this ad.
Price £32·00 + 12½% VAT + 62p p&p.

TC60 KIT

A beautifully designed genuine TEAK WOOD veneered cabinet to put the professional touches to your home built amplifier. Full set of parts incl. Front & Back Panels, Knobs, Chassis, Fuses, Sockets, Noen, etc. Ideal for the MA60. Size: 425mm × 290mm × 95mm.
Price £19·95 + 12½% VAT + 86p p&p

TRANSFORMERS

T538 For use with S.450 AL30A MPA30
Order No. 2036 Price: £3·20 + 55p p&p + 12½% VAT
T2050 For use with Stereo 30
Order No. 2050 Price: £3·25 + 55p p&p + 12½% VAT
BMT80 For use with AL60 SPM80
Order No. 2034 Price: £5·40 + 86p p&p + 12½% VAT
BMT250 For use with AL250
Order No. 2035 Price: £6·35 + £1·10 p&p + 12½% VAT

BI-PAK

DEPT. E.T.I. 11, P.O. Box 6, Ware, Herts.

SEMICONDUCTORS - COMPONENTS

CERAMIC PAK

Containing a range of first quality miniature ceramic capacitors.

16160 — 24 — 3 of each value 22pf, 27pf, 33pf, 39pf, 47pf, 68pf, 82pf **60p***
16161 — 24 — 3 of each value 100pf, 120pf, 150pf, 180pf, 220pf, 270pf, 330pf, 390pf **60p***
16162 — 24 — 3 of each value — 470pf, 560pf, 680pf, 820pf, 1000pf, 15000pf, 2200pf, 2200pf, 3300pf **60p***
16163 — 21 — 3 of each value 4700pf, 6800pf, —01uf, —015uf, —022uf, —033uf, —047uf **60p***

ELECTROLYTIC PAKS

A range of paks each containing 18 first quality, mixed value miniature electrolytics.

16201 — values from —47mFD — 10mFD **60p***
16202 — values from 10mFD — 100mFD **60p***
16203 values from 100mFD — 680mFD **60p***

CARBON RESISTOR PAKS

These paks contain a range of Carbon Resistors assorted into the following groups.

16213 — 60 mixed ⅛w 100 ohms — 820 ohms **60p***
16214 — 60 mixed ⅛w 1K ohms — 8.2K ohms **60p***
16215 — 60 mixed ⅛w 10K ohms — 83K ohms **60p***
16216 — 60 mixed ⅛w 100K ohms — 820K ohms **60p***
16217 — 40 mixed ½w 100 ohms — 820 ohms **60p***
16218 — 40 mixed ½w 1K ohms — 8.2K ohms **60p***
16219 — 40 mixed ½w 10K ohms — 82K ohms **60p***
16220 — 40 mixed ½w 100K ohms — 820K ohms **60p***
16230 — 60 mixed ⅛w 1 Meg. — 10 Meg ohms **60p***
16231 — 40 mixed ½w 1 Meg — 10 Meg ohms **60p***
16231 — 40 mixed ½w 1 Meg — 10 Meg ohms **60p***

COMPONENT PAKS

16164 — 200 Resistor mixed value approx (Count by weight) **60p***
16165 — 150 Capacitors mixed value approx (Count by weight) **60p***
16166 — 50 Precision resistors Mixed values **60p**
16167 — ⅛w resistors mixed values 80 **60p***
16168 — 5 pieces assorted ferrite rods **60p***
16169 — 2 Tuning gangs MW/LW VHF **60p***
16170 — 1 Pack wire 50 meters, assorted colours, single strand **60p**
16171 — 10 Reed switches **60p***
161 — 3 Micro switches **60p***
16173 — 15 Assorted pots **60p***
16174 — 5 Metal jack sockets 3 x 3 5 mm 2 x standard switch types **60p***
16175 — 30 Paper condensers — mixed values **60p***
16176 — 20 Electrolytics, trans. types **60p***
16177 — 1 Pack assorted hardware — Nuts/bolts, gromets, etc **60p**
16178 — 5 Mains slide siwtches, assorted **60p***
16179 — 20 Assorted tag strips and panels **60p**
16180 — 15 Assorted control knobs **60p***
16181 — 3 Rotary wave change switches **60p***
16182 — 2 Relays 6-24v operating **60p***
16183 — 1 Pak copper laminate approx. 200 sq inches **60p**
16184 — 15 Assorted fuses 100mA-5 amp **60p**
16185 — 50 metres PVC sleeving assorted size and colours **60p**

METAL FOIL CAPACITOR PAK

Containing 50 metal foil Capacitor — like Mullard C280 series. Mixed values ranging from —01uf-2 2uf. Complete with identification sheet. O/N 16204 **£1.20***

SLIDER PAKS

16190 — 6 Slider potentiometers mixed values **60p***
16191 — 6 Slider potentiometers, all 470 ohm **60p***
16192 — 6 Slider potentiometers, all 10k 1in **60p***
16193 — 6 Slider potentiometers, all 22K 1 in **60p***
16194 — 6 Slider potentiometers, all 47K 1 in **60p***
16195 — 6 Slider potentiometers, all 47K log **60p***

TRANSISTORS

BRAND NEW — FULLY GUARANTEED

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC126	£0.18	BC108C	£0.10	BC479	£0.20	BFX87	£0.22	TIP41B	£0.51	2N3646	*£0.09
AC127	£0.18	BC109A	£0.08	BC547	*£0.12	BFX88	£0.22	TIP41C	£0.53	2N3702	*£0.08
AC128	£0.18	BC109B	£0.09	BC548	*£0.12	BFX90	*£0.55	TIP42A	£0.53	2N3703	*£0.08
AC128K	£0.26	BC109C	£0.10	BC549	*10.12	BFY50	£0.16	TIP42B	£0.55	2N3704	*£0.07
AC132	£0.20	BC147	*£0.08	BC550	*£0.14	BFY51	£0.16	TIP42C	£0.57	2N3705	*£0.07
AC134	£0.20	BC148	*£0.08	BC556	*£0.14	BFY52	£0.16	TIP2955	£0.65	2N3706	*£0.08
AC137	£0.20	BC149	*£0.08	BC557	*£0.13	BIP19	£0.38	TIP3055	£0.50	2N3707	*£0.08
AC141	£0.22	BC157	*£0.10	BC558	*£0.12	BIP20	£0.38	TIS43	£0.24	2N3708	*£0.07
AC141K	£0.30	BC158	*£0.10	BC559	*£0.14	BIP19/20MP		TIS90	*£0.22	2N3708A	*£0.07
AC142	£0.20	BC159	*£0.10	BD115	£0.50		£0.80	UT46	*£0.22	2N3709	*£0.07
AC176	£0.18	BC167	*£0.12	BD116	£0.80	BRY39	£0.45	ZTX107	*£0.10	2N3710	*£0.07
AC176K	£0.26	BC168	*£0.12	BD121	£0.65	BU105	£1.40	ZTX108	£0.10	2N3711	*£0.07
AC178	£0.25	BC169	*£0.12	BD124	£0.70	BU105/02	£1.95	ZTX109	*£0.10	2N3819	£0.20
AC179	£0.25	BC169C	*£0.12	BD131	£0.38	BU204	£1.70	ZTX300	*£0.12	2N3820	£0.35
AC180	£0.20	BC170	*£0.10	BD132	£0.40	BU205	£1.40	ZTX500	*£0.14	2N3821	£0.60
AC180K	£0.28	BC171	*£0.10	BD131/132MP		BU208/02	£2.95	2N1613	£0.20	2N3823	£0.60
AC181	£0.20	BC172	*£0.10		£0.85	EI222	£0.38	2N1711	£0.20	2N4058	*£0.12
AC181K	£0.28	BC173	*£0.12	BD133	£0.40	MJE2955	£0.98	2N1889	£0.45	2N4059	*£0.14
AC187	£0.18	BC177	£0.16	BD135	£0.38	MJE3055	£0.60	2N1890	£0.45	2N4060	*£0.14
AC187K	£0.20	BC178	£0.16	BD136	£0.35	MJE3440	£0.52	2N1893	£0.30	2N4061	*£0.12
AC188	£0.18	BC179	£0.16	BD137	£0.35	MP8113	£0.52	2N2147	£0.75	2N4062	*£0.12
AC188K	£0.20	BC180	£0.25	BD138	£0.40	MPF102	£0.35	2N2148	£0.70	2N4284	*£0.18
AD140	£0.60	BC181	*£0.25	BD139	£0.36	MPF104	£0.38	2N2160	£1.00	2N4285	*£0.18
AD142	£0.85	BC182L	*£0.10	BD140	£0.36	MPF105	£0.38	2N2192	£0.38	2N4286	*£0.18
AD143	£0.75	BC183	*£0.10	BD139/140Mp		MPSA05	*£0.30	2N2193	£0.38	2N4287	*£0.18
AD149	£0.60	BC183L	*£0.10		£0.80	MPSA06	*£0.30	2N2194	£0.38	2N4288	*£0.18
AD161	£0.42	BC184L	£0.60	BD155	£0.80	MPSA55	*£0.28	2N2217	£0.22	2N4289	*£0.18
AD162	£0.42	BC207	£0.11	BD175	£0.60	MPSA56	*£0.28	2N2218	£0.22	2N4290	*£0.18
AD161/161MP		BC208	*£0.11	BD176	£0.60	OC22	£1.50	2N2218A	£0.20	2N4291	*£0.18
	£0.35	BC209	*£0.12	BD177	£0.68	OC23	£1.50	2N2219	£0.20	2N4292	*£0.18
AF114	£0.21	BC212	*£0.11	BD178	£0.68	OC24	£1.35	2N2219A	£0.24	2N4293	*£0.18
AF115	£0.21	BC212L	*£0.11	BD179	£0.75	OC25	£1.00	2N2904	£0.18	2N4921	*£0.55
AF116	£0.21	BC213	*£0.11	BD201/202MP		OC26	£1.00	2N2904A	£0.21	2N4923	*£0.65
AF117	£0.21	BC213L	*£0.11		£1.70	OC28	£0.80	2N2905	£0.18	2N5135	*£0.10
AF118	£0.40	BC214	*£0.12	BD203	£0.80	OC29	£0.95	2N2905A	£0.20	2N5136	*£0.10
AF124	£0.30	BC214L	*£0.12	BD204	£0.80	OC35	£0.90	2N2906	£0.16	2N5138	*£0.10
AF125	£0.30	BC237	*£0.16	BD203/204MP		OC36	£0.90	2N2906A	£0.19	2N5194	£0.56
AF126	£0.30	BC238	*£0.16		£1.70	OC70	£0.24	2N2907	£0.20	2N5245	£0.40
AF127	£0.32	BC251	*£0.15	BDY20	£0.80	OC71	£0.15	2N2907A	£0.22	2N5294	£0.34
AF139	£0.35	BC251A	*£0.16	BDX77	£0.90	TIC44	*£0.29	2N296G	*£0.09	2N5296	£0.56
AF180	£0.40	BC301	£0.28	BF457	£0.37	TIC45	*£0.35	2N2926Y	*£0.08	2N5457	£0.32
AF181	£0.60	BC302	£0.28	BF458	£0.37	TIP29A	£0.40	2N29260	*£0.08	2N5458	£0.32
AF186	£0.58	BC303	£0.28	BF459	£0.38	TIP29B	£0.52	2N2926R	*£0.08	2N5459	£0.35
AF239	£0.35	BC304	£0.38	BF594	*£0.30	TIP29C	£0.50	2N2926B	*£0.08	2N5551	*£0.36
AL102	£1.20	BC327	*£0.16	BF596	*£0.28	TIP30A	£0.50	2N3053	£0.16	2N6027	£0.39
AL103	£1.20	BC328	*£0.15	BFR39	£0.24	TIP30B	£0.60	2N3054	£0.40	2N6121	£0.70
AU104	£1.18	BC337	*£0.15	BFR40	*£0.25	TIP30C	£0.60	2N3055	£0.40	2N6122	£0.70
AU110	£1.00	BC338	*£0.15	BFR79	*£0.28	TIP31A	£0.45	2N3414	*£0.16		
AU113	£1.00	BC440	£0.30	BFR80	*£0.28	TIP31B	£0.47	2N3415	*£0.16		
BC107A	£0.08	BC441	£0.30	BFX29	£0.22	TIP31C	£0.49	2N3416	*£0.29		
BC107B	£0.09	BC460	£0.38	BFX30	£0.30	TIP32A	£0.49	2N3417	*£0.29		
BC107C	£0.10	BC461	£0.38	BFX84	£0.22	TIP32B	£0.51	2N3614	£1.00		
BC108A	£0.08	BC477	£0.20	BFX85	£0.24	TIP32C	£0.53	2N3615	£1.05		
BC108B	£0.09	BC478	£0.20	BFX86	£0.25	TIP41A	£0.49	2N3616	£1.05		

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7401	£0.11	7410	£0.12	7442	£0.54	7483	£0.70	7494	£0.75	74123	£0.46
7402	£0.11	7411	£0.17	7446	£0.65	7484	£0.88	7495	£0.50	74141	£0.55
7403	£0.11	7412	£0.20	7447	£0.60	7485	£0.88	7496	£0.62	74154	£0.95
7404	£0.11	7413	£0.24	7448	£0.56	7486	£0.25	74100	£0.92	74180	£0.84
7405	£0.11	7414	£0.50	7475	£0.29	7489	£1.05	74110	£0.45	74181	£1.60
7406	£0.26	7416	£0.16	7480	£0.44	7490	£0.32	74118	£0.80	74190	£1.00
7407	£0.26	7417	£0.26	7481	£0.85	7491	£0.64	74119	£1.18	74198	£1.45
7408	£0.13	7440	£0.12			7492	£0.37	74121	£0.24	74199	£1.45

CMOS ICs

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
CD4000	0.15	CD4012	0.20	CD4022	0.90	CD4031	2.20	CD4046	1.30	CD4071	0.23
CD4001	0.18	CD4013	0.52	CD4023	0.20	CD4035	1.30	CD4047	1.10	CD4072	0.23
CD4002	0.18	CD4015	0.98	CD4024	0.80	CD4037	0.95	CD4049	0.55	CD4081	0.20
CD4006	0.98	CD4016	0.50	CD4025	0.20	CD4040	0.95	CD4050	0.55	CD4082	0.23
CD4007	0.18	CD4017	0.98	CD4026	1.70	CD4041	0.82	CD4054	1.10	CD4510	1.30
CD4008	0.98	CD4018	1.00	CD4027	0.60	CD4042	0.82	CD4055	1.40	CD4511	1.60
CD4009	0.58	CD4019	0.55	CD4028	0.98	CD4043	0.98	CD4056	1.35	CD4516	1.40
CD4010	0.58	CD402D	1.10	CD4029	1.15	CD4044	0.94	CD4069	0.40	CD4518	1.25
CD4011	0.20	CD4021	0.98	CD4030	0.55	CD4045	1.40	CD4070	0.40	CD4520	1.25

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CA3014*	£1.70	CA3123*	£1.90	NE550D*	NLA	LM320-24v	£1.50	μA711C*	£0.32	SN76115*	£1.90
CA2018*	£0.75	LM301*	£0.39	NE555	£0.32	LM380-14P	£0.85	72711*	£0.32	SN76660*	£0.75
CA3020*	£1.70	LM304	£2.00	NE556	£0.82	LM381*	£1.55	μA723C	£0.45	SL414A*	£1.95
CA3028*	£1.02	LM308*	£1.60	NE561*	£3.95	LM3900N*	£0.65	72723	£0.45	TAA550B	£0.35
CA3035*	£1.70	LM309K	£1.50	NE562B*	£3.95	MC724P	£1.50	μA741C*	£0.24	TAA621A*	£2.00
CA3036*	£1.35	LM320-5v	£1.50	NE565A*	£1.75	MC1303L*	£1.48	72741*	£0.24	TAA661A*	£1.65
CA3042*	£1.50	LM320-12v	£1.50	NE566*	£1.50	MC1304P*	£1.90	741P*	£0.20	TAD100*	£1.30
CA3043*	£1.85	MC1456G*	£1.40	NE567*	£1.80	MC1310P*	£0.95	μA747C*	£0.70	TBA5400*	£2.20
CA3046*	£0.80	MC1466L	£4.50	9A702C*	£0.46	MC1312PQ*	£1.90	72747*	£0.79	TBA641B*	£2.25
CA3052*	£1.60	MC14569R	£2.95	72702*	£0.46	MC1330P*	£1.20	μA748*	£0.35	TBA800*	£0.80
CA3054*	£1.35	MC1496G*	£0.98	μA703A*	£0.25	MC1350*	£1.20	72748*	£0.35	TBA810S*	£1.05
CA3075*	£1.50	NE536*	£3.50	μA709C*	£0.25	MC1351P*	£1.20	748P*	£0.35	TBA820*	£0.80
CA3081*	£1.50	NE515A*	£3.50	72709*	£0.46	MC1352P*	£1.40	SN76013N*	£1.75	TBA920Q*	£3.40
CA3089*	£2.10	NE540*	£1.50	709P*	£0.25	μA710C*	£0.40	SN76023N*	£1.75	TCA2705*	£2.20

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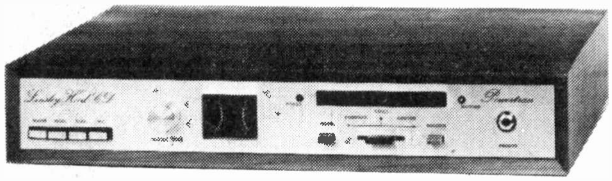
This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hi-Fi News and Record Review and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring whilst distortion is less than 0.01%.

WIRELESS WORLD FM TUNER £70.20 + VAT

A pre-aligned front-end module makes this Wireless World published design very simple to construct and adjust without special instruments. Features include an excellent a.m. rejection, push-button station selection as well as infinitely variable tuning and a phase locked loop stereo decoder incorporating active filters for "birdy" suppression.

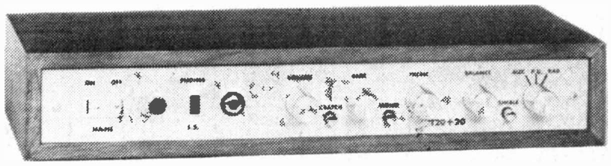


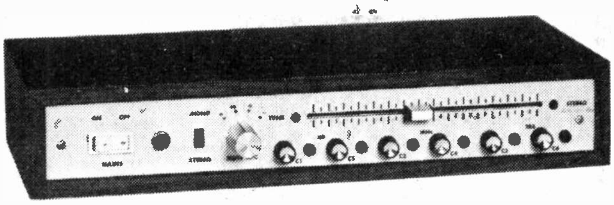
LINSLEY-HOOD CASSETTE DECK £79.60 + VAT

This design, published in Wireless World, although straightforward and relatively low cost provides a very high standard of performance. There are separate record and replay amplifiers and switchable equalisation together with a choice of bias levels are also provided. The mechanism is the Goldring-Lenco CRV with electronic speed control.

T20 + 20 AMPLIFIER £33.10 + VAT

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



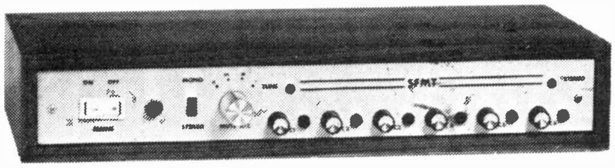


WWII TUNER £47.70 + VAT

This cost reduced model of our highly successful Wireless World FM Tuner kit was designed to complement the T20 + 20 and T30 + 30 amplifiers and the cabinet size, front panel format and electrical characteristics make this tuner compatible with either. Facilities included are pre-aligned front-end module, switchable afc, adjustable switchable muting, LED tuning indication and both continuous and push-button channel selection (adjustable by controls on the front panel).

POWERTRAN SFMT TUNER £35.90 + VAT

This is a simple low cost design which can be constructed easily without special alignment equipment but which still gives a first class output suitable for feeding any of our very popular amplifiers or any other high quality audio equipment. A phase-locked-loop is used for stereo decoding and controls include switchable afc, switchable muting and push-button channel selection (adjustable by controls on the front panel). This unit matches well with the T20 + 20 and T30 + 30 amplifiers.



COMPLETE KITS: Our complete kits really are complete. All of the projects shown on this page are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet, cables, nuts, bolts, etc., and full instructions — in fact everything!

All of the kits shown on this page are available as separate packs (except the Powertran SFMT Tuner) for those customers who wish to spread their purchase or perhaps make their own cabinets or metalwork. Prices are given in our FREE CATALOGUE.

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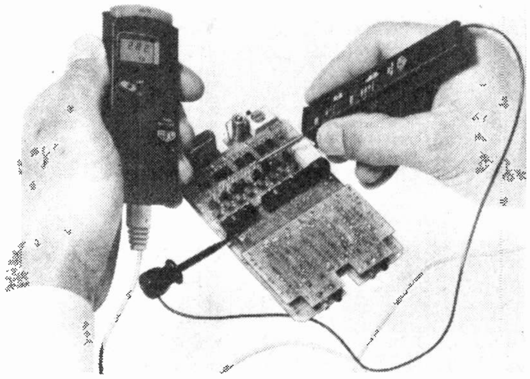
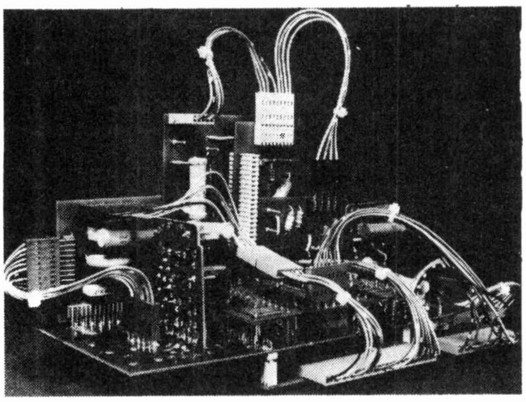
news digest

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.

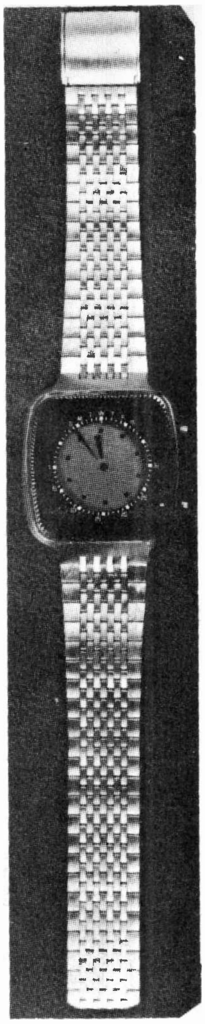
eye of the tornado?

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.

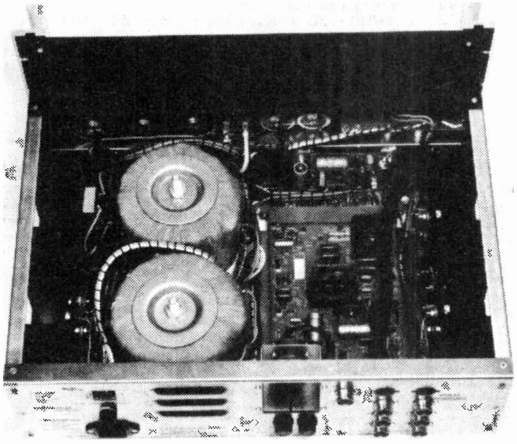
The chip is I^{2}L — and this is unusual. I^{2}L is not normally employed in LCD units because of the problem of driving the highly capacitive elements. Bipolar drivers are used to avoid this, and are designed to drive the large capacitance with a (relatively) large 150μA initial current for about 100 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^{2}L 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.

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 key-board 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. . . .

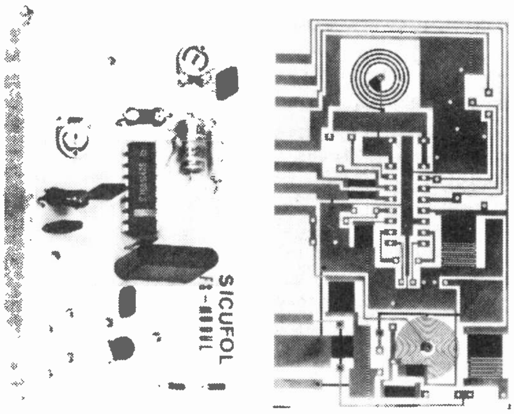
● Supervisor is a remote controlled helicopter for use on the modern battlefield. It has been developed by Marconi and Westland. The machine stands about as high as a man and contains cameras and other surveillance equipment. It has just passed its first flight tests successfully and could be of great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

foiled again

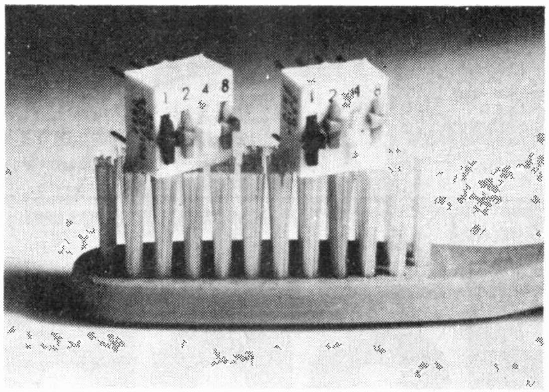


These structures made of chrome-nickel and copper represent an integrated passive circuit with capacitors, coils and resistors, the carrier being a plastic foil. The rectangular, spiral and meandrous shapes largely determine the capacitances, inductances and resistances. Using the name "Sicufol" (Siemens 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.

On October 13th a brand new magazine is launched in the electronics field. It is written and produced by ETI staff and aimed at the newcomer to electronics — not necessarily young people.

We did think of doing an ad which would tell you about the contents in minute detail but instead we have decided to appeal to your curiosity. We don't ask you to buy it; it may be of no interest to you but we hope that some ETI readers at least will pick up a copy and thumb through it. Please put it back neatly if you don't want to buy: the next person may be more interested.

Hobby Electronics

No. 1 will carry a cover date of November and will be available at newsagents on October 13th. 40p.

QUALITY COMPONENTS BY RETURN

Linear Circuits by RCA, National etc.

709 DIL14	25p	LM382N	105p
741 DIL8	22p	LM1303	110p
741 DIL14	35p	LM3900	50p
747C DIL14	50p	LM3909	60p
748C DIL8	30p	MC1310P	150p
CA3011	80p	MC1312P	160p
CA3014	130p	MC1314P	300p
CA3018	80p	MC1315P	520p
CA3020	160p	MC1330	100p
CA3028	125p	MC1458N	35p
CA3035	140p	MC1496N	60p
CA3036	170p	NE555	25p
CA3042	170p	NE556	60p
CA3043	180p	NE560	300p
CA3046	55p	NE561B	350p
CA3052	150p	NE562B	350p
CA3054	115p	NE565A	120p
CA3075	180p	NE566V	150p
CA3080	70p	NE567V	170p
CA3081	125p	SN76003N	200p
CA3089	180p	SN76013N	140p
CA3090	400p	SN76023N	140p
CA3123	150p	SN76033N	200p
CA3130	90p	TAA621A	215p
CA3140E	70p	TBA120S	65p
LM300H	130p	TBA540	200p
LM301AN	28p	TBA641	240p
LM304H	70p	TBA800	70p
LM308N	65p	TBA920	320p
LM318N	125p	TCA270SQ	200p
LM324N	50p	TDA1002	450p
LM339	50p	TDA1022	570p
LM380N	75p	TDA2020	320p
LM381N	105p	ZN414	75p

CMOS from RCA, National etc.

4000	15p	4040	68p
4001	15p	4042	54p
4002	15p	4043	55p
4007	15p	4046	100p
4008	65p	4049	28p
4009	35p	4050	28p
4010	35p	4051	55p
4011	15p	4052	55p
4012	15p	4066	40p
4013	35p	4068	20p
4015	60p	4069	16p
4016	35p	4070	16p
4017	55p	4071	16p
4018	65p	4072	16p
4020	60p	4073	16p
4022	55p	4075	16p
4023	15p	4078	16p
4024	45p	4081	16p
4025	15p	4510	70p
4026	95p	4511	70p
4027	35p	4516	65p
4028	52p	4518	65p
4029	60p	4520	65p
4030	35p	4585	70p

TTL from National, Texas, ITT etc.

7400	12p	7495	52p
7401	12p	7496	50p
7402	12p	7497	140p
7403	12p	74100	90p
7404	13p	74104	50p
7405	13p	74105	40p
7406	24p	74107	25p
7407	24p	74109	30p
7408	14p	74110	35p
7409	14p	74111	45p
7410	12p	74116	95p
7411	19p	74118	82p
7412	17p	74119	140p
7413	25p	74121	25p
7414	48p	74123	40p
7416	24p	74125	35p
7417	24p	74126	35p
7420	12p	74132	50p
7421	22p	74141	56p
7422	18p	74142	200p
7423	22p	74145	58p
7425	22p	74147	110p
7426	24p	74148	90p
7427	24p	74150	70p
7428	28p	74151	50p
7430	12p	74153	50p
7432	23p	74154	85p
7433	32p	74155	52p
7437	22p	74156	52p
7438	22p	74157	53p
7440	13p	74160	60p
7441	52p	74161	65p
7442	43p	74162	65p
7443	75p	74163	65p
7444	75p	74164	70p
7445	70p	74165	70p
7446	55p	74166	80p
7447	55p	74167	180p
7448	58p	74170	125p
7450	14p	74172	400p
7451	14p	74173	95p
7452	13p	74174	68p
7454	14p	74175	65p
7460	14p	74176	58p
7470	28p	74177	58p
7472	24p	74178	80p
7473	25p	74181	145p
7474	25p	74182	60p
7475	32p	74185	110p
7476	28p	74190	72p
7483	60p	74191	72p
7485	70p	74192	64p
7486	24p	74193	64p
7489	145p	74194	60p
7490	32p	74195	55p
7491	45p	74196	55p
7492	35p	74197	55p
7493	34p	74198	110p
7494	80p	74199	110p

1702A	420p	MC6800	950p
2102 (450nS)	90p	MC6810	310p
2107	350p	MC6820	425p
2708	750p	MC6850	550p
AY5-1013	380p	8080A	595p

Transistors

		BC478	18p	TIP33C	118p	N2906A	22p
AC125	18p	BC479	18p	TIP34	98p	2N2907	22p
AC126	18p	BC547	11p	TIP34A	95p	2N2907A	25p
AC127	17p	BC548	10p	TIP34B	128p	2N2926G	10p
AC128	18p	BC549	11p	ZTX107	14p	2N2926R	8p
AC176	18p	BC550	14p	ZTX108	14p	2N3011	22p
AC186	24p	BC558	12p	ZTX109	14p	2N3053	18p
AD161	38p	BC559	13p	ZTX300	16p	2N3054	50p
AD162	38p	BCY70	14p	ZTX301	16p	2N3055	50p
AF124	27p	BCY71	14p	ZTX302	23p	2N3121	25p
AF125	27p	BCY72	14p	ZTX303	23p	2N3133	25p
AF126	27p	BD115	52p	ZTX304	25p	2N3440	80p
AF127	27p	BD131	35p	ZTX310	13p	2N3441	120p
AF139	36p	BD132	35p	ZTX311	14p	2N3442	135p
AF239	40p	BD133	44p	ZTX314	22p	2N3702	8p
BC107	8p	BD135	38p	ZTX341	21p	2N3703	8p
BC107B	10p	BD136	36p	ZTX500	18p		
BC108	8p	BD137	38p	ZTX501	16p	2N3704	8p
BC108B	8p	BD138	38p	ZTX502	20p	2N3705	9p
BC108C	10p	BD139	35p	ZTX503	20p	2N3706	9p
BC109	8p	BD140	35p	ZTX504	25p	2N3707	9p
BC109C	10p	BF244B	38p	ZTX530	30p	2N3708	8p
BC147	7p	BFX29	25p	ZTX550	24p	2N3709	8p
BC148	7p	BFX84	23p	2N696	32p	2N3710	8p
BC149	8p	BFX87	20p	2N697	12p	2N3711	8p
BC157	9p	BFX88	20p	2N698	28p	2N3715	10p
BC158	9p	BFY50	15p	2N699	50p	2N3819	22p
BC159	9p	BFY51	15p	2N706	13p	2N3823	65p
BC167	8p	BFY52	15p	2N706A	13p	2N3824	75p
BC168	8p	BU105	170p	2N708	20p	2N3866	55p
BC169	8p	BU205	140p	2N914	22p	2N3903	8p
BC169C	9p	BU208	160p	2N918	30p	2N3904	8p
BC170	9p	MJ2955	98p	2N919	50p	2N3905	8p
BC171	9p	MPF102	36p	2N920	54p	2N3906	8p
BC172	7p	MPSA06	30p	2N929	25p	2N4037	30p
BC173	9p	MPSA56	30p	2N930	20p	2N4058	12p
BC177	14p	TIP29	40p	2N1131	23p	2N4059	10p
BC178	14p	TIP29A	44p	2N1132	23p	2N4060	12p
BC179	14p	TIP29B	40p	2N1302	38p	2N4061	12p
BC182	10p	TIP29C	60p	2N1303	54p	2N5179	50p
BC182L	10p	TIP30	40p	2N1304	54p	2N5457	32p
BC183	10p	TIP30A	48p	2N1613	22p	2N5458	30p
BC183L	10p	TIP30B	55p	2N1671	130p	2N5459	32p
BC184	10p	TIP30C	70p	2N2160	100p	2N5777	50p
BC184L	10p	TIP31	50p	2N2243	28p	**Diodes**	
BC207	10p	TIP31A	50p	2N2297	45p	0A47	10p
BC208	8p	TIP31B	60p	2N2368	15p	0A91	5p
BC209C	10p	TIP31C	65p	2N2369	16p	0A200	8p
BC212	10p	TIP32	55p	2N2484	22p	1N914	4p
BC212L	10p	TIP32A	60p	2N2846	70p	1N916	5p
BC213	10p	TIP32B	75p	2N2904	22p	1N4001	4p
BC213L	10p	TIP32C	80p	2N2094A	23p	1N4002	4p
BC214	10p	TIP33	75p	2N2905	22p	1N4006	6p
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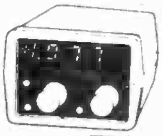

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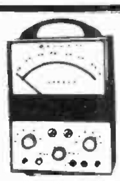

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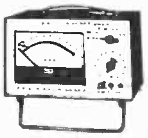

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We are looking for someone to join the editorial team and reckon that an enthusiastic reader is likely to be the type to join us. Not an uncritical reader — we want to continue to improve. The work will entail dealing with articles and news — licking 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.

Experience has told us that people who read ads like this think a) that it doesn't apply to them b) that their own knowledge is far too limited or c) that ads of this type are only put in because we have to fill half a page. None of these is true.

Apply in writing to:
Halvor Moorshead,
Editor,
Electronics Today International,
25-27 Oxford Street,
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Applications should reach us as soon as possible with C.V. Prospective applicants may telephone the Editor for further details but this must be followed by written application.

ETIPRINTS

ETIPRINTS are a fast new aid for producing high quality printed circuit boards. Each ETIPRINTS sheet contains a set of etch resistant rub down transfers of the printed circuit board designs for several of our projects. ETIPRINTS are made from our original artwork ensuring a neat and accurate board. We thought ETIPRINTS were such a good idea that we have patented the system (patent numbers 1445171 and 1445172).

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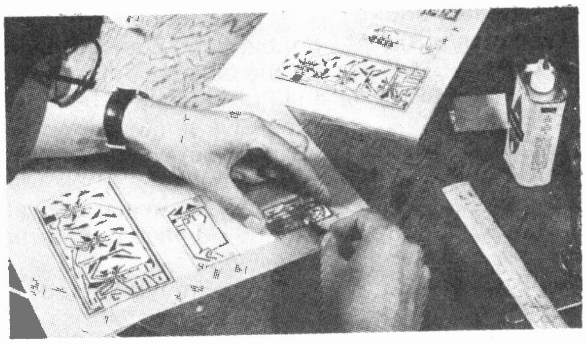

Lay down the ETIPRINT and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!

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	Metronome	Feb 78
	Shutter Time	Feb 78
005	Op-Amp Supply	
	Frequency Shifter	Mar 78
	LCD Panelmeter	
	Light Dimmer (3 times)	
006	CMOS Switched Preamp	
	From Experimenters P.S.U.	"Electronics Tomorrow"
	555 Boards (twice	
007	Star Trek Radio	May 78
	CD Ignition	May 78
	CCD Phaser	May 78
	White Line Follower	April 78
008	Tank Battle	May 78
	Helping Hand	
009	AM/FM Radio	
	Bridge Oscillator	June 78
	CMOS Stars & Dots	
010	Bench Amplifier	
	Freezer Alarm	Project Book Six
	Marker Generator	
	LED Dice	
	Watchdog (2 PCBs)	
	Stars & Dots PSU	
011	Noise Generator	
	General Preamp	Project Book Six
	Flash Trigger	
	Compander	
	Active Crossover (2 PCBs)	
012	Disco Lightshow	Project Book Six
	Stereo Simulator	
	Digital Thermometer	
013	Amplifier Module	Project Book Six
	Amplifier PSU	
	Equaliser	
	Equaliser PSU	
014	Skeet Game	Project Book Six
	Sweep Oscillator	
	Burglar Alarm	
	GSR Monitor	
015	UFO Detector	July 78
	Torch Finder (twice)	July 78
	Etiwet (twice)	Aug 78
016	Stac Timer	
	Xhatch Gen	Sept 78
	Wheel of Fortune	
017	Complex Sound Gen	
	Tele Bell Extender	Oct 78
	Power Bulge	
018	RF Power Meter	Oct 78
	Proximity Switch	Oct 78
	Audio Oscillator (2)	Nov 78

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.

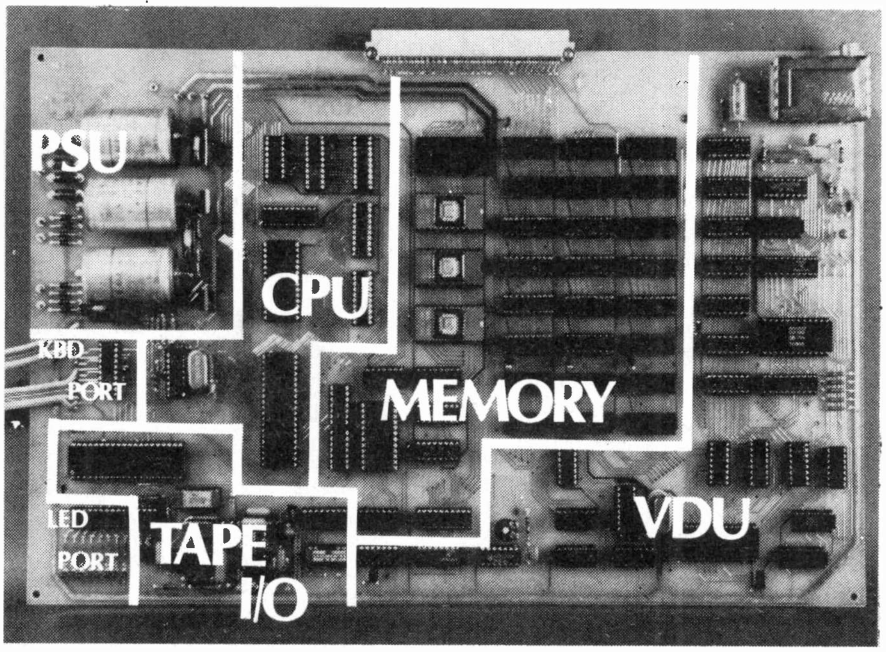
The 2K TINY BASIC that is also resident in the TRITON, allows this popular, easy to learn, language to be used in conjunction with the TRITON's versatile graphic character set and unique VDU function to develop everything from games to education programs quickly and easily.

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.

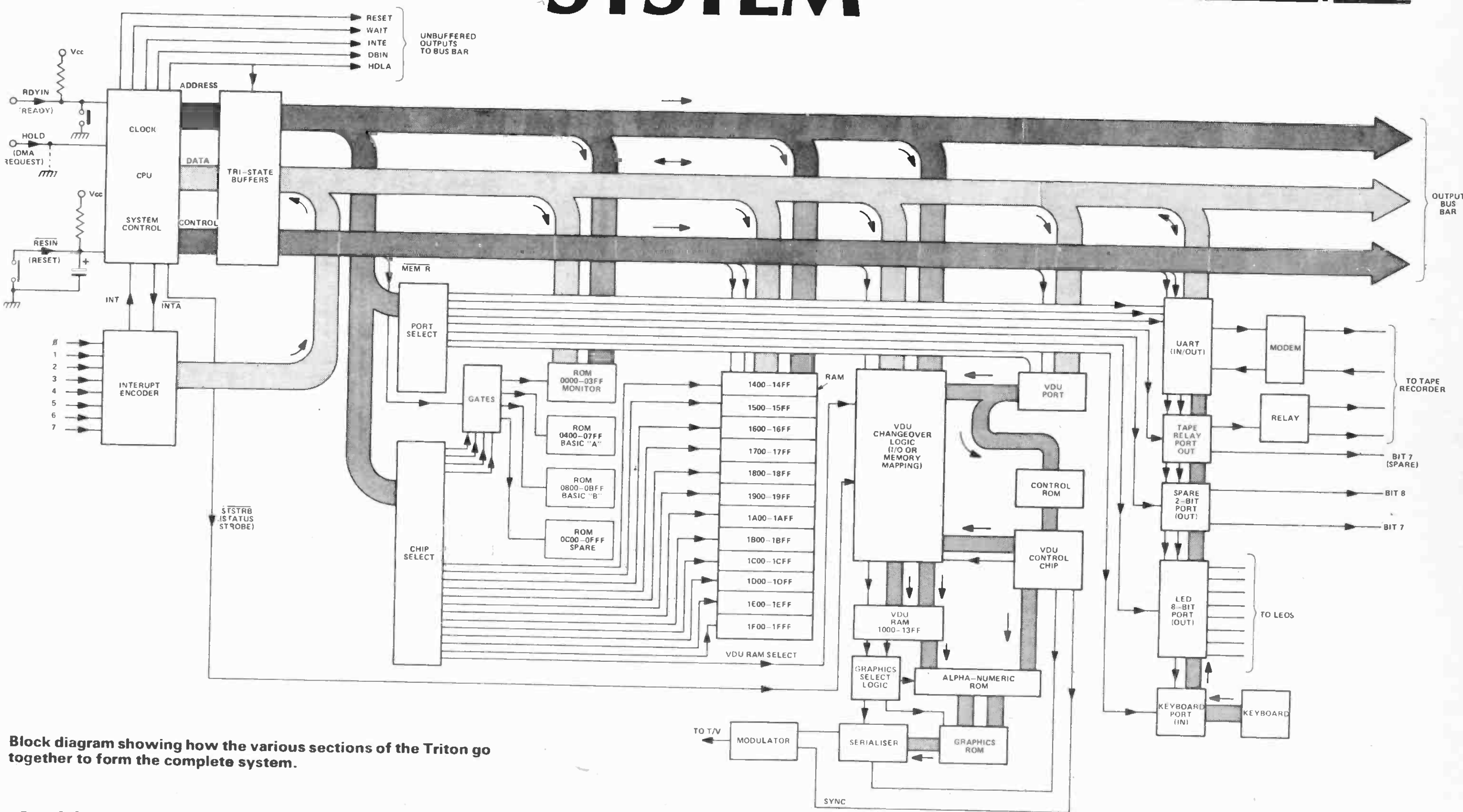
You can now insert, and solder in the three crystals making sure you have them in the correct positions. The crystals have their frequencies stamped on them (usually in kilohertz).

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

SYSTEM



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 $\overline{I/OR}$ 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 $\overline{I/OW}$ 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 $\overline{\text{INTA}}$ (meaning that the computer has just been interrupted by an external "Interrupt Request"), $\overline{\text{MEMR}}$ (reading data from a memory location), $\overline{\text{MEMW}}$ (writing — or storing — data into an internal memory location), $\overline{\text{I70R}}$ (inputting data from an external source — such as a keyboard or a tape system) and $\overline{\text{I/OW}}$ (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 $\overline{\text{STSTRB}}$ (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.

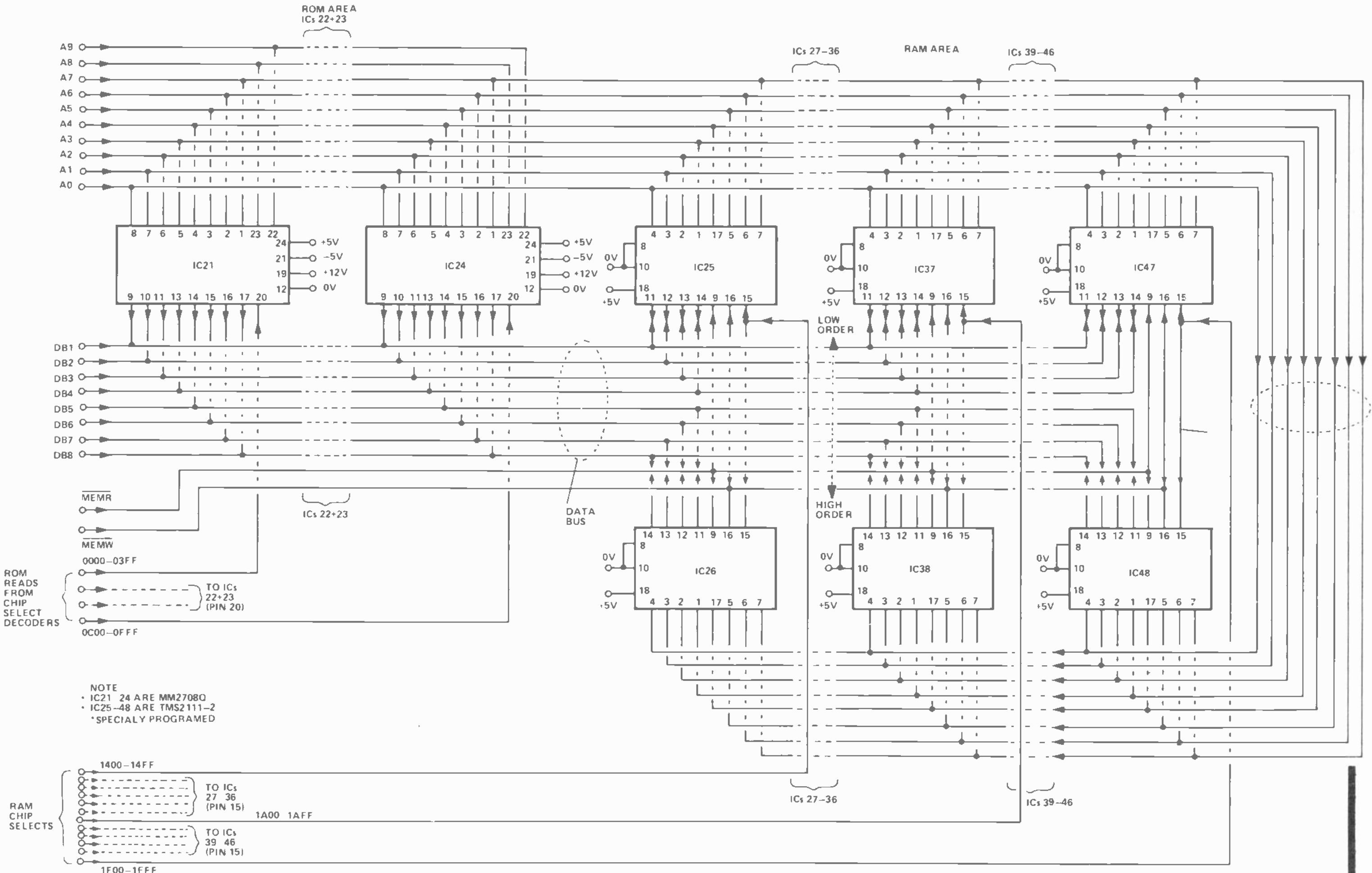
The UART (Universal Asynchronous Receiver/Transmitter) is the device which converts the eight bit wide parallel data on the busbar to a specially formatted serial stream to feed the tape recorder modulator. It also carries out the complementary function of converting a received serial stream into parallel 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.

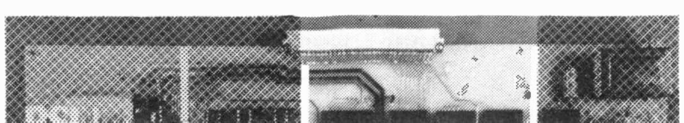
HOW IT WORKS

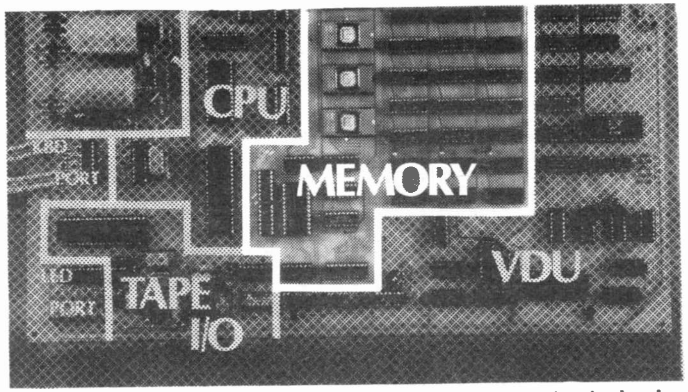
The circuit diagram of this section has been abbreviated as most of the memory circuitry is a repeat of the same theme. You can clearly see the difference between the ROMs and the Read/Write RAMS. There are four of the former – all 2708s but in the standard machine only three are used immediately. The 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.

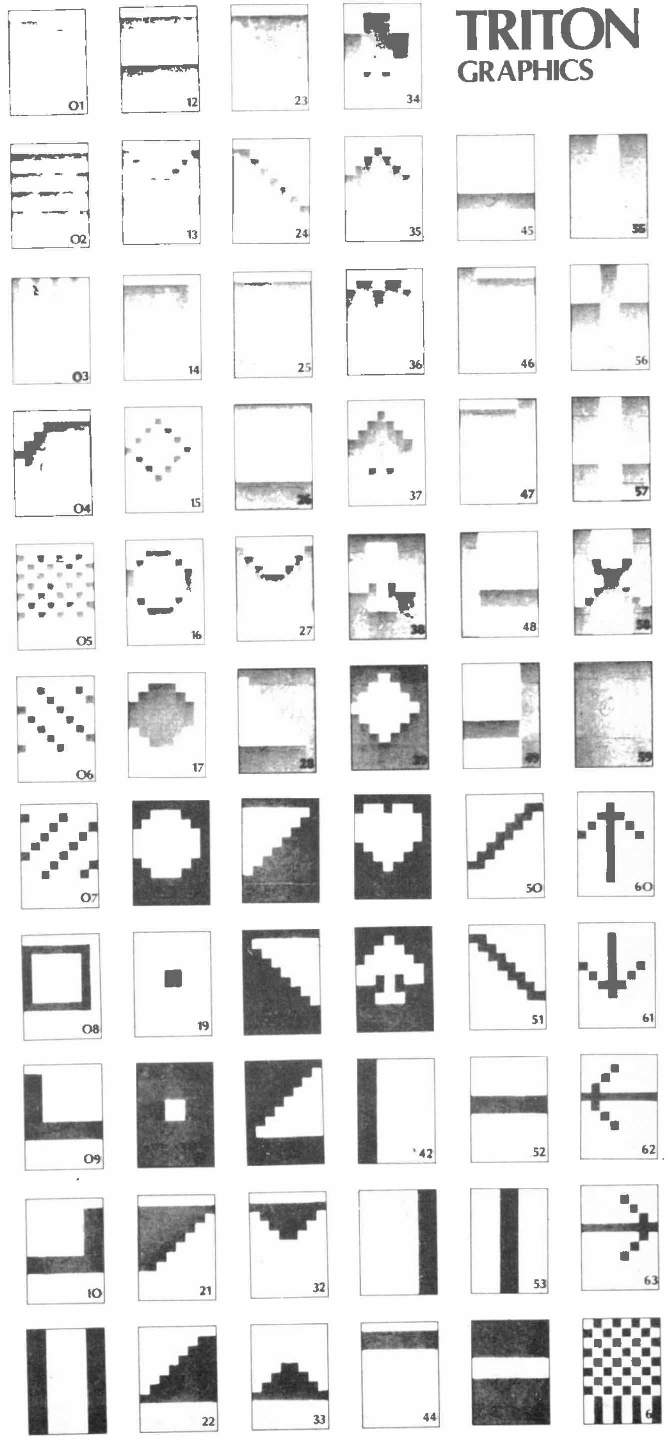
Hopefully this will be the case and you can rest assured that your computer is working! Switch the computer off; wait a few seconds and switch it on again. For a fraction of a second you will see a load of rubbish on the screen which will rapidly clear and the previous message will be repeated.

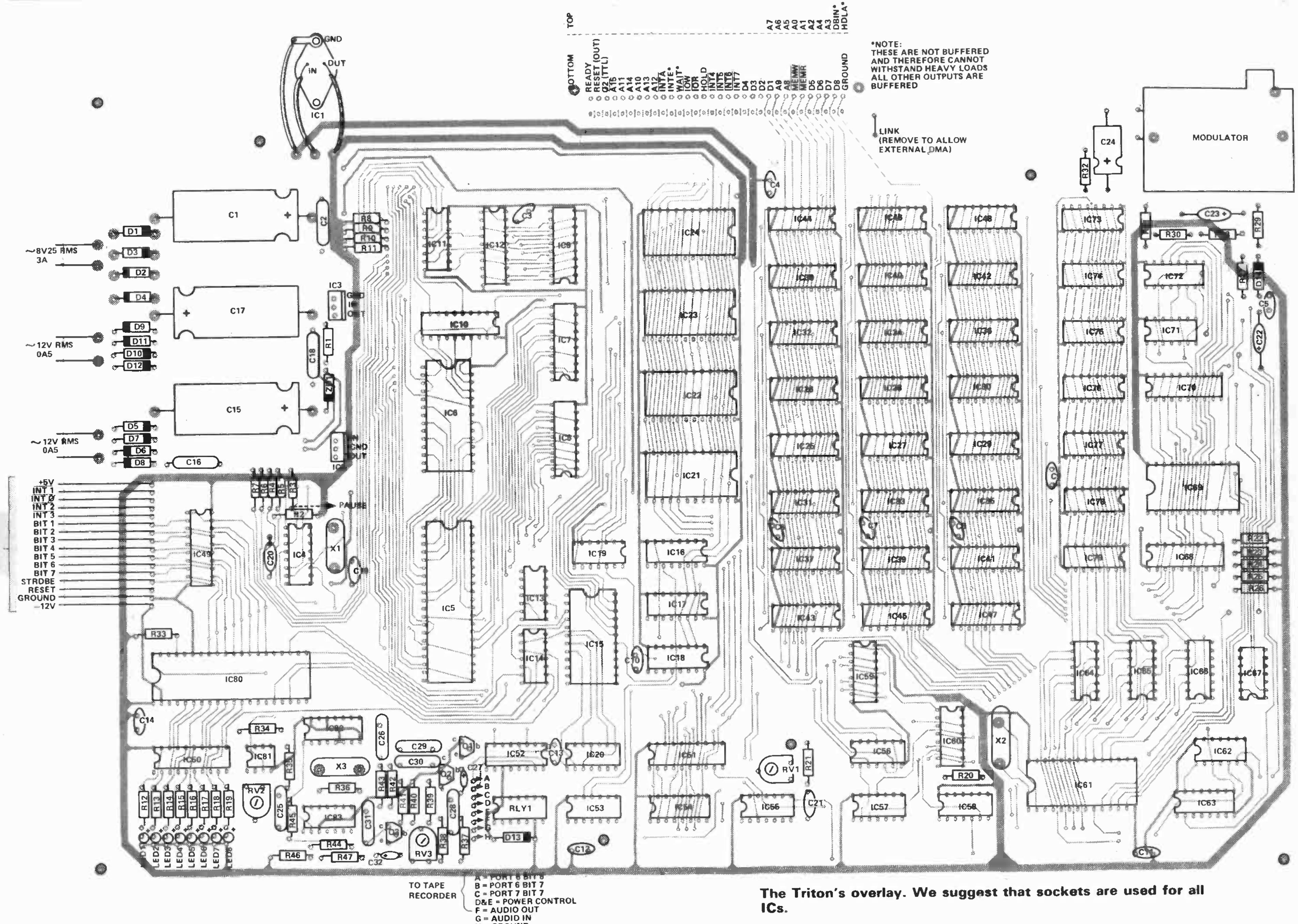
Switch off and make up an umbilical cord of wires to go from the umbilical cord of wires to go from the keyboard socket on the board to the keyboard and associated push switches. Use colour coded wire and ensure that you make no mistake when connecting the relevant leads to the keyboard Cinch connector. 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:

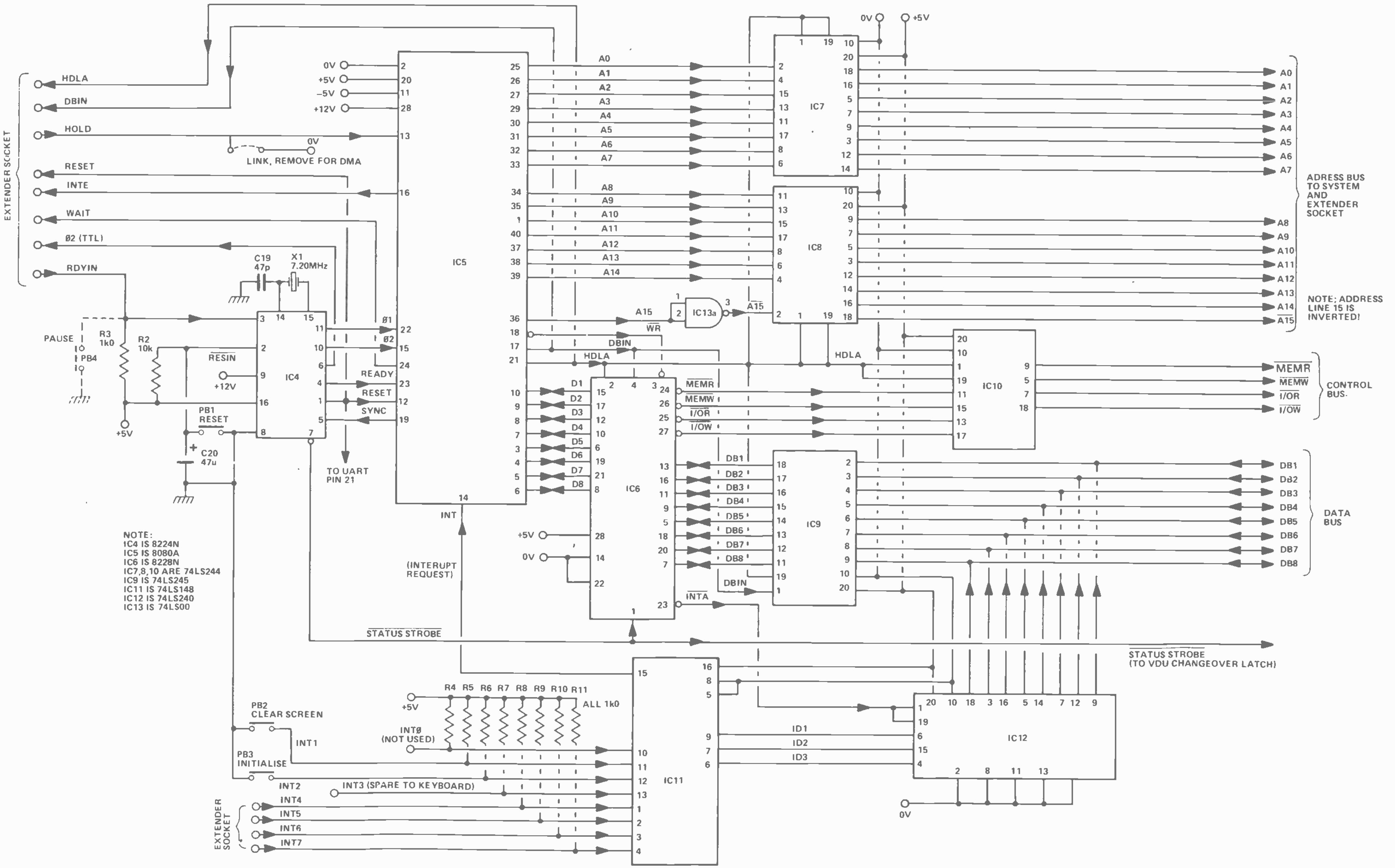
Address location	Data you must enter
1600	CD
1601	27
1602	03
1603	CD
1604	1D
1605	03
1606	CD
1607	13
1608	00
1609	C3
160A	03
160B	16

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 (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 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 (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.

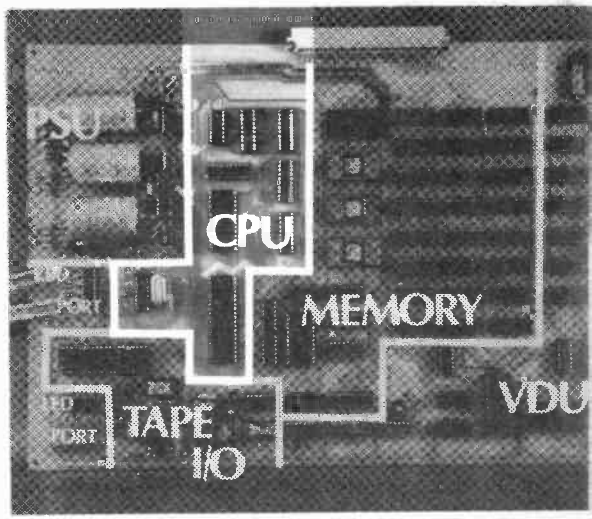
The chances are very high that you will not need RDYIN for external systems so the feature could be built in permanently. Note should be made that it is bad practice to have a push switch hard wired to ground on this line if at any time in the future you derive the RDYIN signal from a gate. Press the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

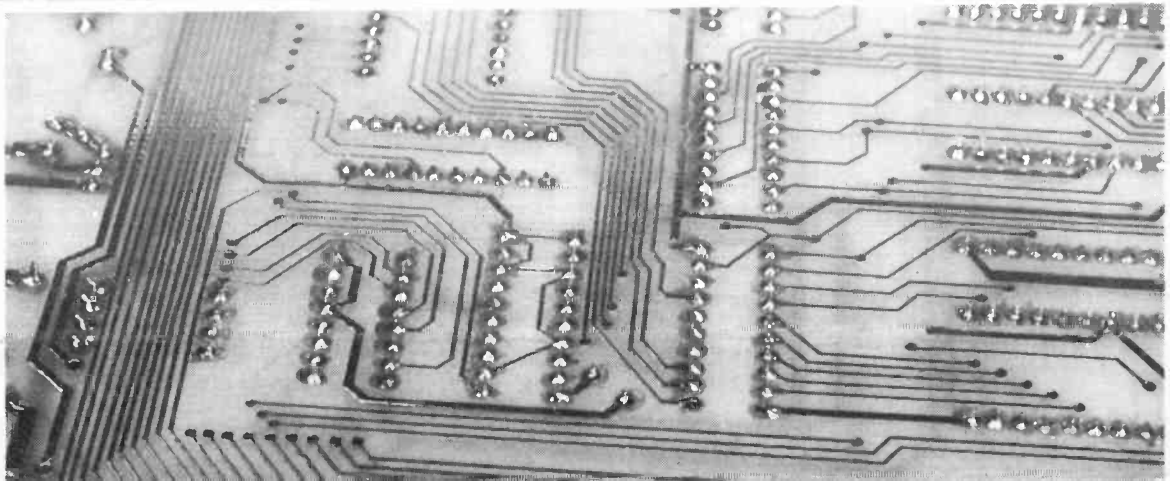
Remember, you must disable the push switch in this mode, that is why we have shown it dotted in and why Transam have not built this facility into their PCB in an obvious way. Why not use common sense and make use of this extremely valuable facility — all that is needed is the cost of 20cms of wire! You 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.

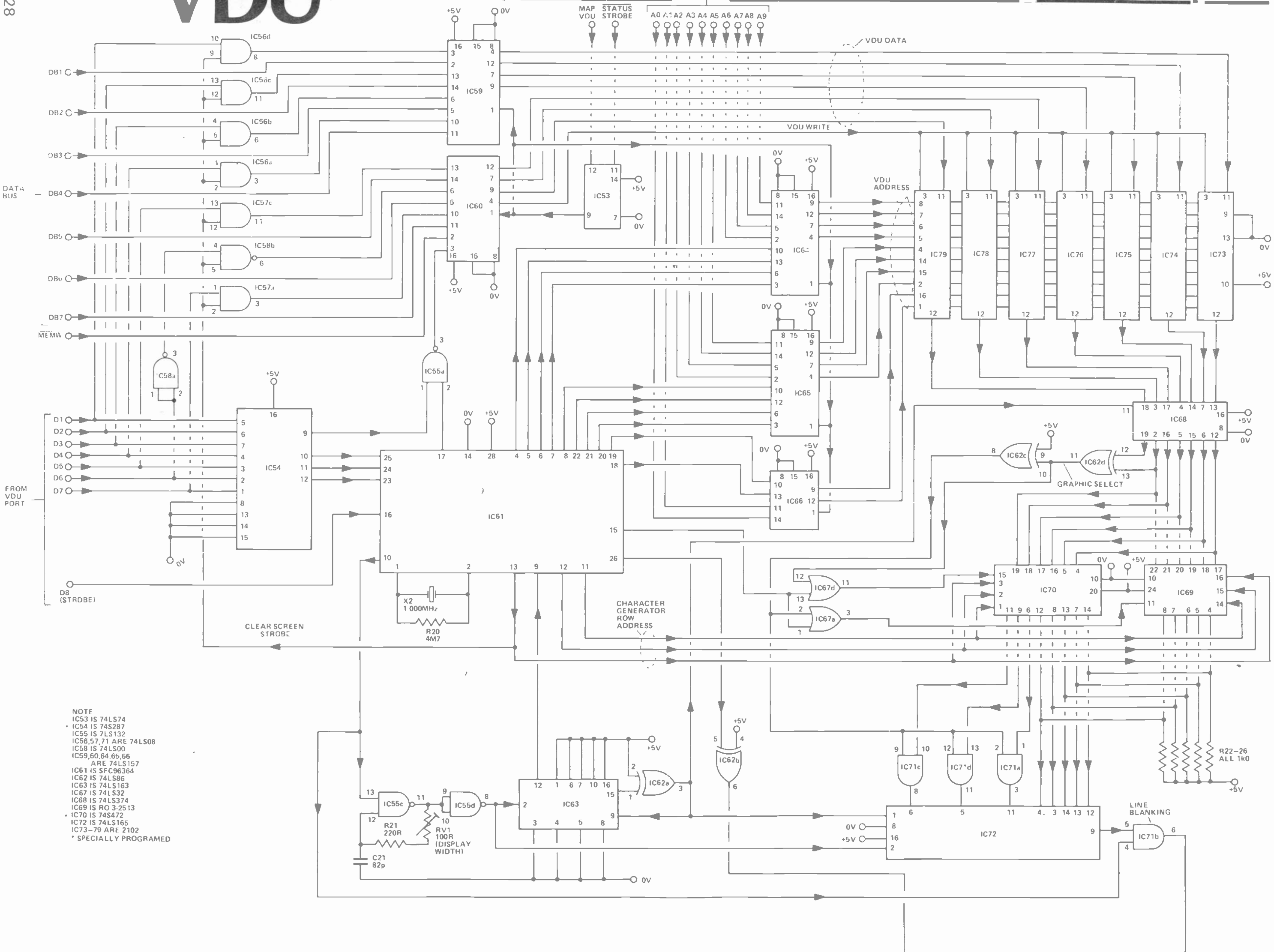
IC11 is the Interupt Encoder which has eight lines going in to it. These are normally held high by pull up resistors R4 to R11. The encoded three-bit nibble is output at pins 6, 7 and 9. If all the inputs are high all the outputs are high and a "0" is placed on the Enable Output line at pin 15 (the latter is used to generate the 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.



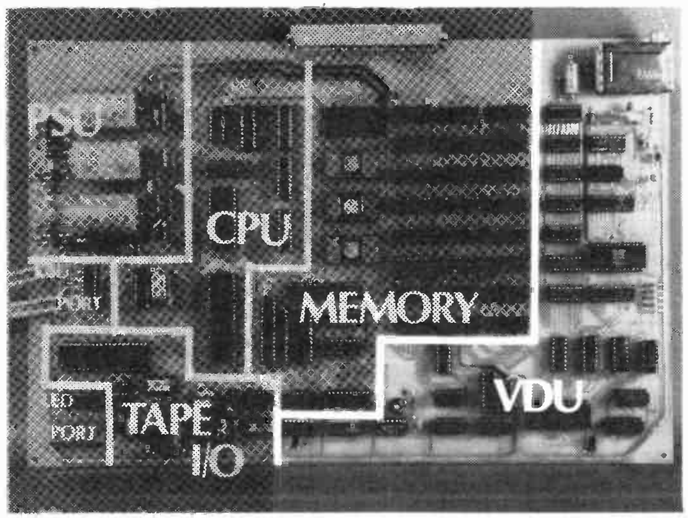
Interupt 0 should not be used even though it is available on the PCB. It simply duplicates the manual reset operation but would create problems if used with the TRITON's Monitor program. INT1 is dedicated by the Monitor to provide a Clear Screen and Reset Cursor facility which can be carried out at any 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.

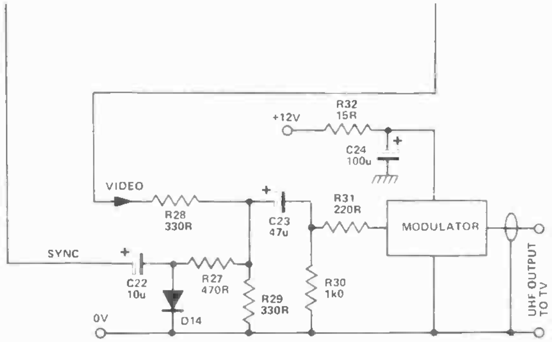




NOTE
IC53 IS 74LS74
* IC54 IS 74S287
IC55 IS 7LS132
IC56,57,71 ARE 74LS08
IC58 IS 74LS00
IC59,60,64,65,66 ARE 74LS157
IC61 IS SFC96364
IC62 IS 74LS86
IC63 IS 74LS163
IC67 IS 74LS32
IC68 IS 74LS374
IC69 IS RO 3-2513
* IC70 IS 74S472
IC72 IS 74LS165
IC73–79 ARE 2102
* SPECIALLY PROGRAMED



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.

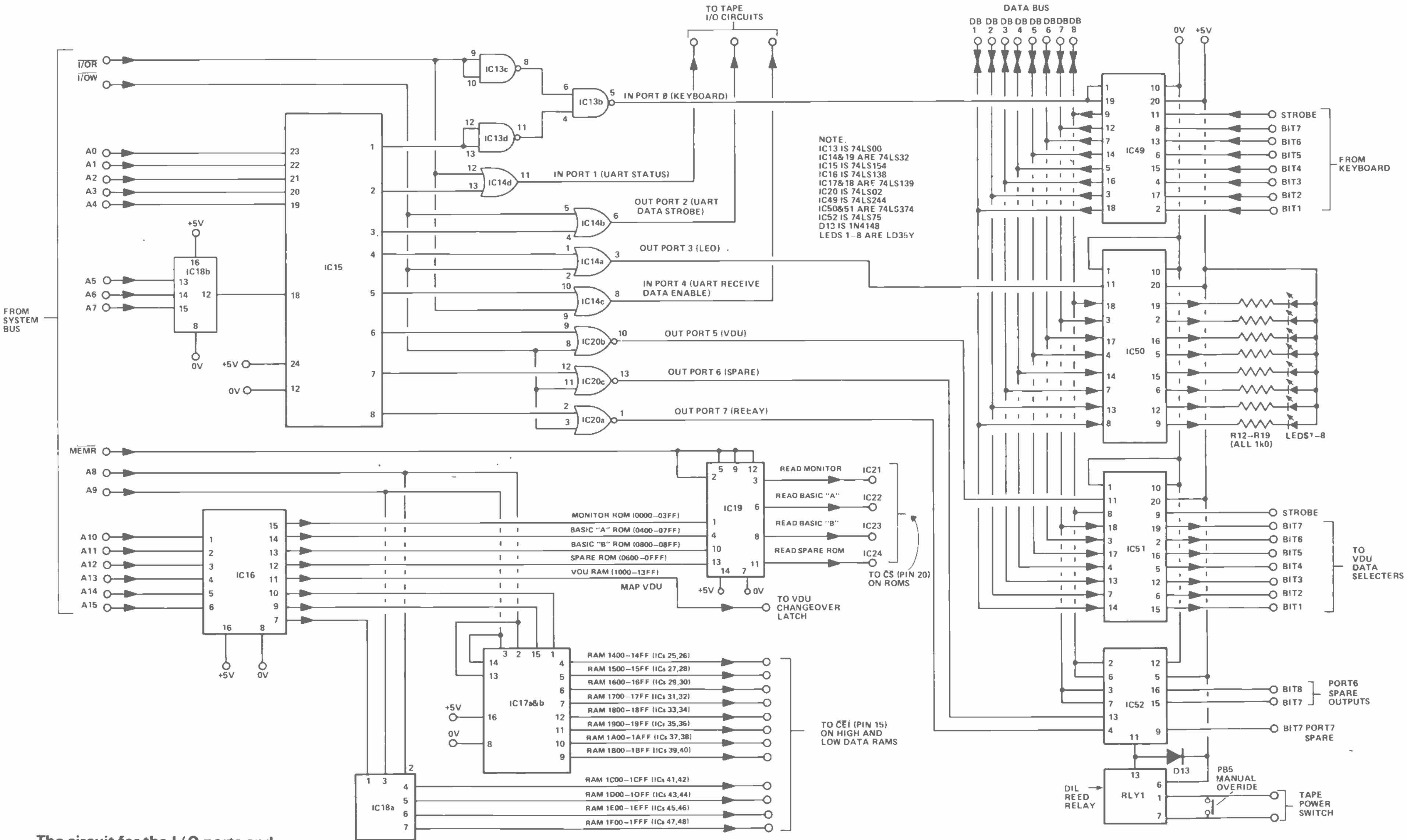
It only remains to describe the gates on the VDUs internal data lines and IC54. The former are used to force the ASCII code for "Space" on to the data lines when pin 13 (IC61) is at "O" in coincidence with a writing pulse to the VDU memory. This is to allow for the very useful internal function provided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

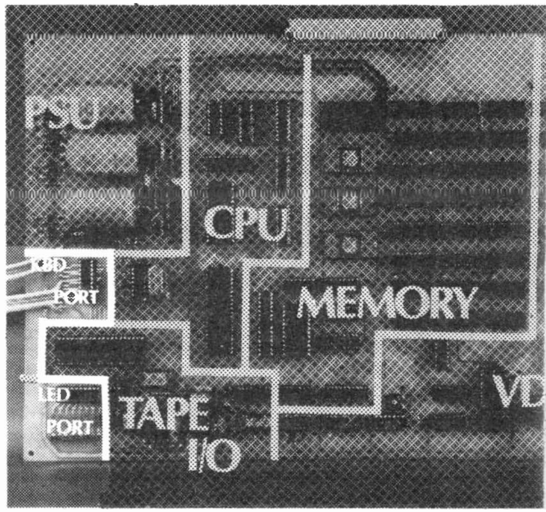
To get best use from the TRITON and its VDU you need to know hexadecimal and decimal values of all the ASCII codes that are used to generate alpha-numerics, graphics, and control characters. You also need to know which of the keyboard keys correspond to each graphic character. To help you we show all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



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 $\overline{I/OR}$ or $\overline{I/OW}$ 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 $\overline{I/OR}$ 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, $\overline{I/OW}$. 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.

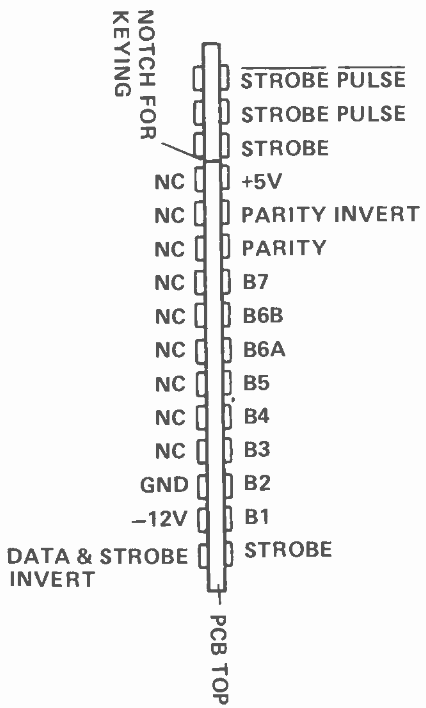
As we've moved on to the subject of tape control take note that there is a push button switch connected across the relay contacts. This is to allow manual override so that the cassette recorder can be rewound etc. under manual control without having to unplug the remote control lead. See the relevant 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.

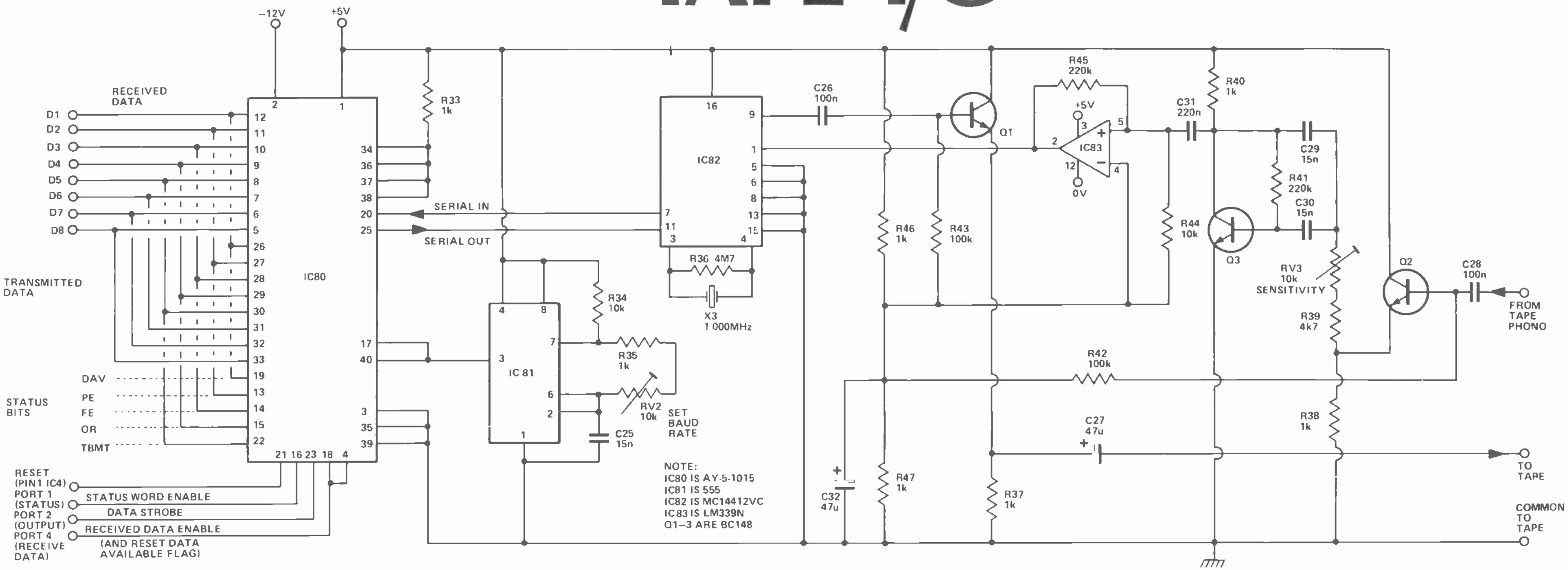
The latter three decoders break down the remaining 1K blocks into 12 blocks — each containing 256 bytes. Each of these 12 lines goes to a specific pair of random access memory integrated circuits that form the main work area of the computer.

Except for the ROMs, gating with $\overline{MEMR}$ and $\overline{MEMW}$ 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

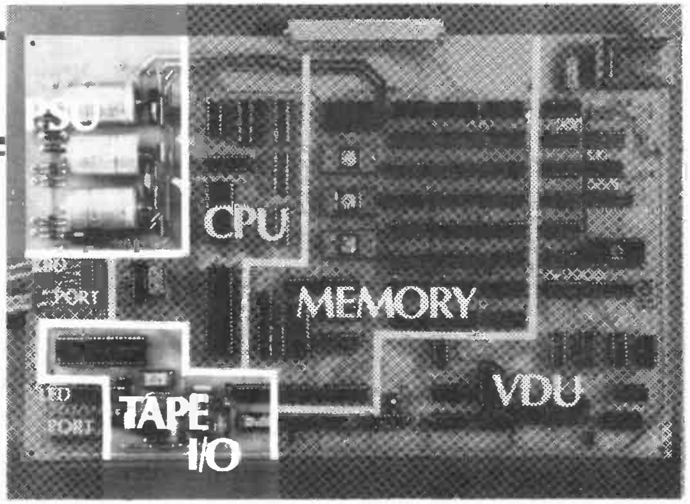
The MODEM interfaces directly with the UART and only needs a crystal and resistor to lock it to the correct frequency pairs. It is most important that a crystal of exactly 1.0000MHz is used here otherwise you will not be able to use pre-recorded tapes! The transmitted carrier of the MODEM is an eight 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

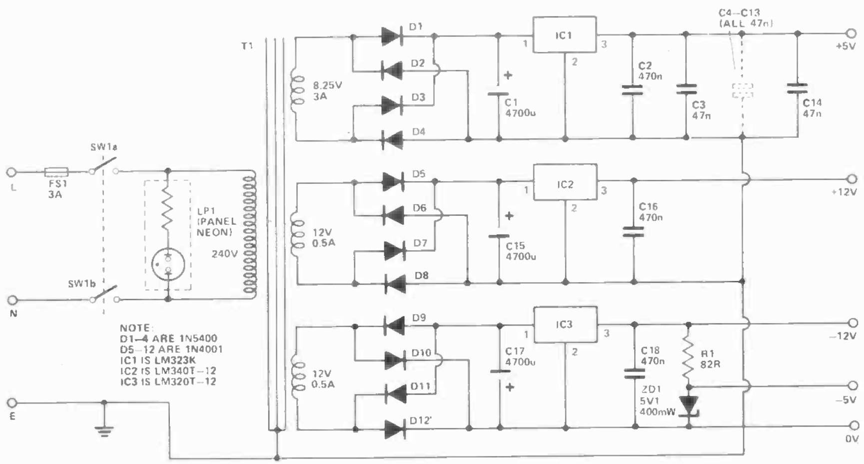
The format of serialised data in TRITON is a START bit, 8 data bits, a parity bit and 2 STOP bits. These are transmitted at a rate of 300 baud set by the clock comprising IC81 (an NE 555). Baud rate is adjustable by about ±50 percent by means of RV2 and, of course, it is important that this is accurately 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.

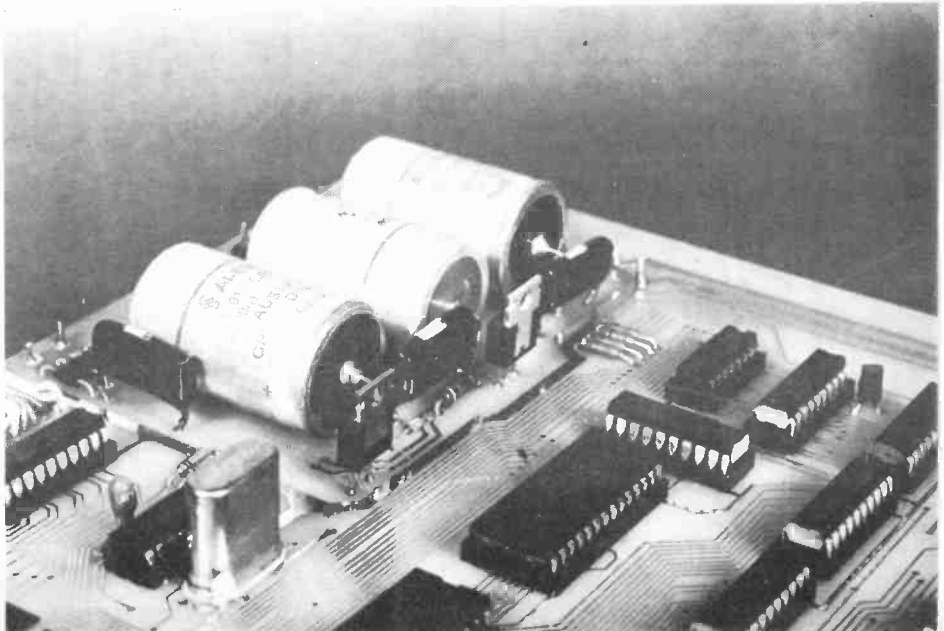
PSU



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



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

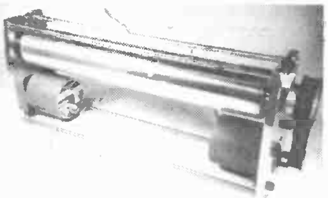


HOW IT WORKS

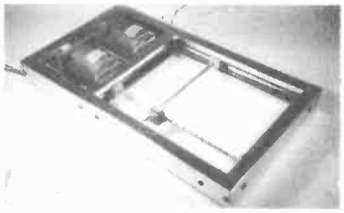
THE POWER supply has been kept as simple as possible, utilising three IC regulators to provide the main rail supplies which are +5 V at 3 A (the TRITON does not draw all this but do not rely on there being any to spare if you are thinking of hanging any other bits and pieces on this line!) +12 V at 0.5 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 (ICI) we decided on a specially wound mains transformer, hence the rather obscure specification for an 8.25 V winding.



BARREL TYPE X-Y PLOTTER ASSEMBLY



X-Y PLOTTER ASSEMBLY

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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.

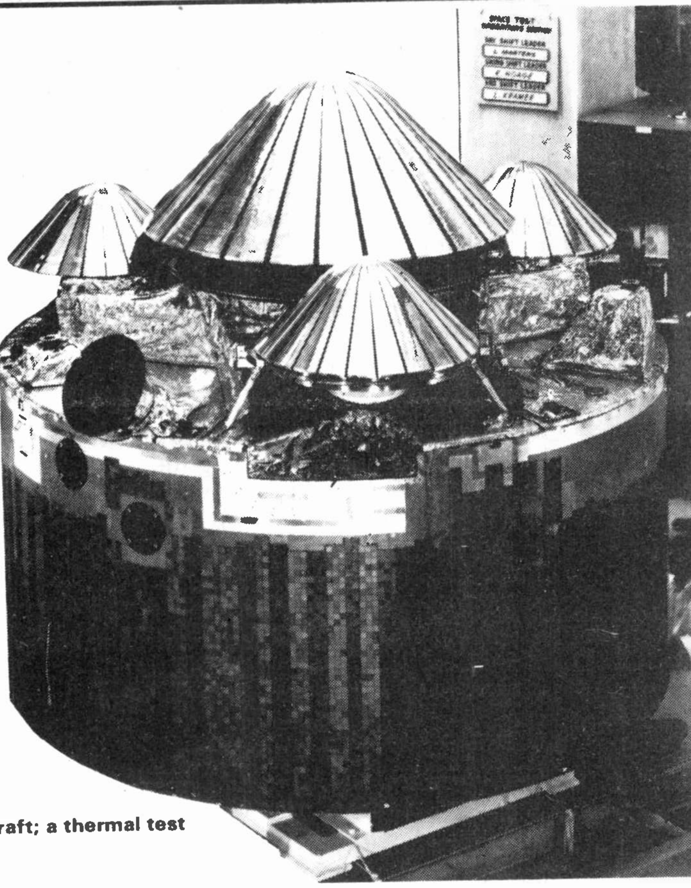


Fig. 1. The Pioneer Venus Multiprobe spacecraft; a thermal test model is shown.

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.

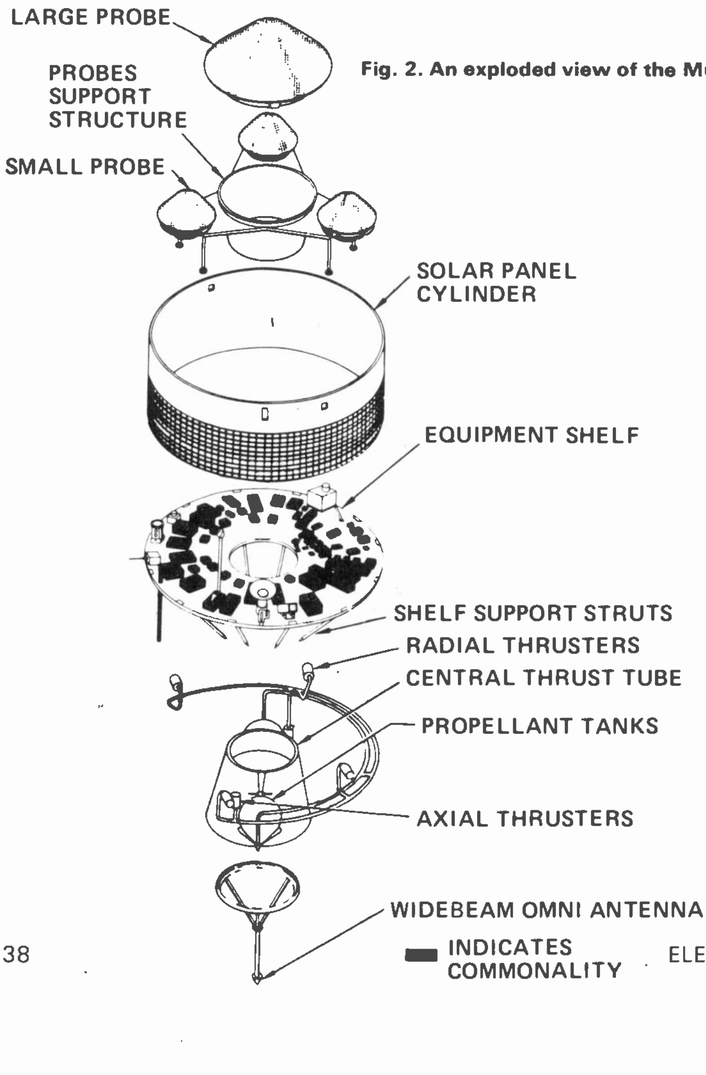


Fig. 2. An exploded view of the Multiprobe unit

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

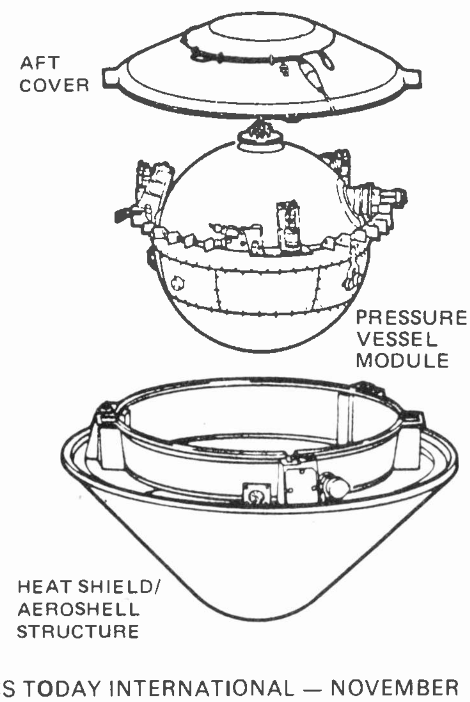


Fig. 4. An exploded view of the Orbiter spacecraft

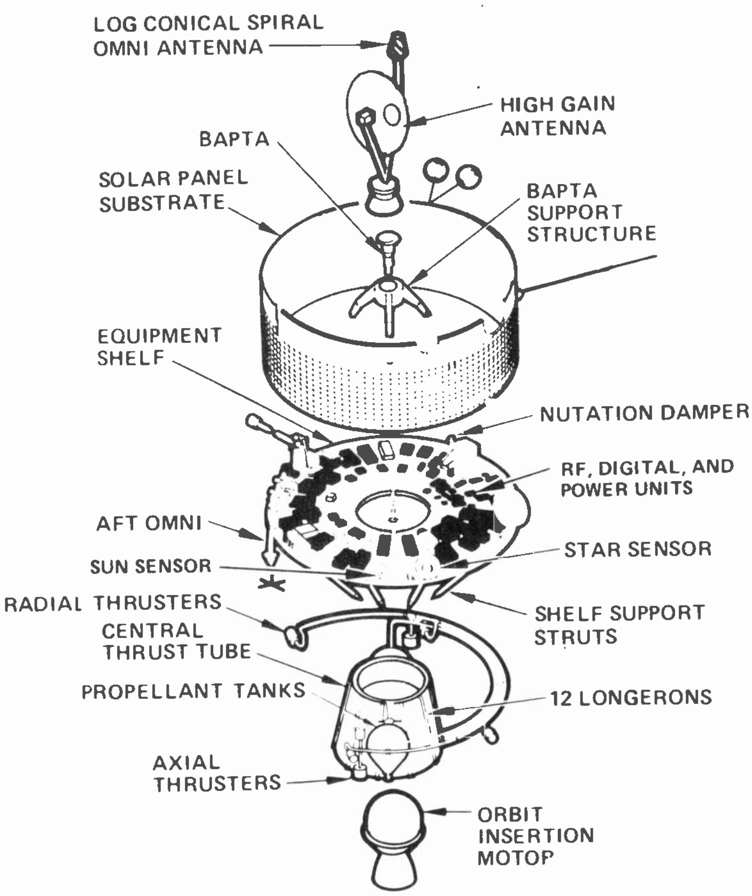
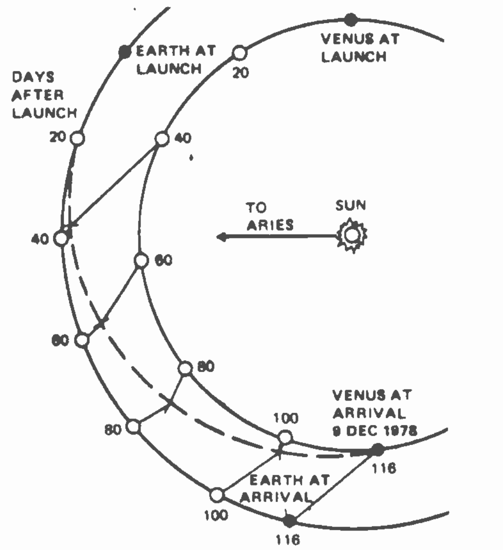


Fig. 5. Trajectory of the Muliprobe unit on its flight to Venus.



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.

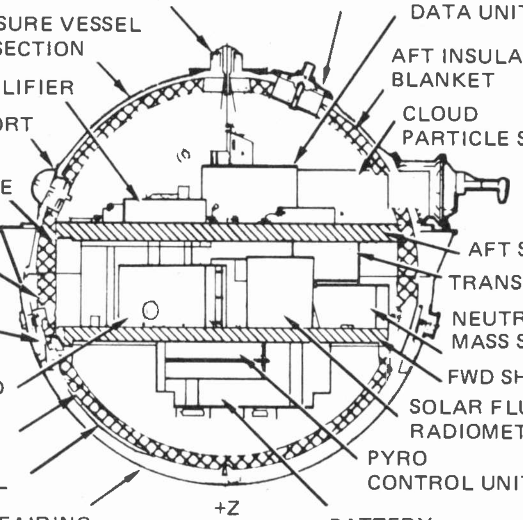
All five vehicles will enter the atmosphere in a two hour period and all will be transmitting simultaneously, so the time of entry will be arranged to be one at which two of the Deep Space Network stations can simultaneously receive signals to avoid possible loss of data.

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.

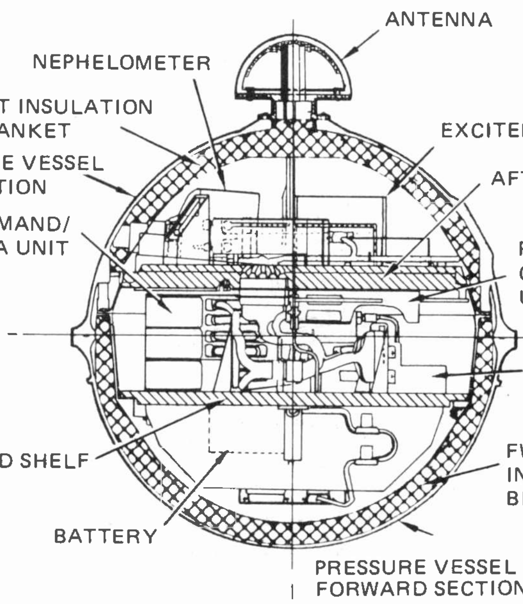
Pressure Vessel

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 1.3 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

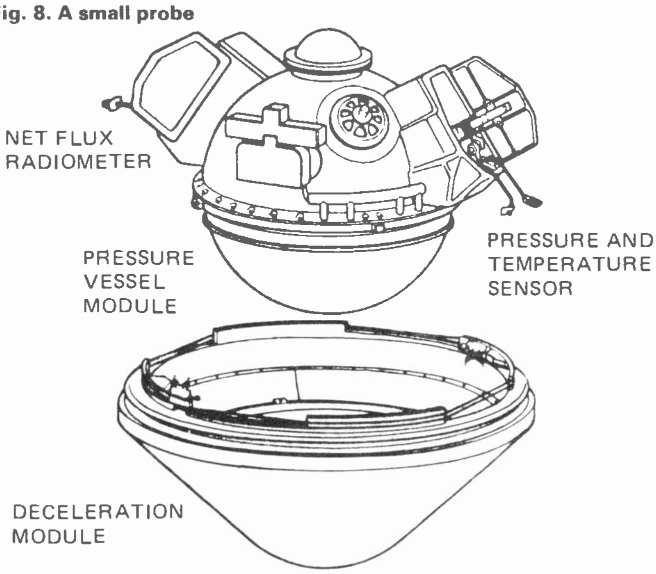
The three identical small probes are designed to measure the characteristics of the Venusian atmosphere simultaneously at three widely different locations. They are designed to withstand the high temperature and pressure at the surface of the planet, but need not necessarily withstand the impact with 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

Fig. 8. A small probe



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.

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

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.

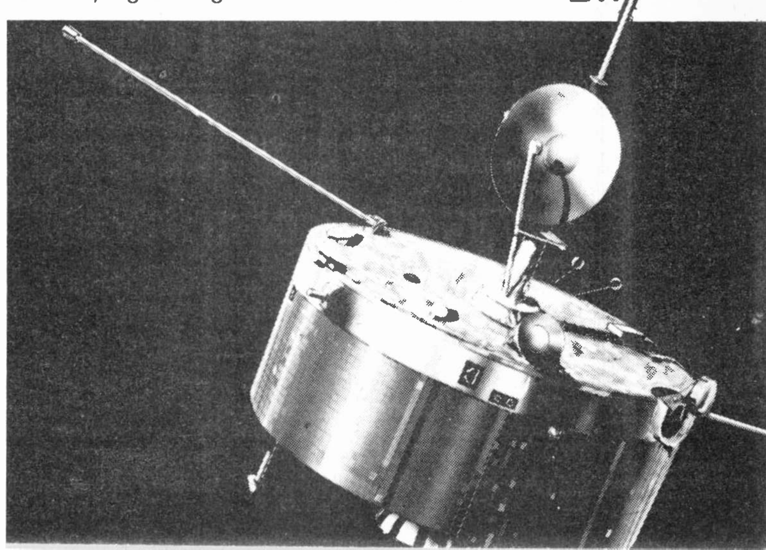
A bearing and power transfer assembly (BAPTA) serves an electrical and mechanical interface between the spinning part of the spacecraft and the despun aerial which must always point towards the earth. As in the case of the multiprobe Bus, 32 kg of liquid Hydrazine propellant is carried in two tanks and 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



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

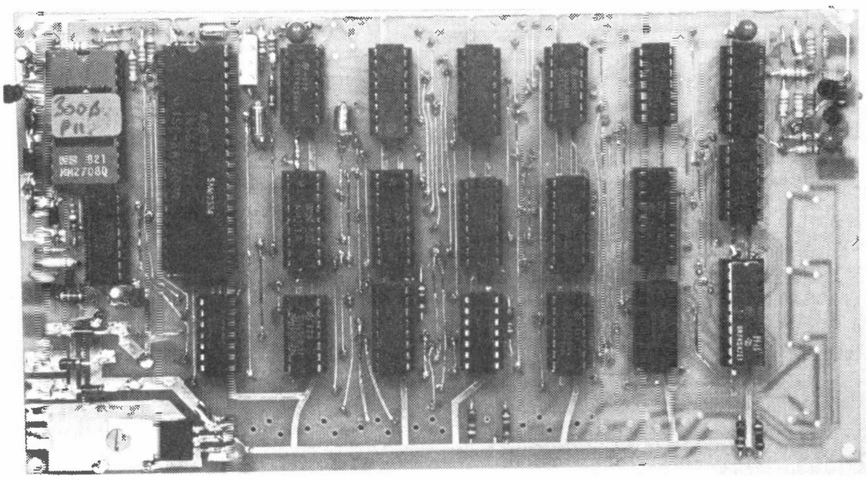
available. The signal must be attenuated for a low level input to avoid overloading. Most recorders have Automatic Volume Control and this helps. The output from Tolinka is bursts of 3.9khz at the data rate, which is 300 baud—or 150Hz maximum. Every high bit generates 12 cycles aapproximately of the 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 ▶

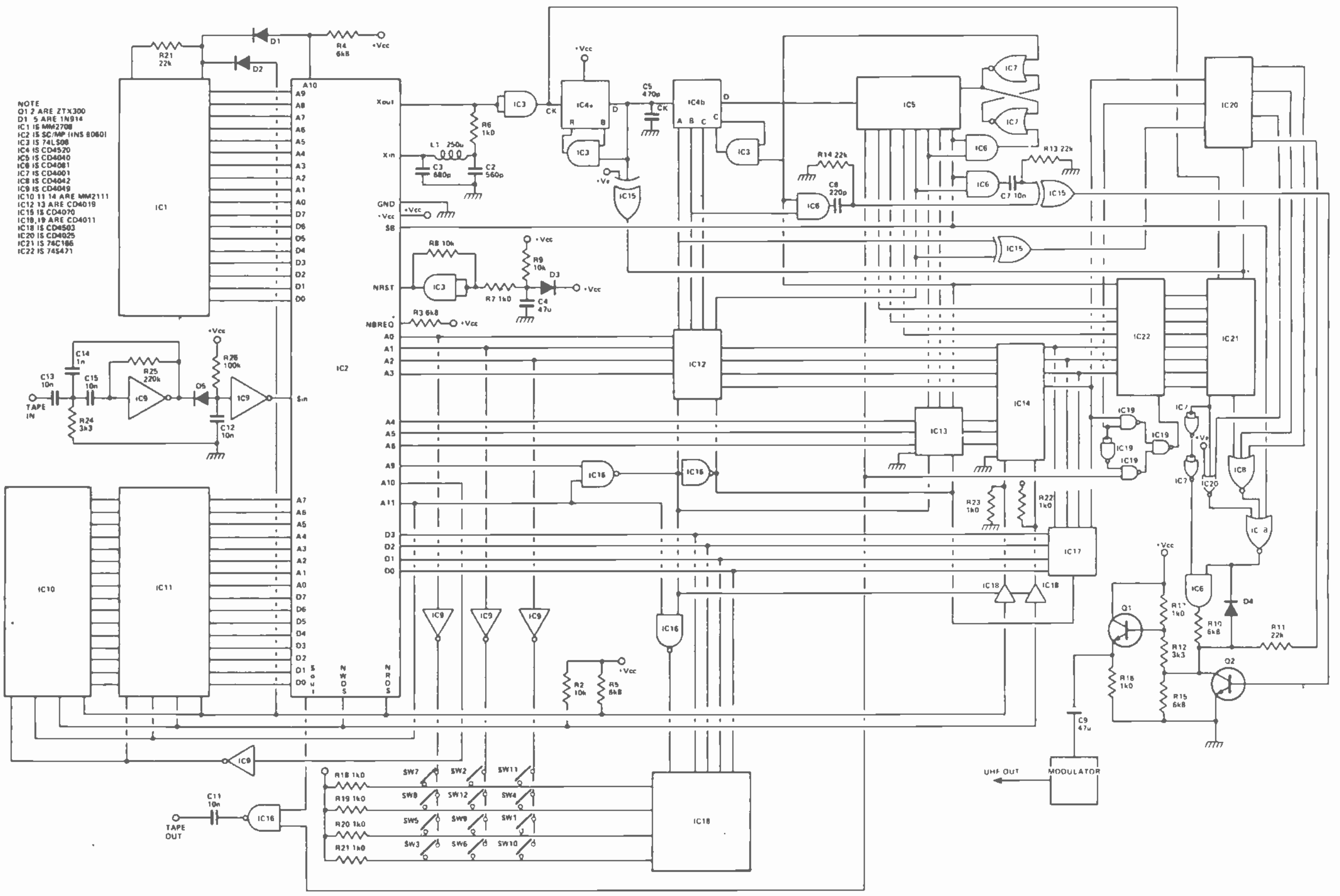


Fig. 1 Main circuit diagram of the Tolinka.

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.

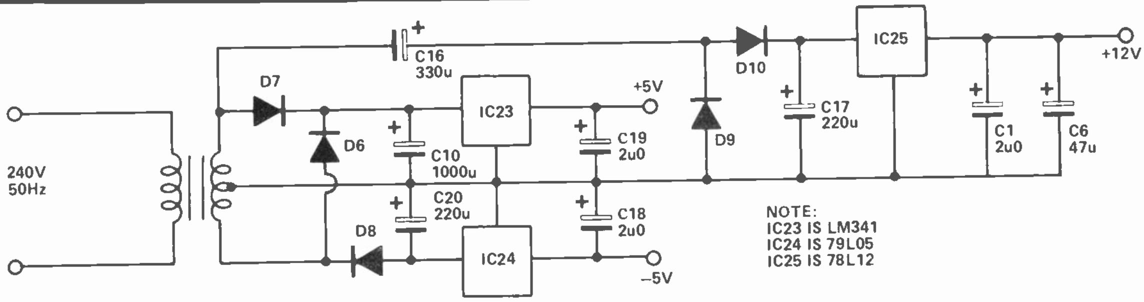
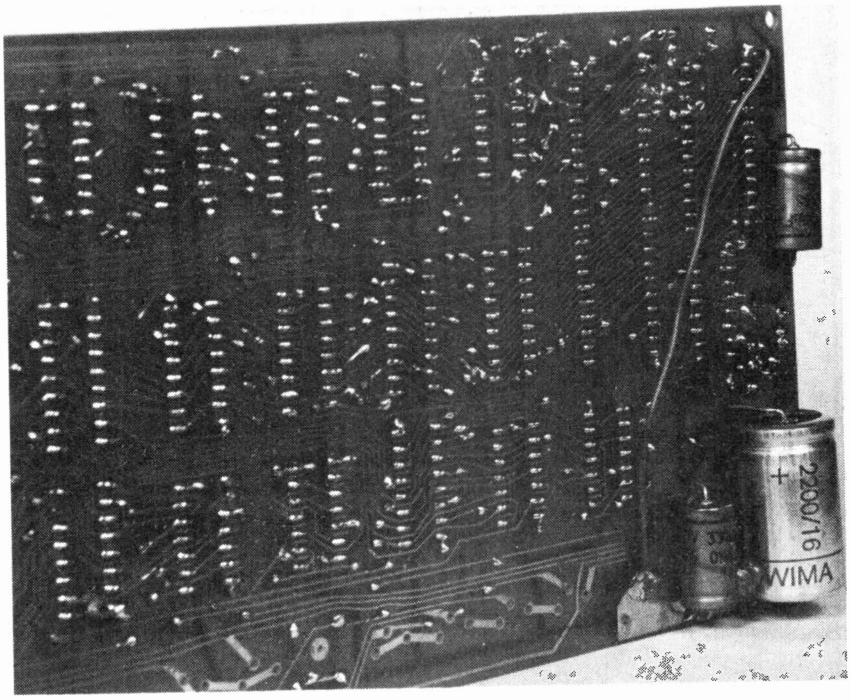


Fig. 2 The Tolinka's power supply is a straightforward design based on three monolithic regulators.

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.

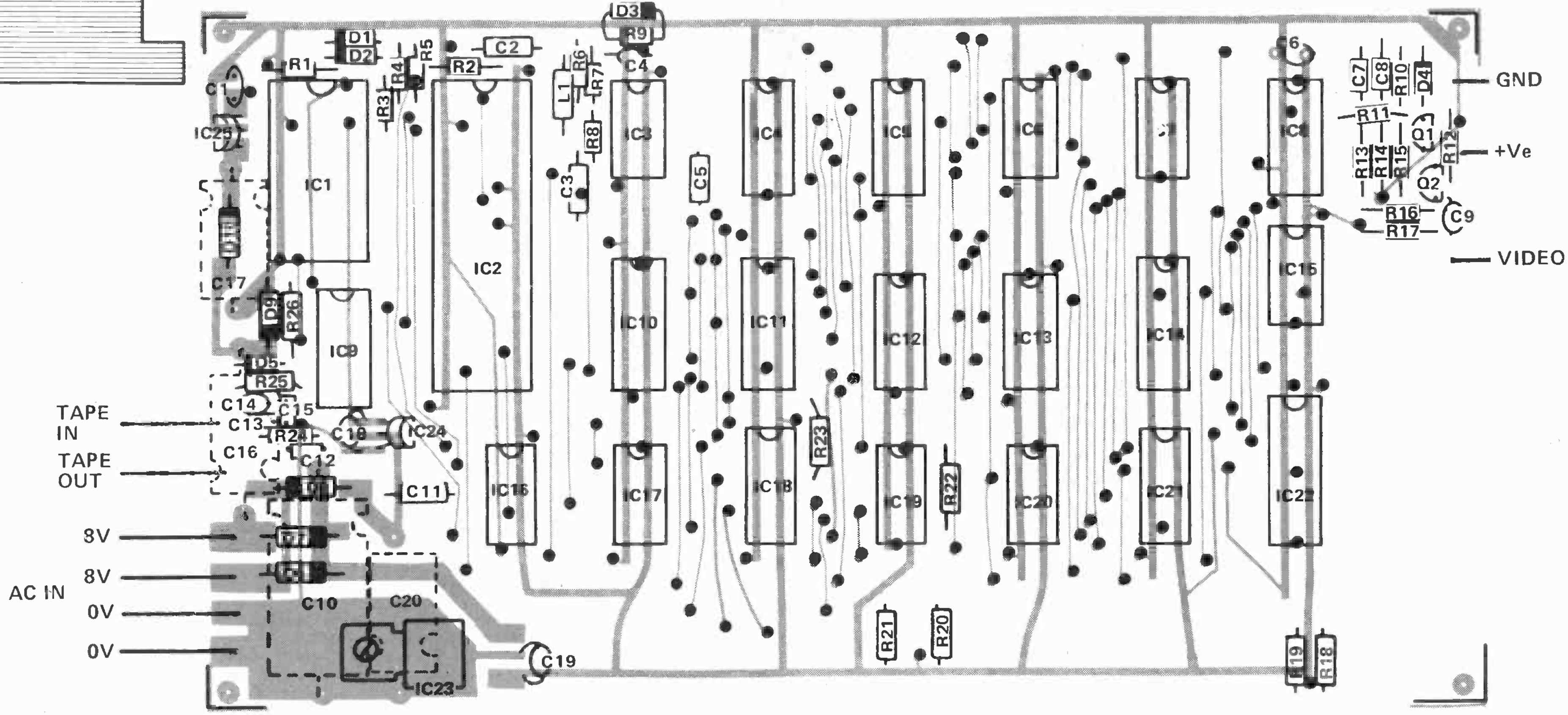
Power-on Reset

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	2u06V3 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

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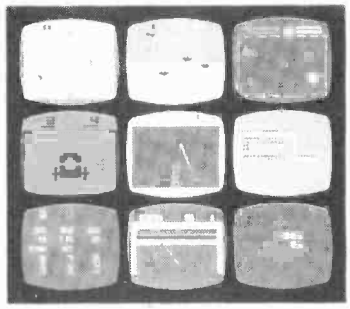

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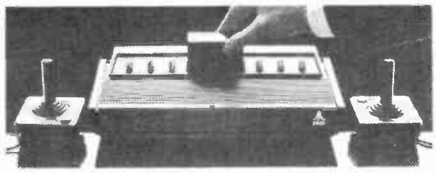

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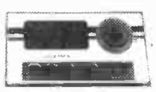

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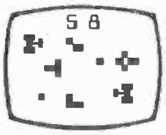

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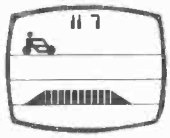

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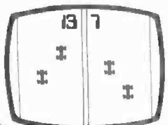

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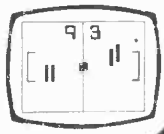

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SWITCH IN LINE SAVES NONE?

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.

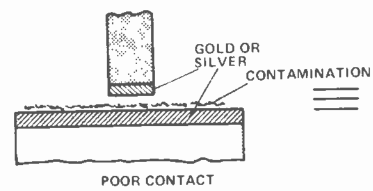
Such level changes could be incorrectly interpreted as differences in amplifier performance. The design of the passive attenuators is important to prevent any significant loading of the circuitry or any imbalancing of impedances which could upset passive filter roll-offs and so alter the frequency response 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.

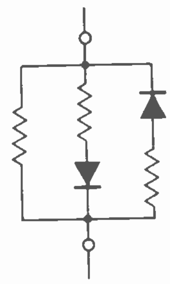
Care should also be taken in the interconnection of the different amplifiers. All connections should be as short as possible using very high quality and identical (in length and quality) cables. Wherever connections have to be made (other than at the amplifier or loudspeaker) high-quality gold-plated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

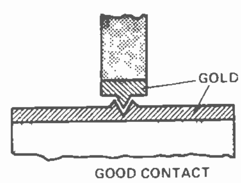
Switch Your Contacts

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







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.

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.

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." ▶

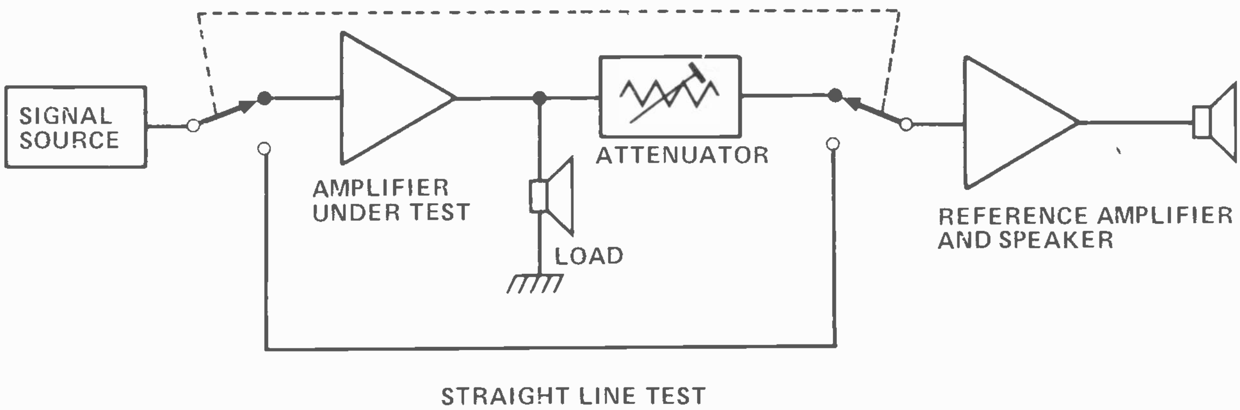


Fig. 2. The straight wire test. First popularised by Peter Walker of Acoustical Manufacturing (or Quad!) this test method has gained wider acceptance of late. It has its faults however.

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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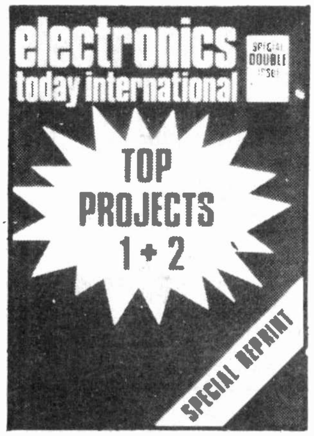

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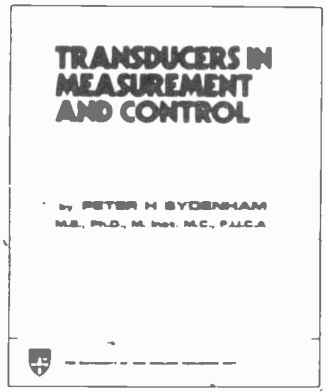

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This book is rather an unusual reprint from the pages of ETI. The series appeared a couple of years ago in the magazine, and was so highly thought of by the University of New England that they have re-published the series splendidly for use as a standard 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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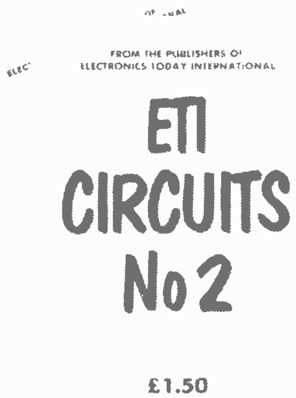

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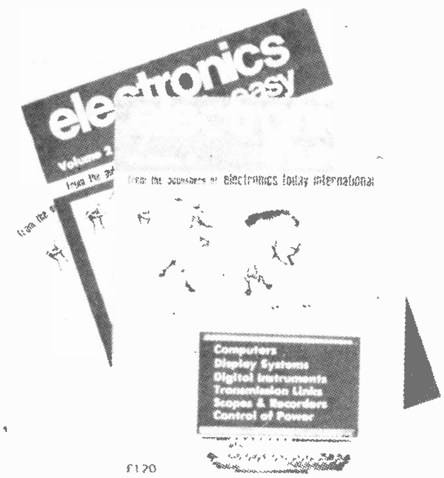

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An example of this watch can be seen and examined in our reception at our Oxford Street offices.

LCD WATCH

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London W1R 1RF

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

Name ....

Address ....

....

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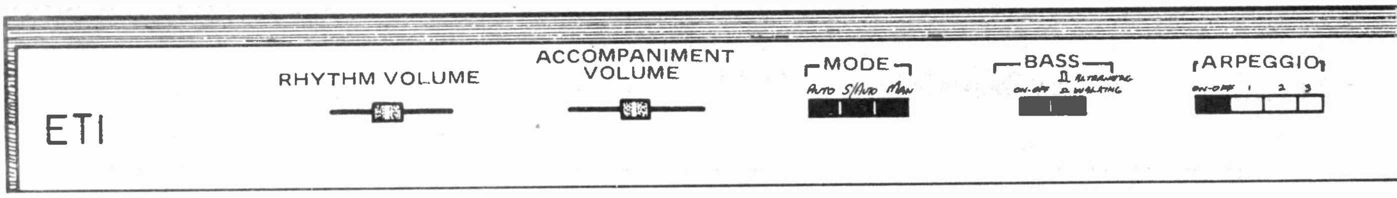
Please allow 14 days for delivery

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**

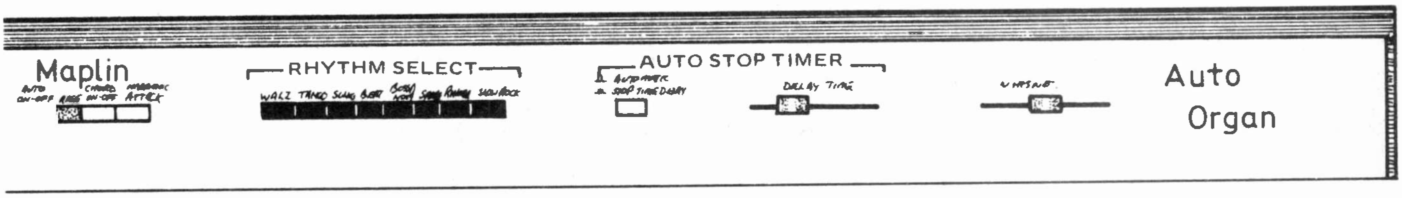
Arpeggio — **Three selectable pitches**

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

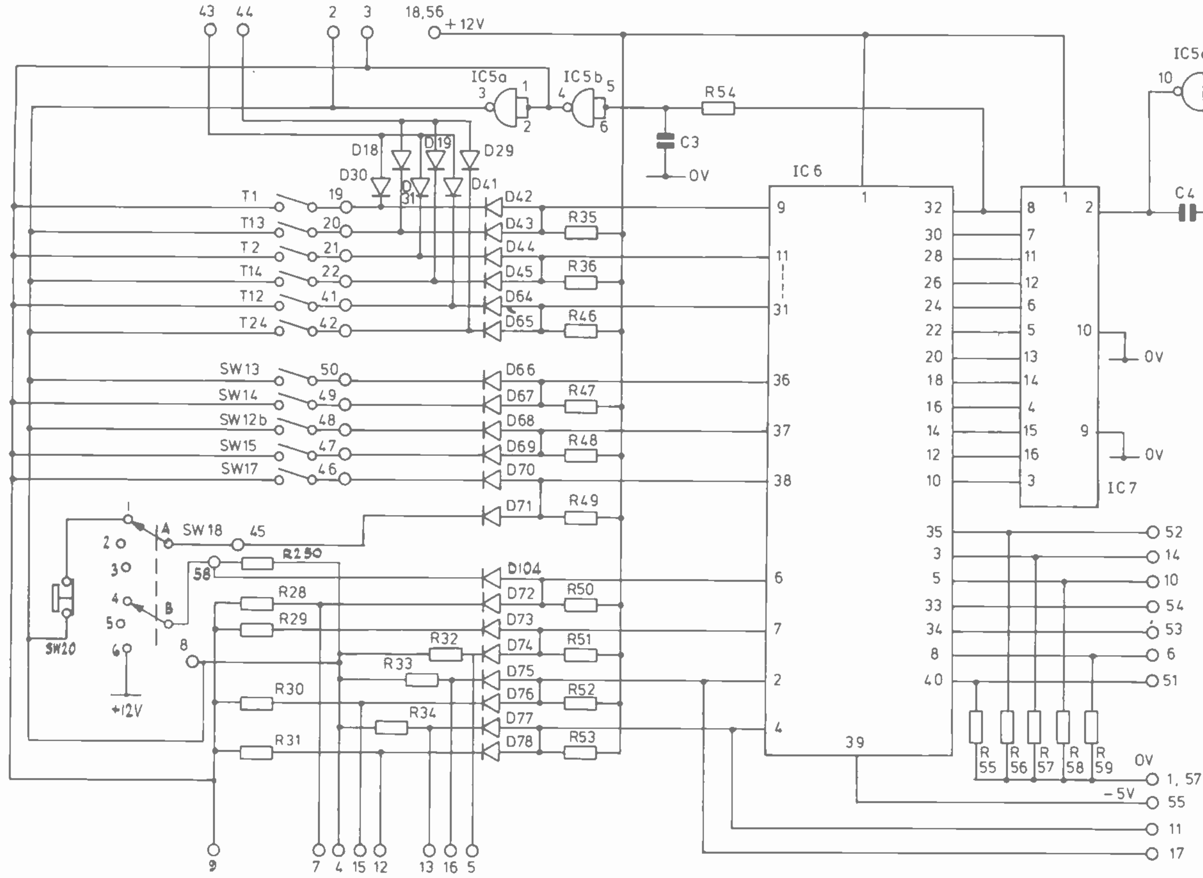
IC1	M254
IC2-5	4011
IC6	M251
IC7	M087
IC8	4069
IC9-11	741
IC12	4016
IC13	4013
Q1-4, 7, 8, 10, 11, 12, 13, 15, 16	BC548
Q9, 14	BC177
Q5	BFY51
Q6	BFX87
D1-86, 94, 105	1N4148
D87-90	1N4002
D91	12 V 400mW
D92	5V6 400mW
D93	12 V 400mW
LED1	TIL209

SWITCHES

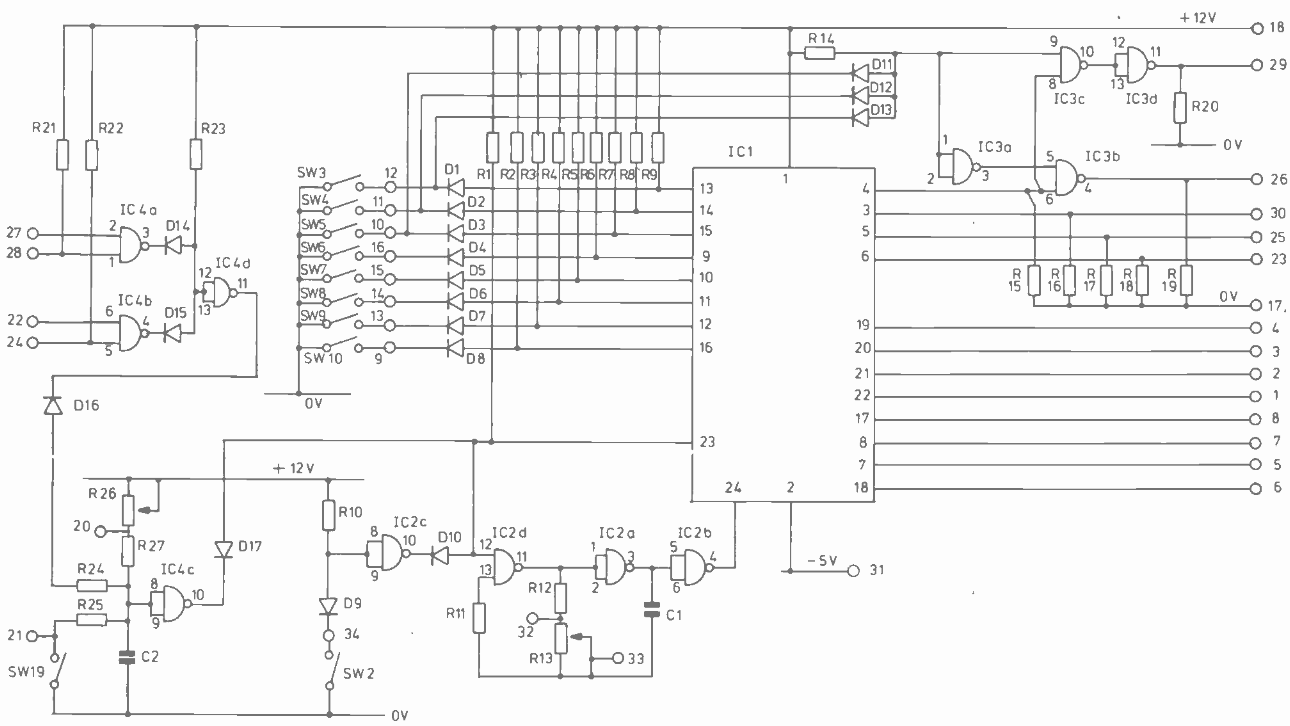
SW1	Mains latchswitch
SW2	2 pole latchswitch
SW3 to 10	8. 2 pole latchswitch interdependent
SW11	2 pole latchswitch
SW12	2 pole latchswitch
SW13	2 pole latchswitch
SW14	2 pole latchswitch
SW16	2 pole latchswitch
SW17	2 pole c/over latch-switch
SW18	4p. 3W rotary
SW19	2 pole latchswitch
SW20	Push (break)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

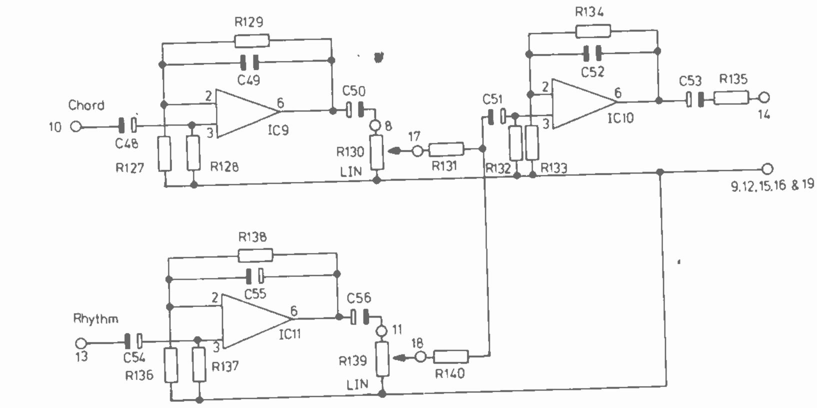
The M251 features a number of different modes of operation, in the automatic mode, when a number of keys in the two available octaves are played, the lowest note will be taken as a reference and memorised.

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

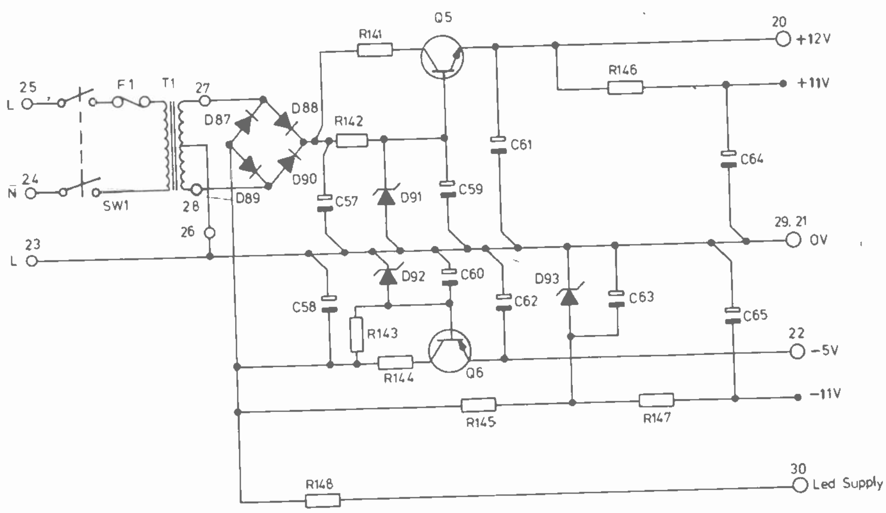
In the semi-automatic mode, the M251 will memorise the lowest four keys played together with the top note played. The circuit will then provide accompaniment until the mode is cancelled by selecting automatic mode briefly and returning to semi-automatic while no keys are played.

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

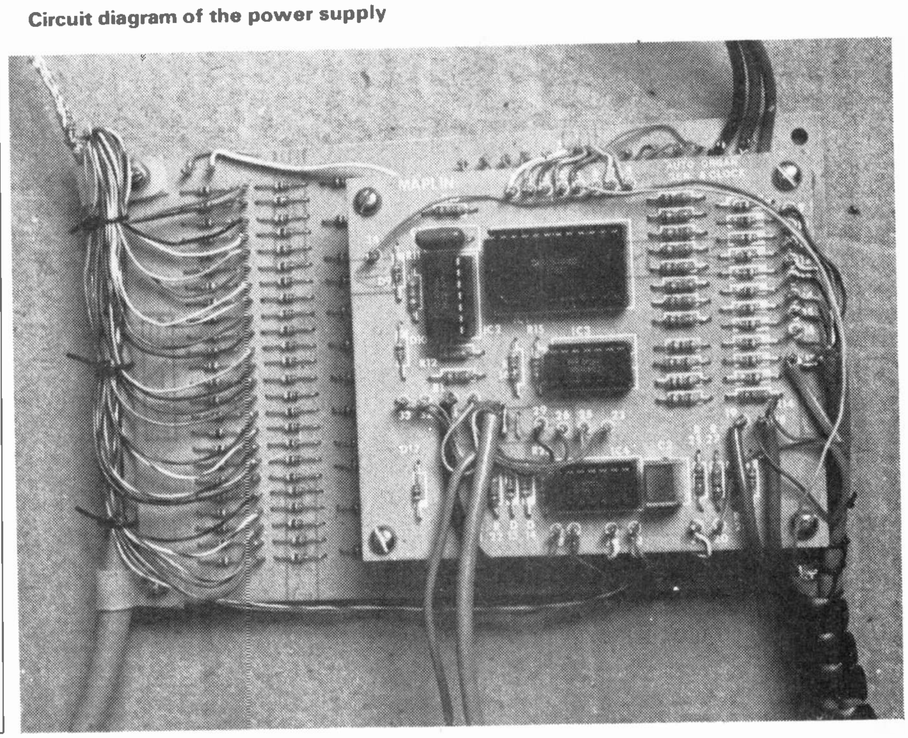
Due to the pin out restrictions of the 40 pin package a system of multiplexing has had to be adopted, this explains some of the complexity in this area of the circuit.

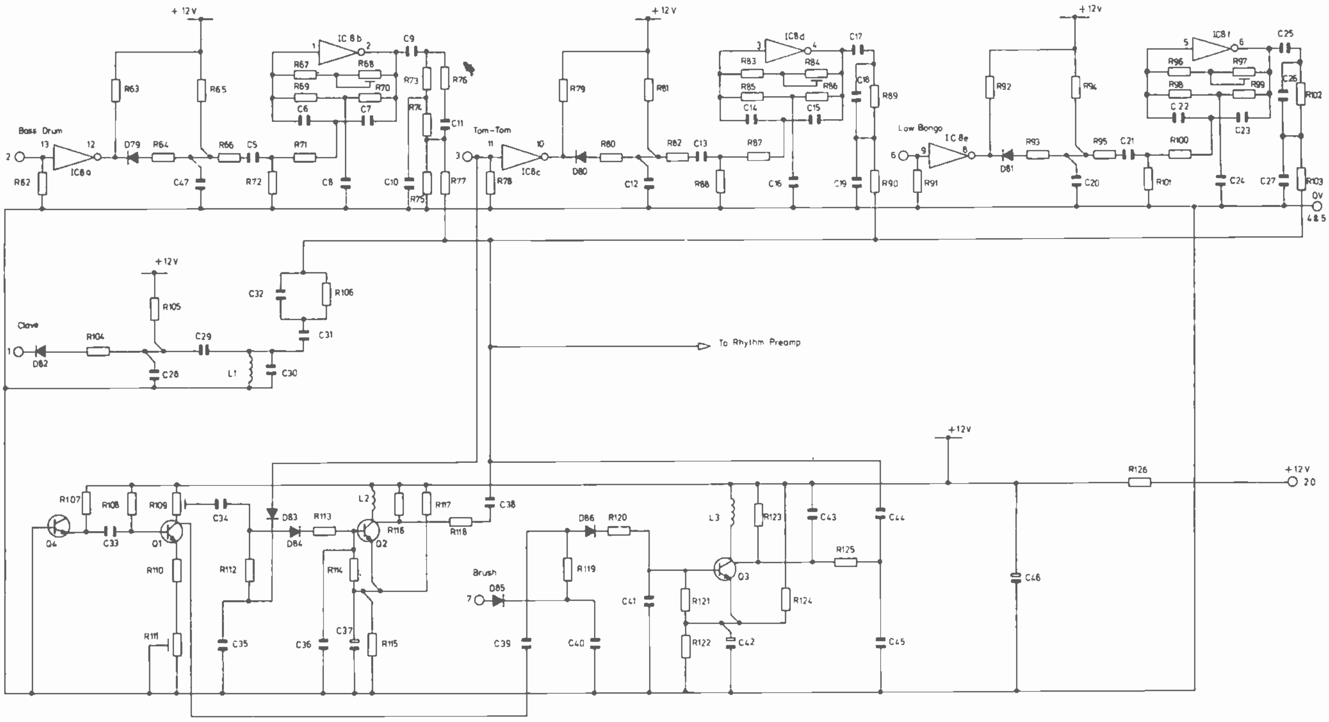


Circuit diagram of the preamplifier



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.

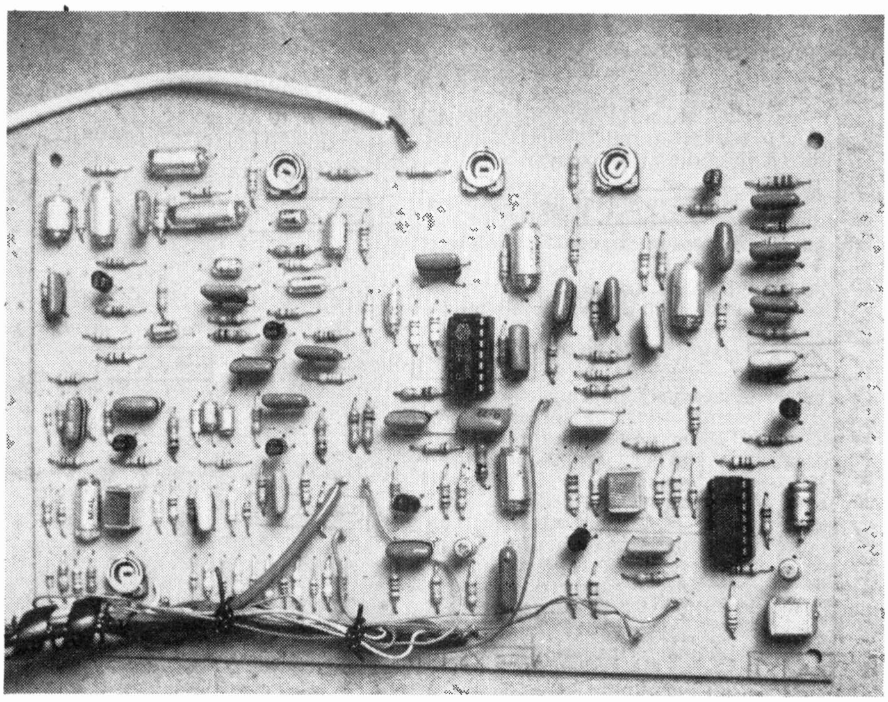
The outputs from the various voice generating circuits are summed and fed to the instruments pre-amplifier.

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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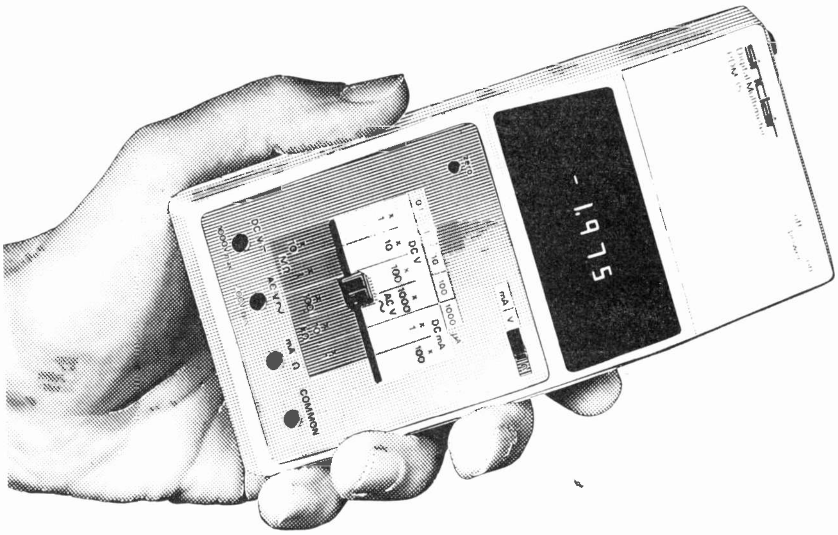

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What you get with a PDM35

3½ digit resolution.
Sharp, bright, easily read LED display, reading to ± 1.999.
Automatic polarity selection.
Resolution of 1 mV and 0.1 nA (0.0001 μA).
Direct reading of semiconductor forward voltages at 5 different currents.
Resistance measured up to 20 MΩ.
1% of reading accuracy.
Operation from replaceable battery or AC adaptor.
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Compare it with an analogue meter!

The PDM 35's 1% of reading compares with 3% of full scale for a comparable analogue meter. That makes it around 5 times more accurate on average.

The PDM35 will resolve 1 mV against around 10 mV for a comparable analogue meter – and resolution on current is over 1000 times greater.

The PDM35's DC input impedance of 10 MΩ is 50 times higher than a 20 kΩ/volt analogue meter on the 10 V range.

The PDM35 gives precise digital readings. So there's no need to interpret ambiguous scales, no parallax errors. There's no need to reverse leads for negative readings. There's no delicate meter movement to damage. And you can resolve current as low as 0.1 nA and measure transistor and diode junctions over 5 decades of current.

Technical specification

DC Volts (4 ranges)
Range: 1 mV to 1000 V.
Accuracy of reading 1.0% ± 1 count.
Note: 10 MΩ input impedance.
AC Volts (40 Hz-5 kHz)
Range: 1 V to 500 V.
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.

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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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Water resistant to 100 feet.
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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?

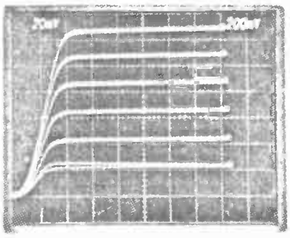
Well ETI plans to change that next month; ours has five frequency channels, with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straight sound to light, or have it strobe all lights. At a speed dependent upon music level (not 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



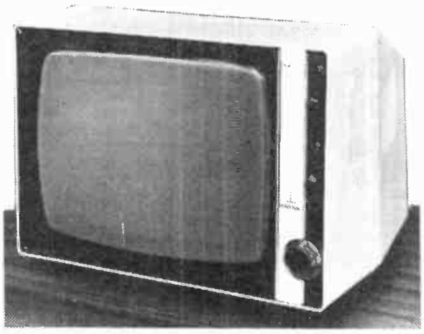
Explaining the shape of Voltage-Current characteristics of diodes, transistors and other non-linear devices is usually dull as it normally involves a tedious plot of static, experimental data.

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.

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.

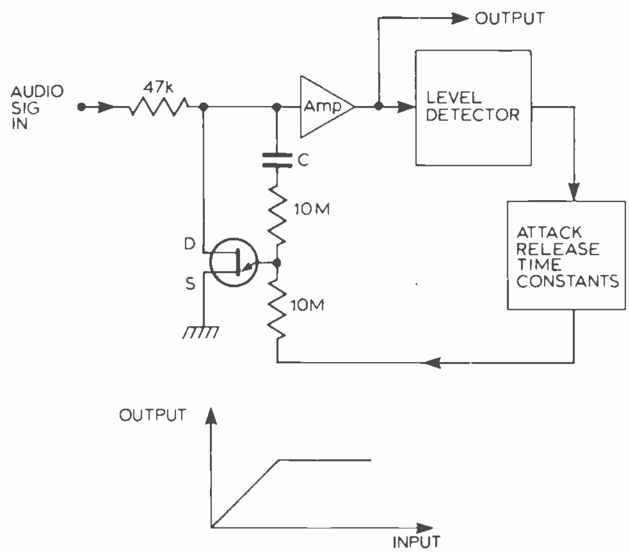
Basic Limiter Circuit

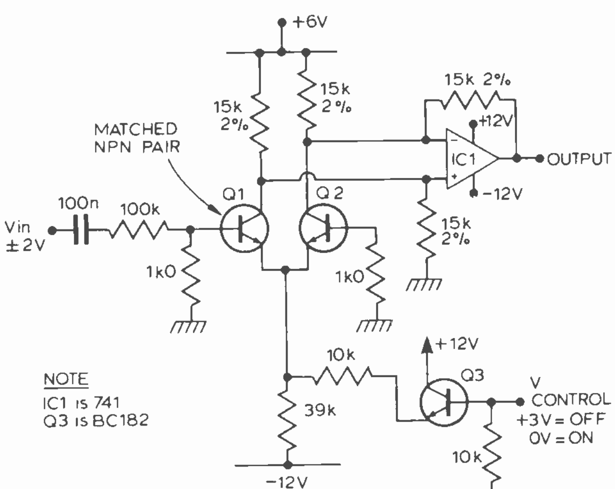
Most professional limiter circuits use a FET as the variable gain element. Relatively low distortion with a reasonable signal to noise rati ~ can be obtained. A basic limiter circuit is shown this being no c.:fferent to previous circuits except for the variable gain element.

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.

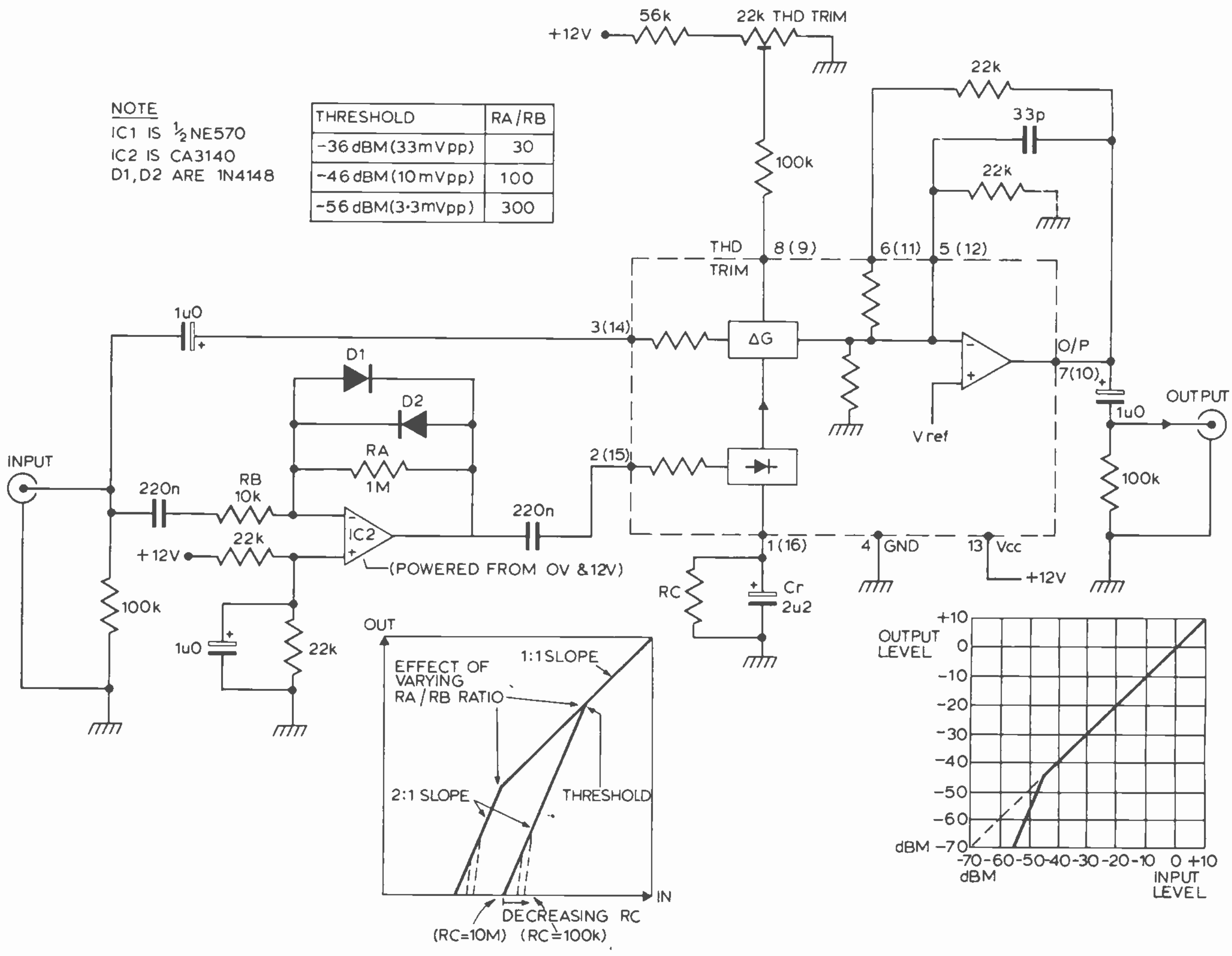




Transistor VCA

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



NOTE
IC1 IS ½ NE570
IC2 IS CA3140
D1, D2 ARE 1N4148

THRESHOLD	RA/RB
-36 dBM (33 mV pp)	30
-46 dBM (10 mV pp)	100
-56 dBM (3·3 mV pp)	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.

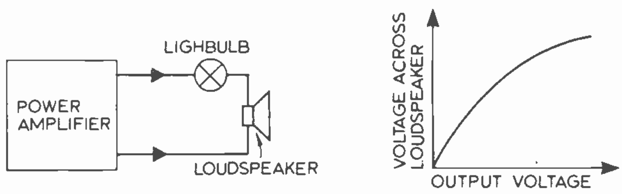
The circuit performs just such an expansion. The inputs signal passes through the variable gain cell and then appears at the op amp output. The gain of the gain cell is controlled by the signal coming from IC1. This is a high gain amplifier with diode clamping, so that the output swing is limited to about 1V0 ptp. Therefore for input signals of 10 mV pp to 10 V pp, the output of IC1 remains at about 1V0 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.

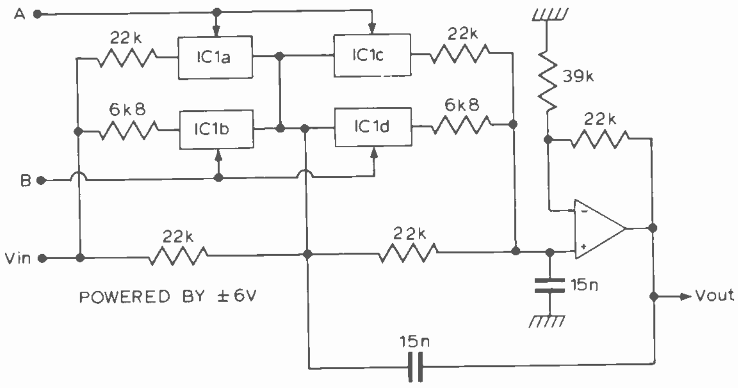
Incredibly Simple Compressor

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!

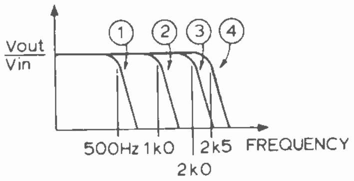


Switched Frequency Low Pass Filter

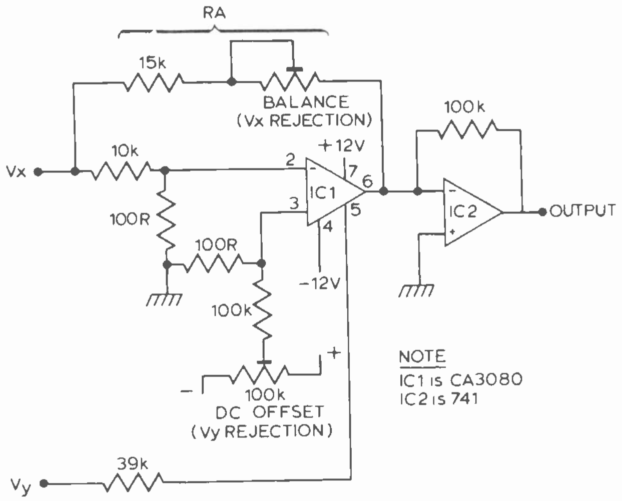
In this example the effective resistance is switched by using 4016 gates. The filter is a lowpass Butterworth and by turning gates A or B ON or OFF the cut off frequency can be altered. This allows the filter control to be physically remote or even to be computer controlled. Mark Space modulation of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

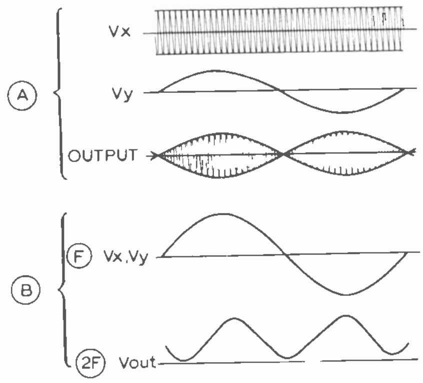


	1	2	3	4
A	OFF	ON	OFF	ON
B	OFF	OFF	ON	ON
Fc	500Hz	1kHz	2kHz	2·5kHz



Four Quadrant Multiplication

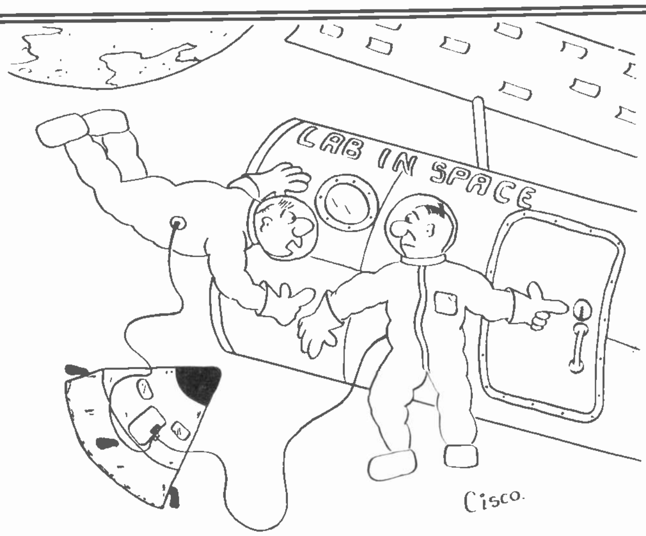




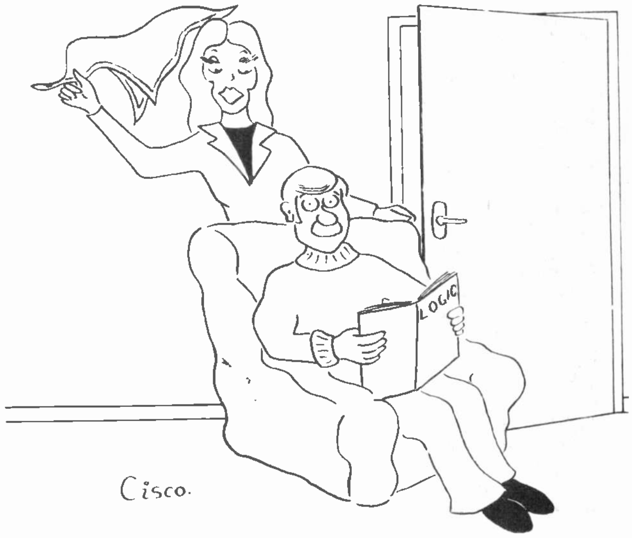
By using a few circuit tricks, the CA3080 can be made to perform 4 quadrant multiplication. In fact the CA3080 performs 2 quadrant multiplication and the trick is to move the axis on the multiplying graph. If we ignore the RA resistor chain then we have a 2 quadrant multiplier circuit similar to that 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.

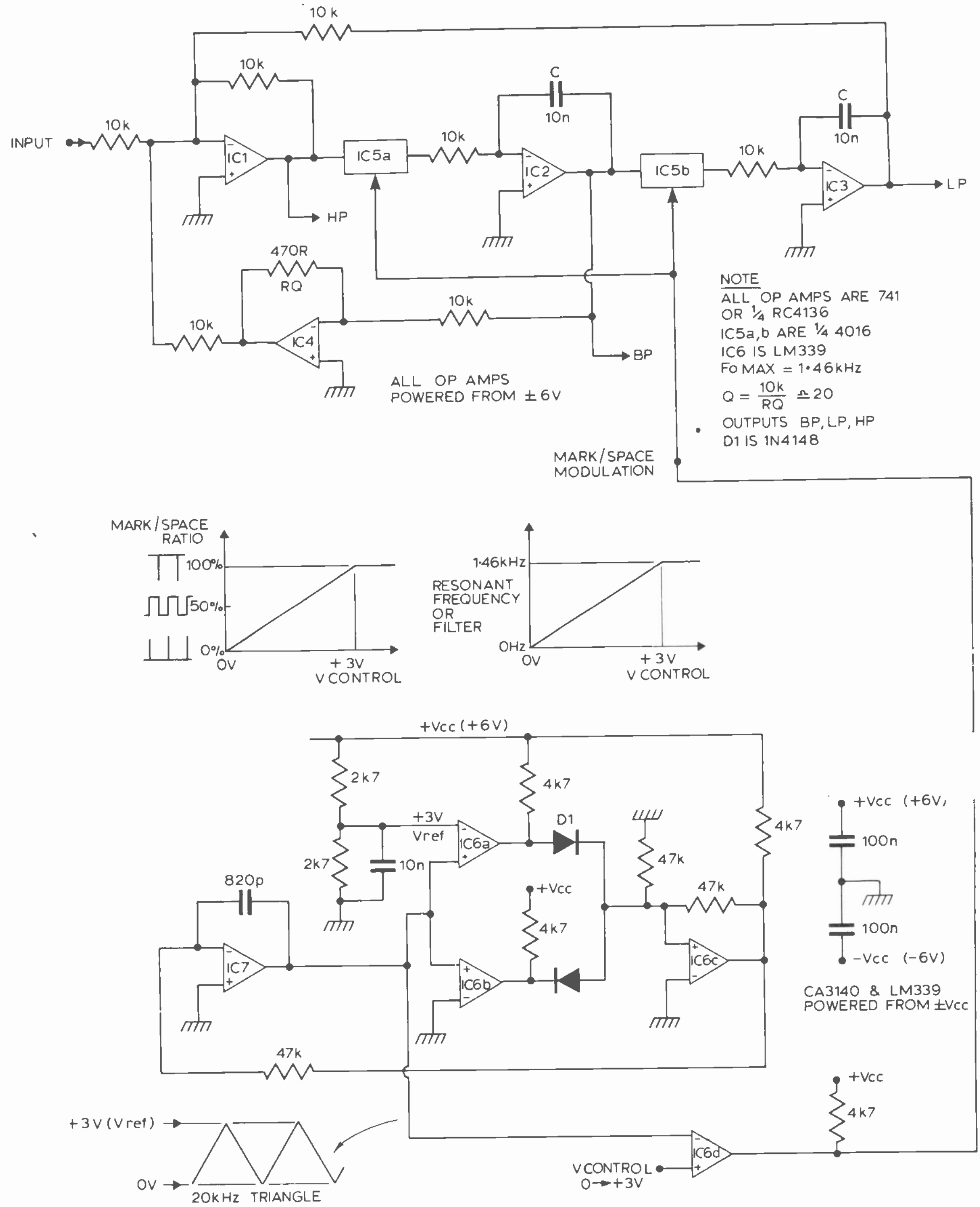


"No. I thought you were supposed to bring the key!"



"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.

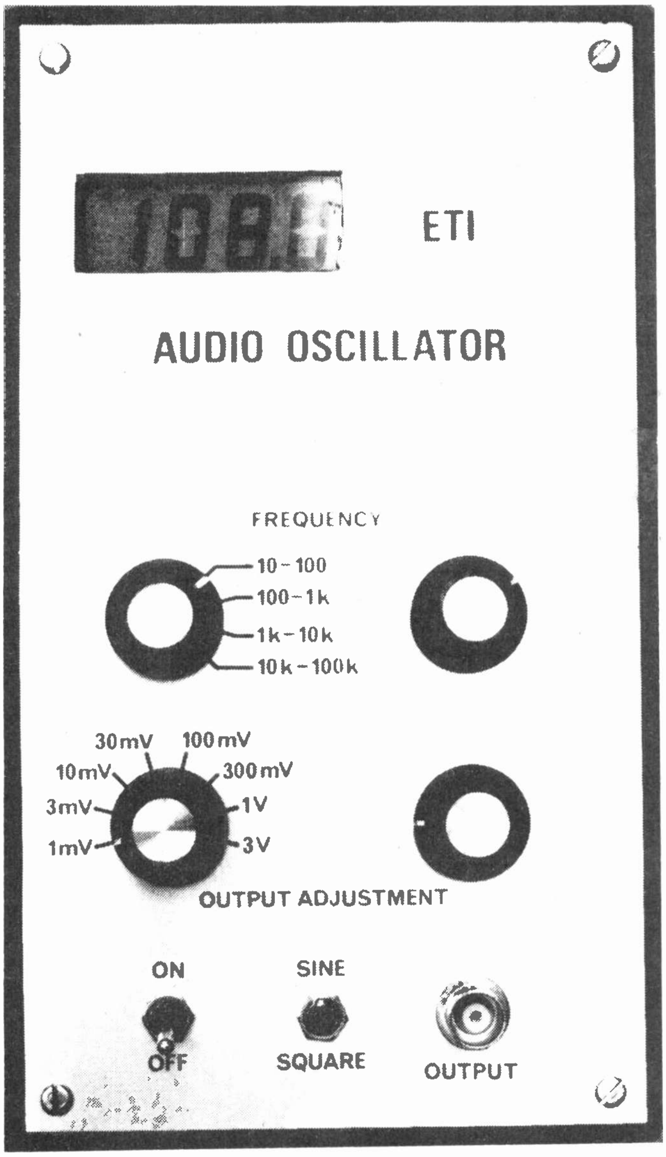
It is important that the frequency of the markspace oscillator be relatively high. As a rule of thumb it should be 2½ times the highest frequency components of the signals that you hope to process. The triangle output is fed into IC11's inverting input, the control voltage into the non inverting input. 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.

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.

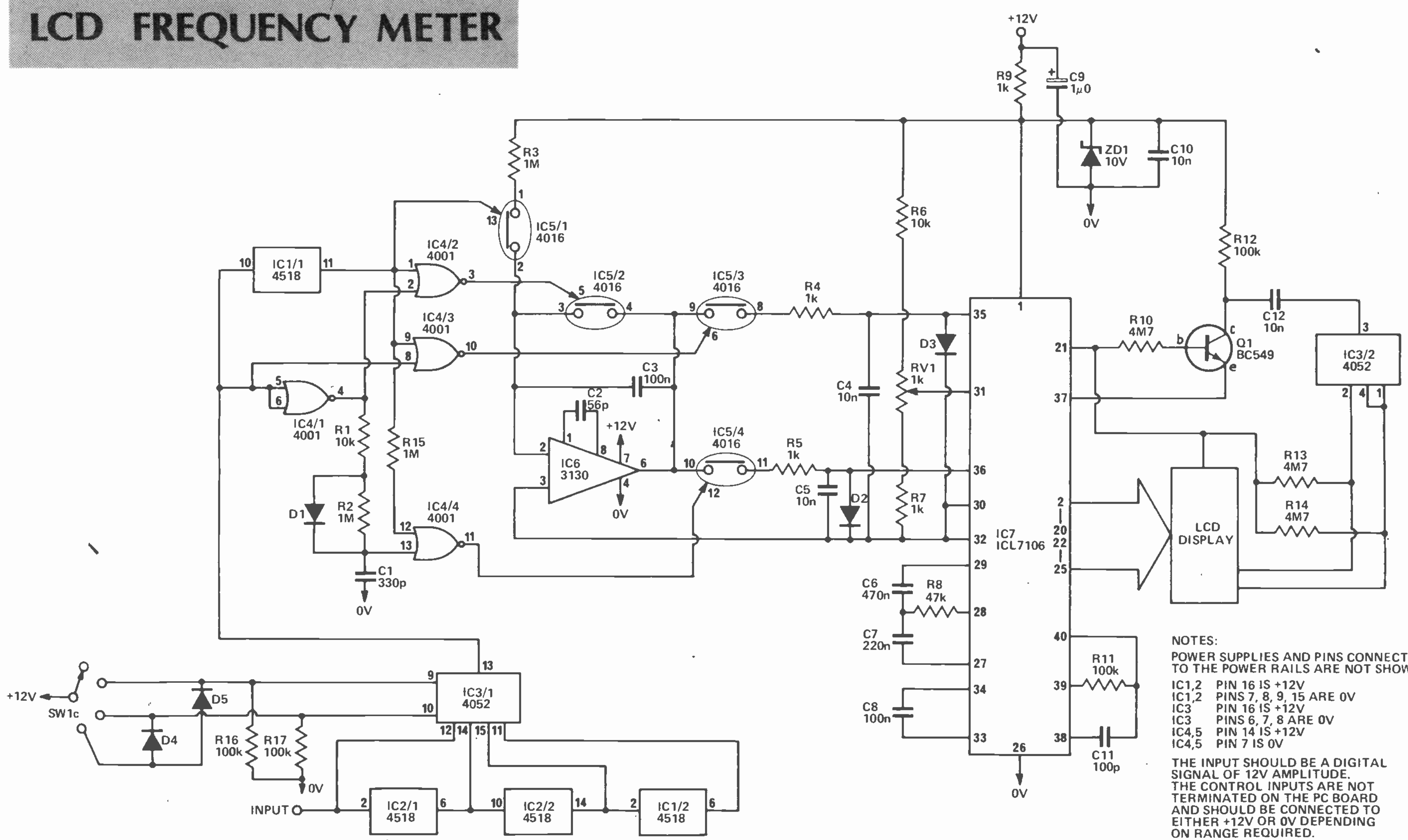
One major problem with all home made oscillators is that of scaling the frequency dial. This is not just a problem of positioning the knob but since normally available potentiometers have a tolerance of ± 20%, the scale length will also vary. In commercial units the use of an expensive wire wound potentiometer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



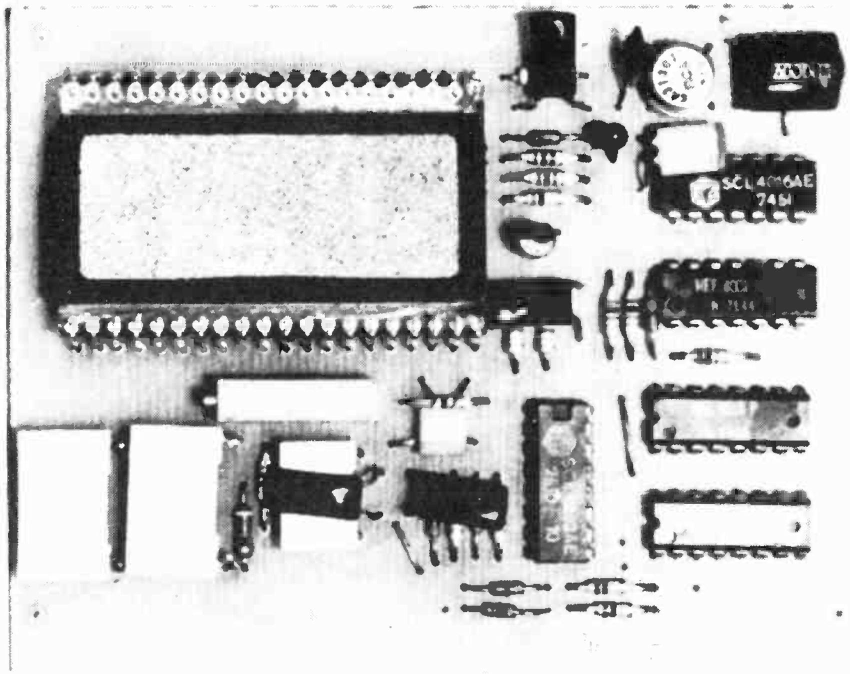
NOTES:
POWER SUPPLIES AND PINS CONNECTED TO THE POWER RAILS ARE NOT SHOWN.
IC1,2 PIN 16 IS +12V
IC1,2 PINS 7, 8, 9, 15 ARE 0V
IC3 PIN 16 IS +12V
IC3 PINS 6, 7, 8 ARE 0V
IC4,5 PIN 14 IS +12V
IC4,5 PIN 7 IS 0V
THE INPUT SHOULD BE A DIGITAL SIGNAL OF 12V AMPLITUDE.
THE CONTROL INPUTS ARE NOT TERMINATED ON THE PC BOARD AND SHOULD BE CONNECTED TO EITHER +12V OR 0V DEPENDING ON RANGE REQUIRED.

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.

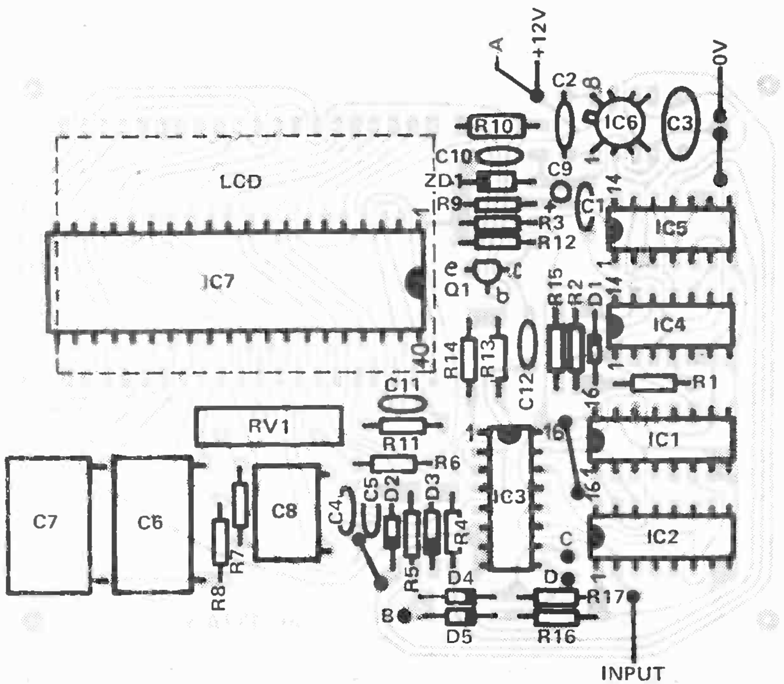
PARTS LIST

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

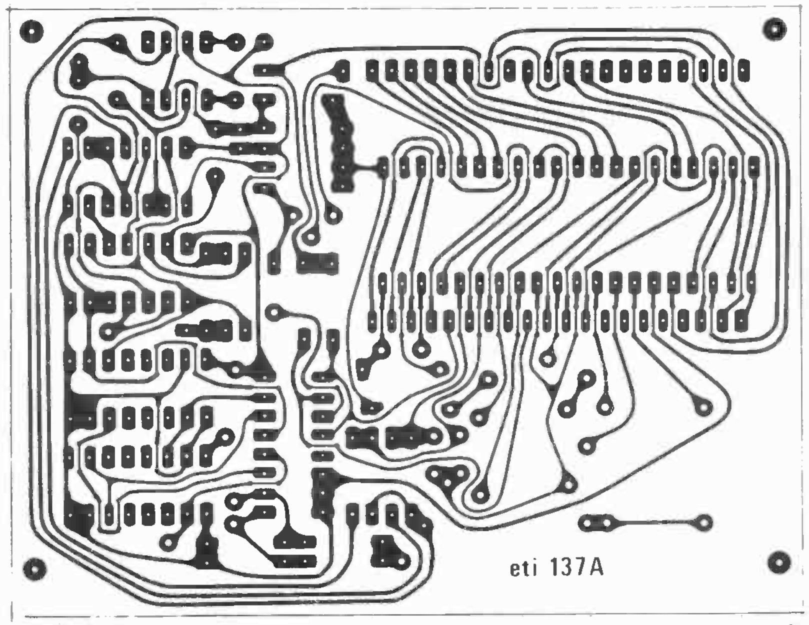
POTENTIOMETER	
RV1	1k ten turn trim

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.



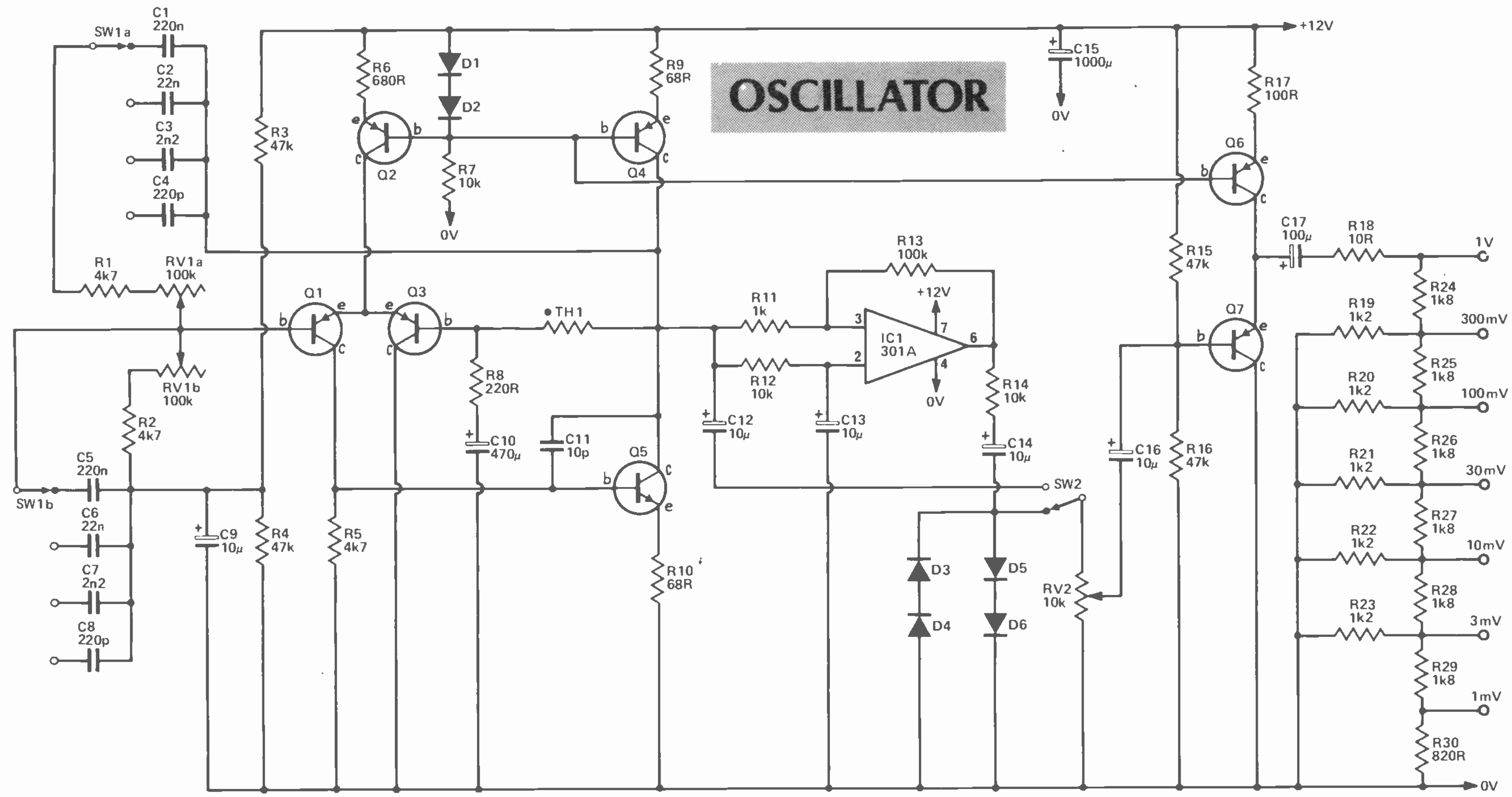


Fig. 2. The circuit diagram of the oscillator section.

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	820R

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

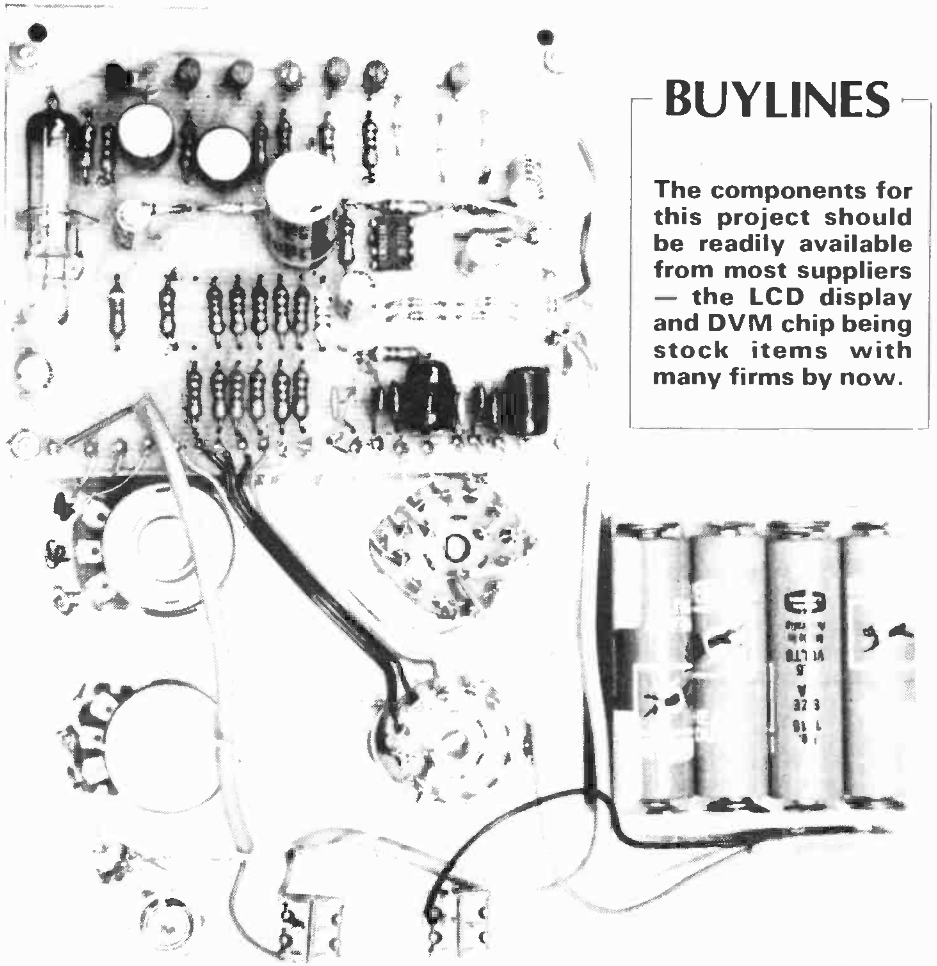
The oscillator is of the conventional Wein bridge type with a differential amplifier made up by Q1-Q5. Gain stabilization is provided by the thermistor TH1. This type of circuit oscillates at the frequency where the impedance of the capacitors equals the resistors in the Wein bridge arms. With this feedback 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.

		Q5	BC549
		Q6, 7	BC559
		D1-D6	1N914
THERMISTOR		SWITCHES	
TH1	type R53	SW1	Three pole four way rotary
		SW2	SPDT
POTENTIOMETERS			
*RV1	100k dual rotary	MISCELLANEOUS	
RV2	10k lin rotary	PCB	

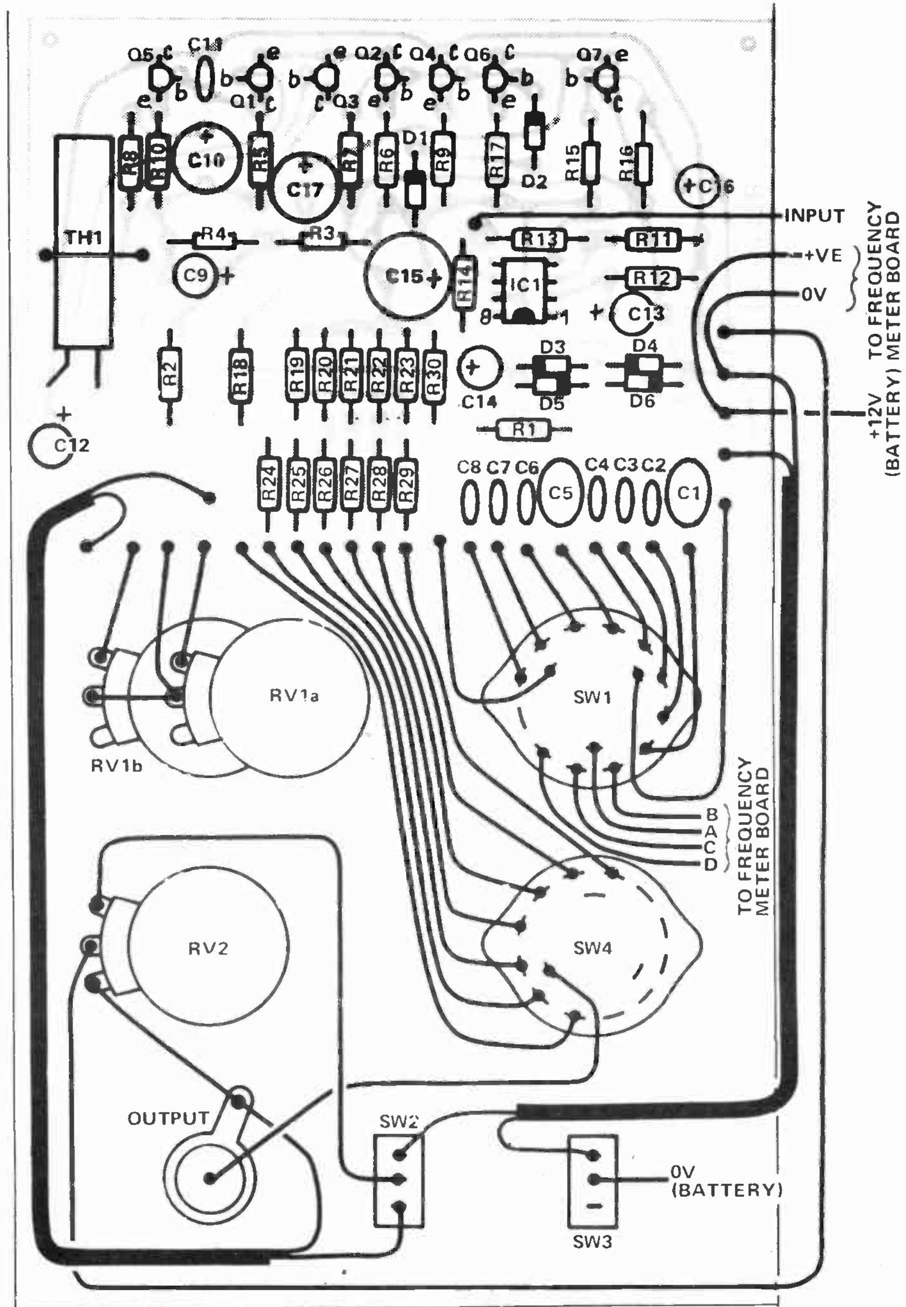
*RV1 — the preferred curve giving best resolution is antilog. If reverse rotation is acceptable log is as good. Otherwise use a linear curve.



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.



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▶

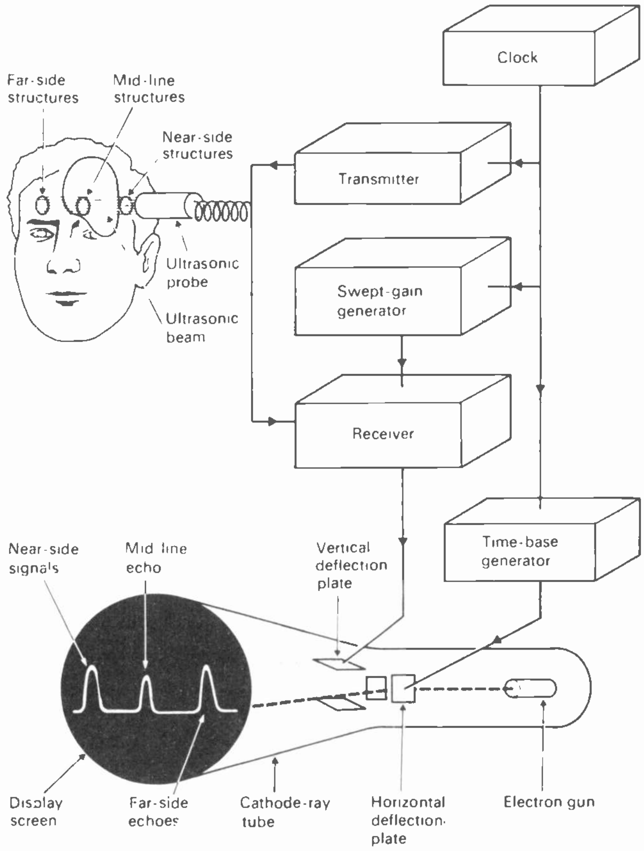


Fig. 1. Basic arrangement of the A-scope system, in use in this instance to show the mid-line structures of the brain in their relative position halfway between the sides of the skull, as indicated by symmetry of the deflections of the cathode-ray tube trace. Asymmetrical spacing of the deflections may 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.

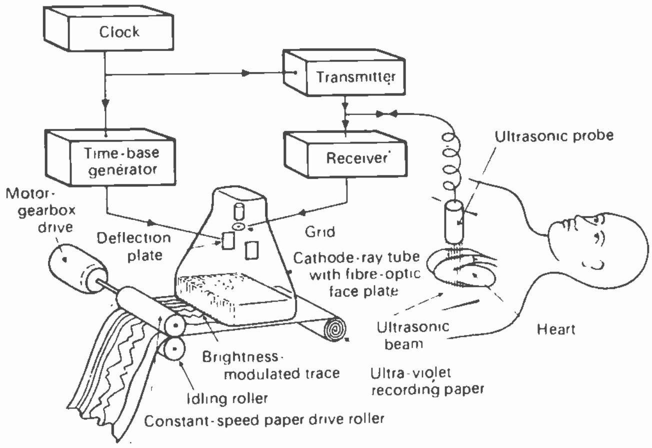


Fig. 2. Time-position recording system based on the B-scope display, shown in use for echocardiography. The fibre-optic face plate of the cathode-ray tube collects enough light to produce a self-developing trace on ultra-violet recording paper.

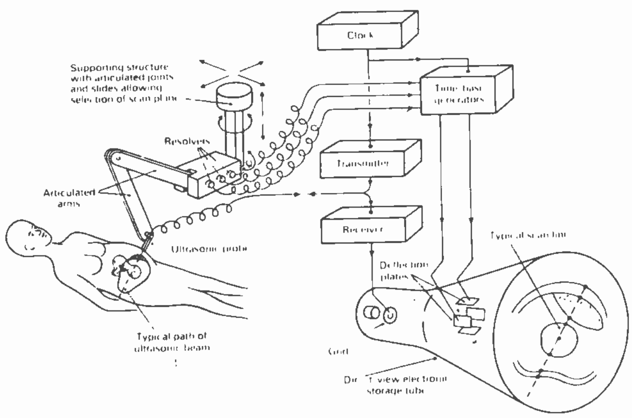


Fig. 3. Two-dimensional scanner and B-scope display system studying a foetus. The time-base generators are driven by electrical outputs from a series of resolvers that measure the position of the ultrasonic beam as it moves across the patient. Horizontal and vertical time-bases combine to deflect the 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.

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

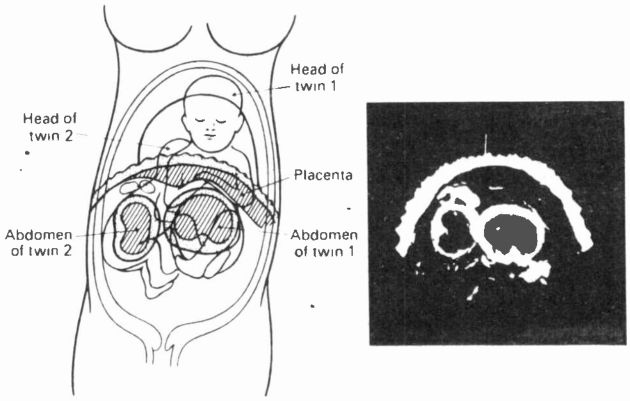


Fig. 4. A two-dimensional scan reveals twins at about 25 weeks of pregnancy. The placenta on the anterior wall of the uterus is clearly defined while the abdomens of the twins, identified in the explanatory diagram, appear in section.

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.

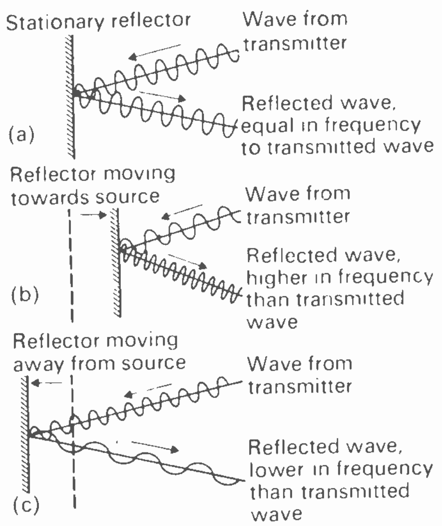
A cross-sectional image of the surfaces can be built up photographically by a camera with an open shutter that records the bright spots on the display while the patient is being scanned. The echo information can also be stored electronically.

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 ▶



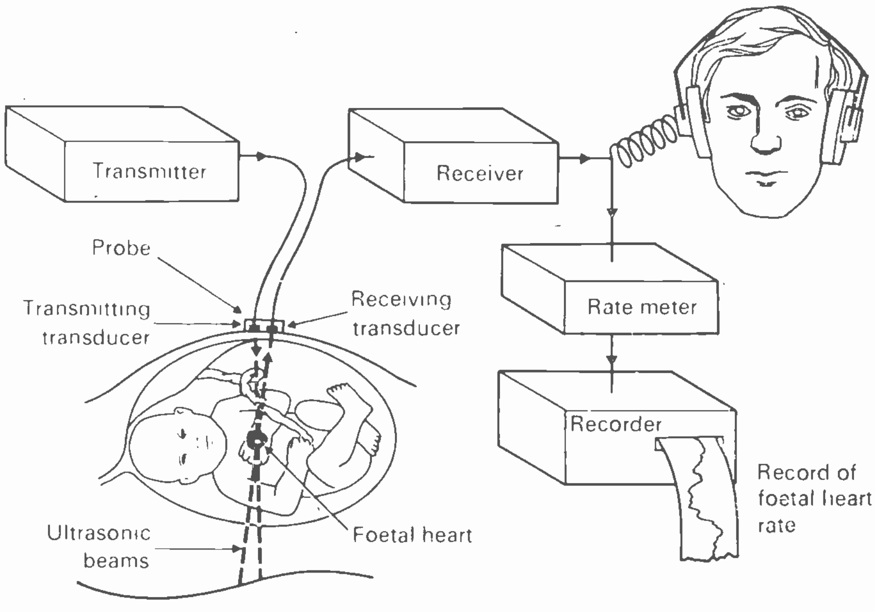


Fig. 5. The Doppler effect occurs when a wave is reflected from a moving surface, giving an upward or downward 'shift' in frequency as in (b) and (c).

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.

ETI

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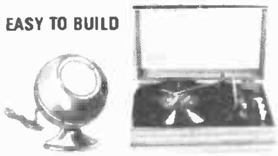

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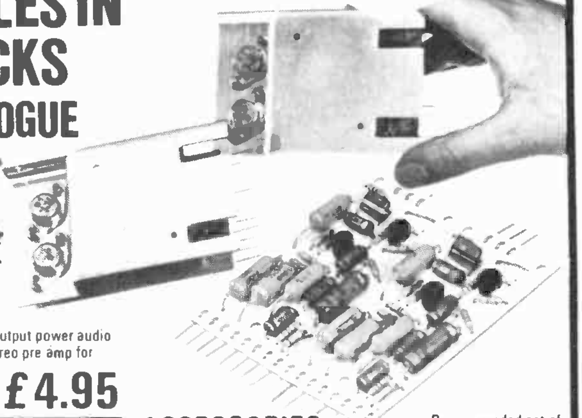

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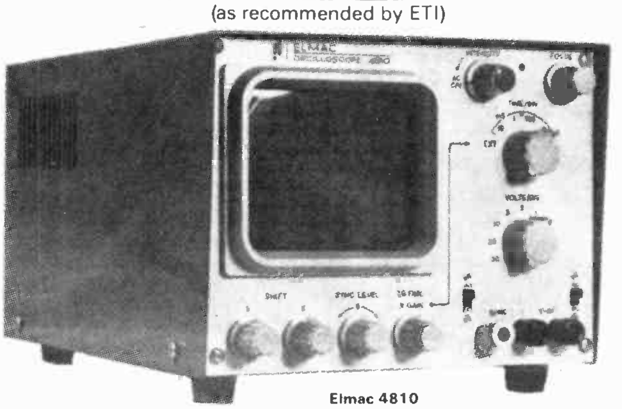
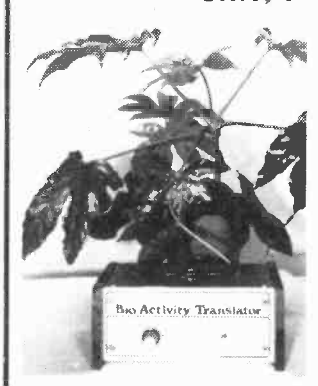




Bio Activity Translator

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.

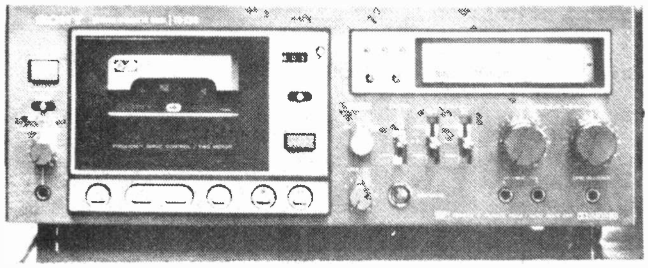
Outlook: Warm and Sony

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?).

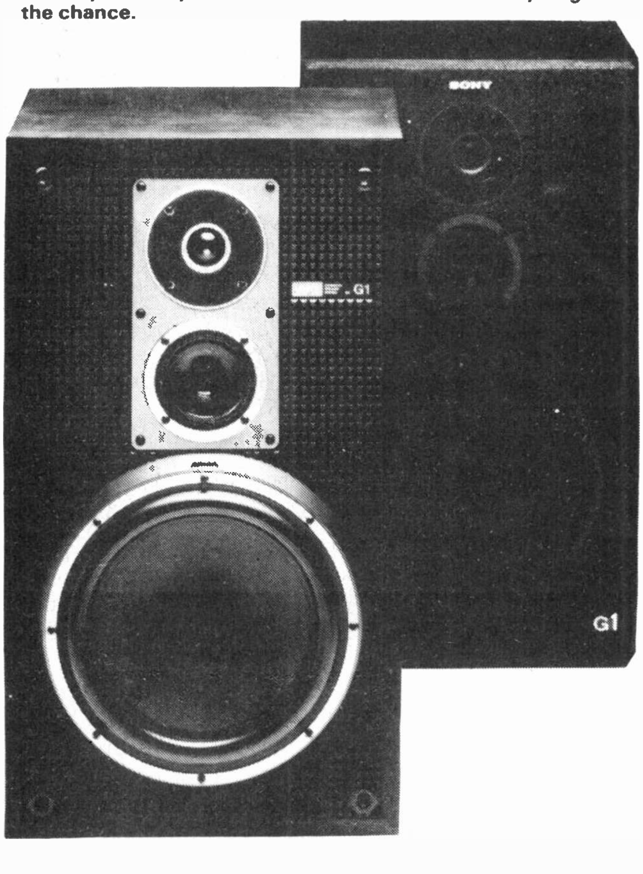
The G1 and G7 speakers came as a surprise too, they're better than any oriental offering previously to assail my ear drums, and are capable of giving any competitor a good run for its cones.

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

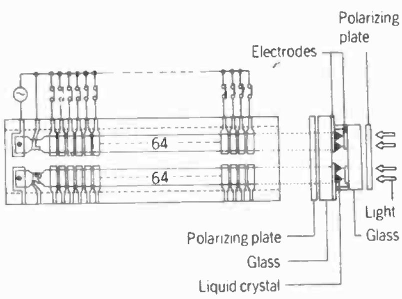


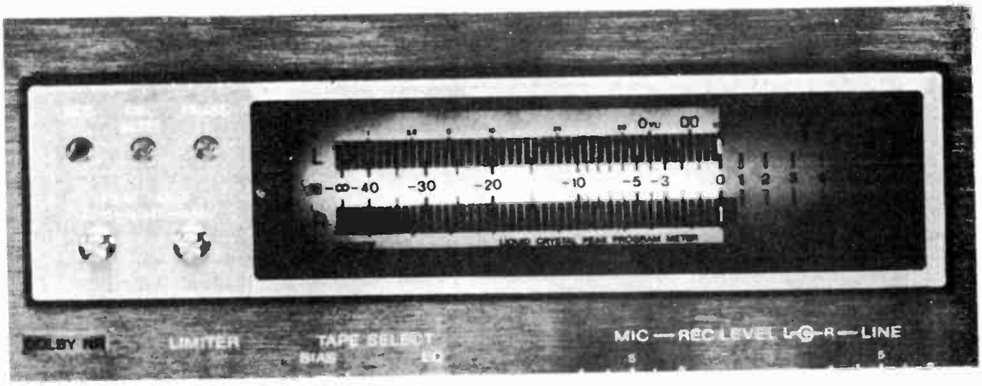
And here we have the TC K8B the new £469 cassette deck released as part of the super-fi Sony range. It incorporates that magnificent LCD display (details on the right) and on the short listen so far gave an excellent audio account of itself.

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.

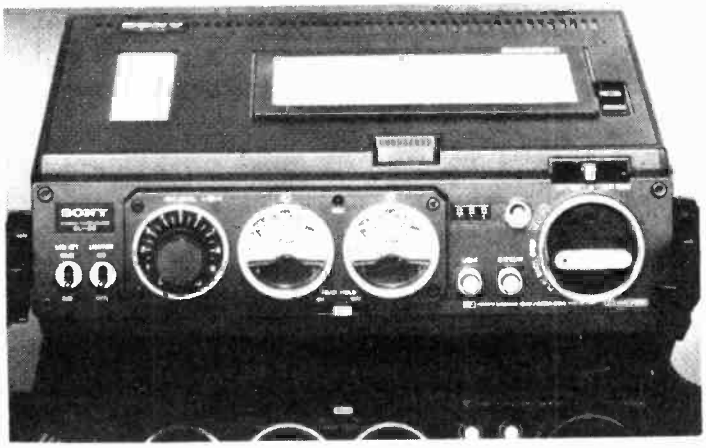


LCD Peak Programme Meter



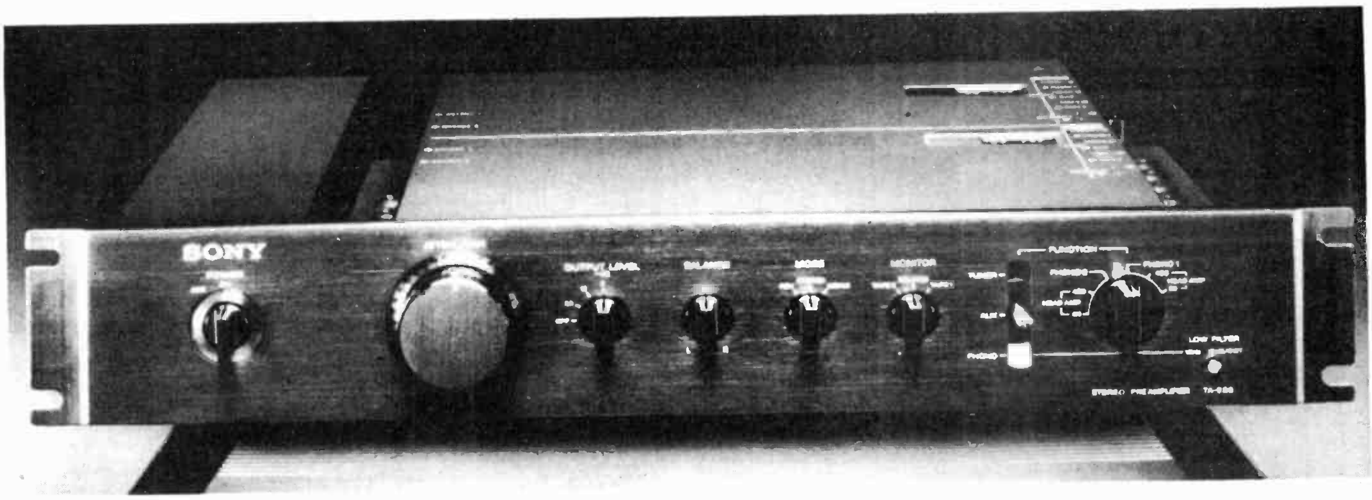


Above: the LCD level meter as used in the TCK8B in close-up. This uses 64 segments to indicate signal level, and has red settable stops to hold peak values. The colours are nice too!



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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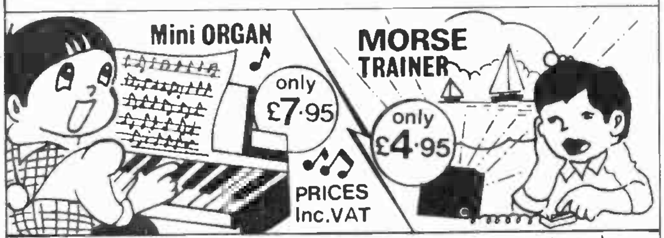

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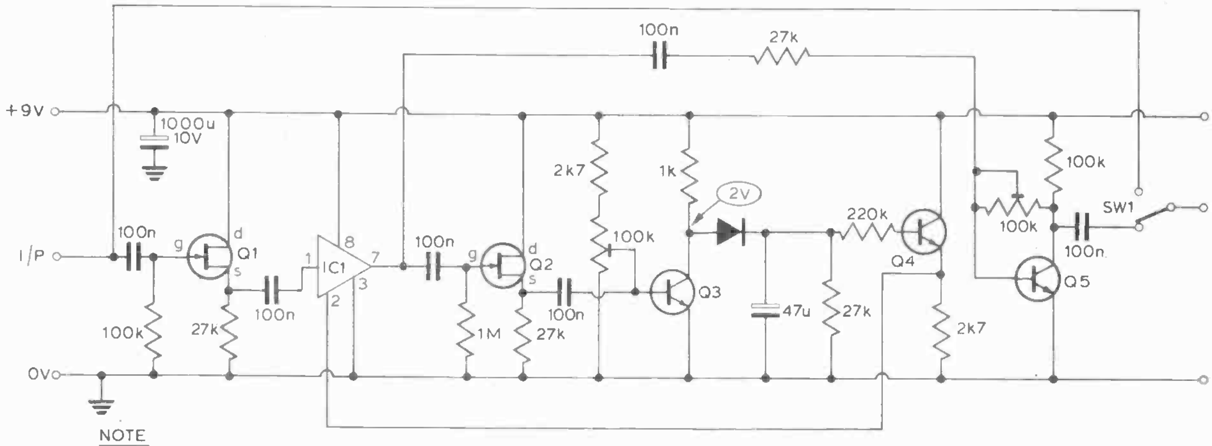
Guitar Sustain Unit

S. D. Maistre



NOTE
Q1, 2 are 2N3819
Q3,4,5 are BC109C
D1 is OA91
IC1 is MC3340

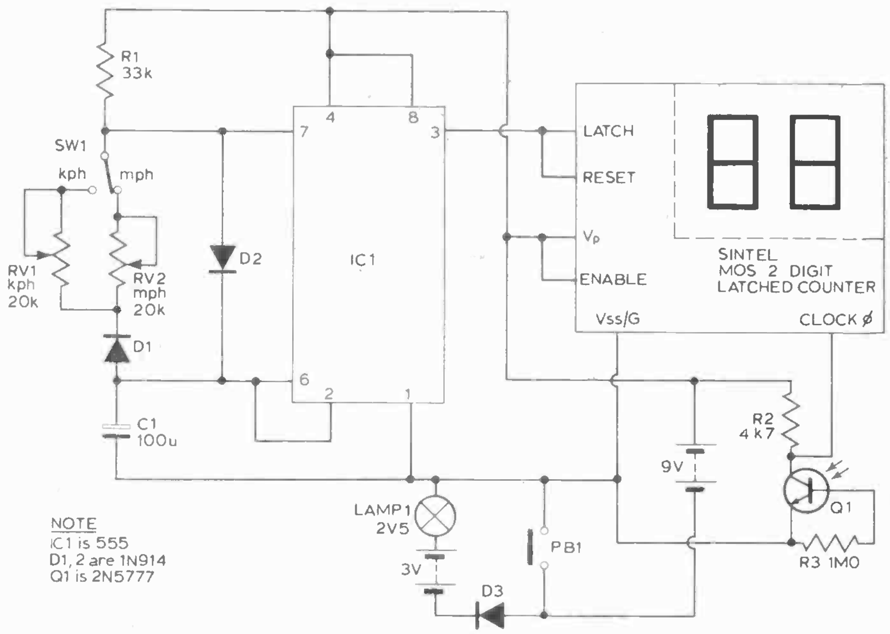
The sustain to be described here holds the output at a constant level over a wide range of input levels. It was designed for use with electric guitars and has a maximum effect with the guitar pick-up volume full up.

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



NOTE
IC1 is 555
D1, 2 are 1N914
Q1 is 2N5777

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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60FE30	30+30	1A EACH	3.60	75p
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50FE15	15+15	1.6A EACH	3.10	70p
50FE20	20+20	1.2A EACH	3.10	70p
50FE28	28+28	0.9A EACH	3.10	70p
50FE30	30+30	0.8A EACH	3.10	70p
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20FE09	9+9	1.0A EACH	2.60	65p
20FE12	12+12	0.8A EACH	2.60	65p
20FE15	15+15	0.6A EACH	2.60	65p
20FE20	20+20	0.5A EACH	2.60	65p
60FE52	26-0-26	1A EACH	3.60	75p
60FE60	30-0-30	1A EACH	3.60	75p
80FE52	26-0-26	1.5A EACH	4.50	75p
80FE60	30-0-30	1.5A EACH	4.50	75p
100FE28	28-0-28	2.0A EACH	4.50	75p

Type	Voltage	Current	£	p/p
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12FE10	10+10	0.6A EACH	2.0	60p
12FE12	12+12	0.5A EACH	2.0	60p
12FE15	15+15	0.4A EACH	2.0	60p
12FE20	20+20	0.25A EACH	2.0	60p
08FE06	6+6	0.6A EACH	1.80	50p
08FE09	9+9	0.5A EACH	1.80	50p
08FE10	10+10	0.4A EACH	1.80	50p
08FE12	12+12	0.3A EACH	1.80	50p
08FE15	15+15	0.25A EACH	1.80	50p
06FE06	6+6	0.5A EACH	1.50	50p
06FE10	10+10	0.35A EACH	1.50	50p
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C. Ching

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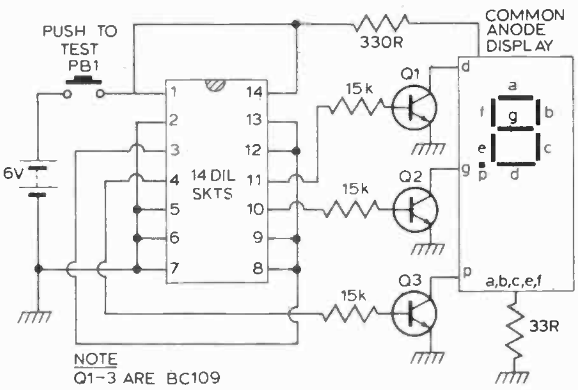
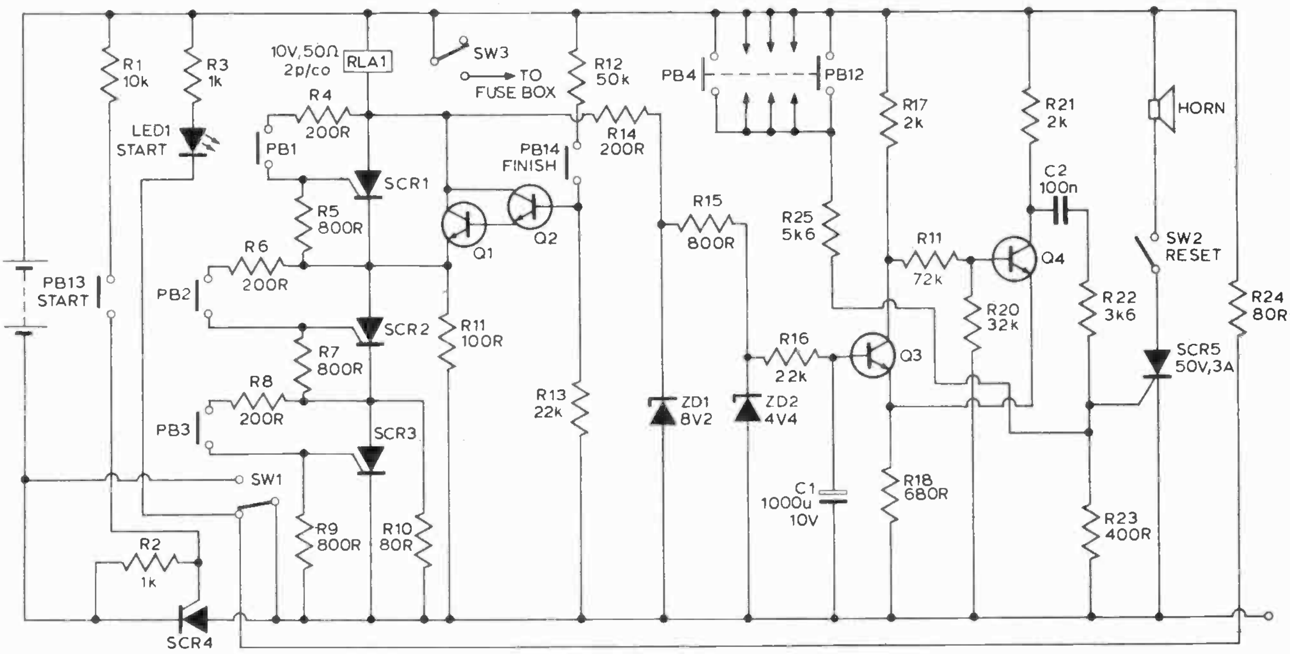


Electronic Ignition Switch

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

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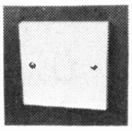

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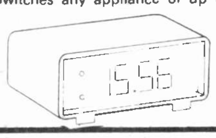

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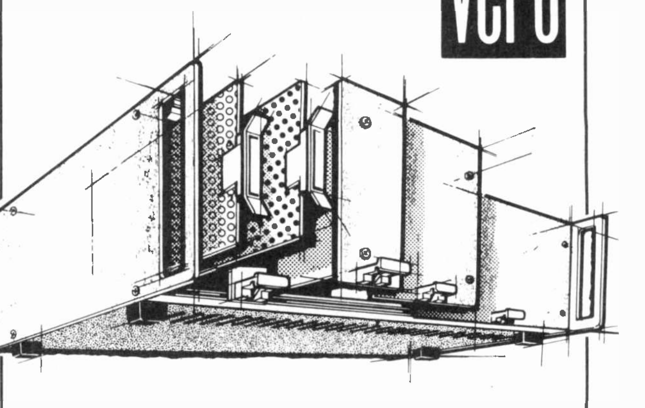

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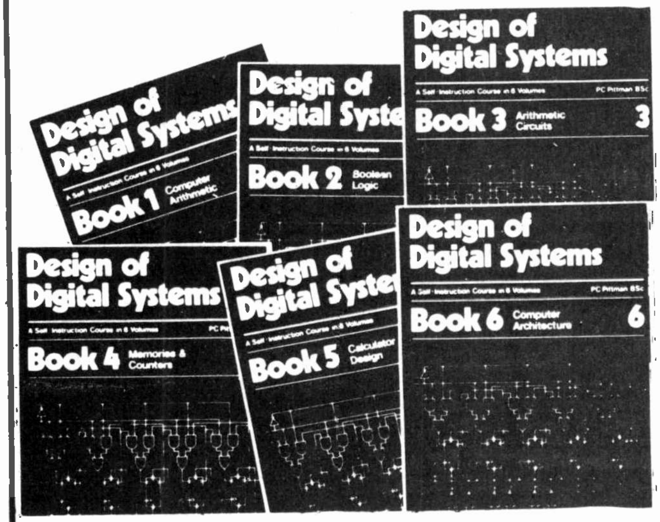

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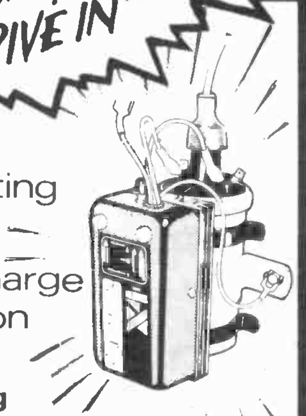

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FEATURES INCLUDE:
- 50p Discount Vouchers
- Quantity prices for bulk buyers
- Bargain List Supplement
- Reply Paid Envelope
- Priority Order Form
- VAT inclusive prices

Price 30p + 15p Post.

HEAT SINK OFFER
Copper TO5 sink 17mm dia x 20mm. 10 for **40p**; 100 for **£3**; 1,000 for **£25.**

74 SERIES PACK
Selection of boards containing many different 74 series ICs. 20 for **£1**; 50 for **£2.20**; 100 for **£4.**

TMS4030 RAM
4096 bit dynamic RAM with 300ns access time; 470ns cycle time; single low capacitance high level clock i/p; Fully TTL compatible; Low power dissipation. Supplied with data **£2.75.**

MISCELLANEOUS ICs
Supplied with data if requested. MC3302 quad comp. **120p;** 710 diff comp. (TO99) **40p;** ZN1034E precision timer **£2.25;** LM711 Dual diff comp **65p;** LM1303 dual stereo pre-amp **75p;** MC1469R voltage reg **£1.50;** UPC1025H audio **£3.50;** 575C2 audio **£2.88;** TDA2640 audio **£2.92;** TBA810S audio **70p;** SN75110 dual line driver **70p;** MC8500 CRCC gen POA.

EXPERIMENTERS CALCULATOR
Based on the C500 chip, this pack of parts enables the more experienced constructor to make an 8 digit 4 function calculator. The comprehensive data supplied includes full-size layout of PC8 required, types of suitable display and keyboard that can be used etc. Components included in the pack are C500 calculator chip, driver IC, all components for inverter/clock circuits, Rs Cs etc. All for only **£3.50.**

RELAYS
W847 Low profile PC mntg 10 x 33 x 20mm 6V coil, SPCO 3A contacts **93p.**
W832 Sub. min type, 10 x 19 x 10mm 12V coil DPCO 2A contacts **£1.15.**
W701 6V SPCO 1A contacts 20 x 30 x 25mm. Only **56p.**
W817 11 pin plug in relay; rated 24V AC, but works well on 6V DC. Contacts 3 pole c/o rated 10A. **95p.**
W819 12V 1250R DPCO 1A contacts. Size 29 x 22 x 18mm min. plug-in type **72p.**
W839 50V ac (24V DC) coil. 11 pin plug-in type. 3 pole c/o 10A contacts. Only **85p.**
W846 Open construction mains relay. 3 sets 10A c/o contacts. **£1.20.**
Send SAE for our relay list — 84 types listed and illustrated.

LOW COST PLASTIC BOXES
Made in high impact ABS. The lids are retained by 4 screws into brass inserts. Interior of box has PCB guide slots (except V219).

V210	80x62x40mm black	**58p**
V213	100x75x40mm black	**72p**
V216	120x100x45mm black	**86p**
V219	120x100x45mm white	**86p**

SPECIAL SUMMER OFFERS
Audio ICs

76003N	**£1.40**	76013N	**£1.00**
76023N	**£1.00**	76033N	**£1.40**
LM380	**80p**	TBA810S	**90p**

Linear ICs etc.

741(8DIL)	**18p**	BD131	**24p**
555	**25p**	BD132	**28p**
1N4148	**2p**	2N3819	**18p**

DIODE SCOOP!!!
We have been fortunate to obtain a large quantity of untested, mostly unmarked glass silicon diodes. Testing a sample batch revealed about 70% useable devices — signal diodes, high voltage rets and zeners may all be included. These are being offered at the incredibly low price of **£1.25**/1,000 — or a bag of 2,500 for **£2.25.** Bag of 10,000 **£8.** Box of 25,000 **£17.50.** Box of 100,000 **£60.**

ELECTROVALUE Buying Guide

Section 5

If you have bought from us before, you will know just how large and varied our stocks are. For those who have yet to know, we are publishing a series of five advertisements month by month to give up-to-date information and prices on the most important items we carry. These advertisements will appear in stepped rotation in five journals — E.T.I., Elektor, Practical Wireless, Practical Electronics and Everyday Electronics, so that the complete series will be available each month. In this way, no matter which journals you read, BY DETACHING AND SAVING THESE PAGES, YOU WILL HAVE A VALUABLE AND COMPREHENSIVE MONEY SAVING CATALOGUE. Next month — Section One.

HARDWARE / SOLDER TOOLS

SOLDER TOOLS

ORYX50 Temp. controlled . . . £8.90N
Spare element £3.60N
Bits (11 types) . . . ea 90pN
ORYX Super 30 . . . £3.50N
Spare element . . . £2.50N
Bits as for ORYX50

ISO-TIP Quick Charge cordless iron £18.50N
Bits micro 7566 . . . . £2.30N
fine 7545 . . . £2.30N
h.d. 7546 . . . £2.30N
Std 7535 . . . . £2.30N
PC drill attachment 6500 . . . . £10.60N
Spare bulb 35pN
ERSA Sprint
Solder gun £8.62N
Spare element £5.00N
Bit No. 862VN . . . 40pN
ERSA solder station
Temp. controlled iron with stand £59.00N
GREENWOOD PYROMETER £25.00N
DESOLDER TOOL
SR3A £5.95N
Spare nozzle, PTFE SR3AN 65pN
ANTEX C-240V 15W . £3.60N
Spare element £1.60N
Nickel plated bits 46pN
No 2 .094"; No. 4 . 187" No. 6 047"
Iron coated bits . . . 46pN
No. 102, 104, 106
ANTEX CCN-240V . . £3.80N
(low capacitance) 15W
Spare element £1.90N
Iron coated bits . . . 46pN
1100 ; 094", 1101 225" 1102 . 187"
ANTEX CX 240V . . . £3.60N
Spare element £1.60N
Bits for CCN above
ANTEX X25-240V 25W £3.60N
Spare element . . . £1.60N
Iron coated bits . . . 50pN
50 . 094"; 51 125" 52 . 187"
ANTEX STAND ST3 £1.50N
No. 666 Sponge . . . 6pN
SOLDERSTAT RANGE
HMS 240V 16W . . . £4.75N
HMS 240V 24W . . . £4.75N
HMS 110V 16W . . . £4.75N
HMS 110V 24W . . . £4.75N
Spare elements . . . £2.35N
Nickel plated bits
2037 3.2mm 80pN
2038 2.4mm 80pN
2003 2mm stub . . . 80pN
Iron plated
2032 4 5mm £1.90N
2033 6.5mm £1.90N
IC desolder head for HMS Irons
14-way £5.70N
16-way £5.70N
HMS 240V Solder Kit in presentation box £8.90N
HMS 12V solder kit in wallet £7.60N

VERO PRODUCTS

VEROBOARD
0.1" matrix copper clad 3.75" x 2 5" 46p
5" x 2.5" 55p
5" x 3.75" 55p
5" x 3.75" 62p
8.45" x 1.5" 53p
DIP-BOARD £2.24
VQ Dip-Board 91p
24-way plug-in £2.20
32-way £2.40
EURO Dip-Board £3.57
0.1" matrix unclad
3.75" x 2.5" **31p** 5" x 3.75" **50p**
EURO Board 89p
0.15" matrix, copper clad
3.75" x 2.5" **36p** 5" x 2 5" **50p**
3 75" x 3.75" **50p** 5" x 3.75" **67p** 8.45" x 1 5" **53p**
0.2" matrix, copper clad
5" x 3.4" 76p
PIN INSERTION TOOLS
No. PIT1 for 0.040" pins (0.1" matrix) £1.10
No. PIT5 for 0.052" pins (0 15" matrix) £1.10
SPOT FACE CUTTER
Suitable for any matrix . . . 81p

TERMINAL PINS
(Not made by Vero)
0 040" dia for 0.1" matrix per 100 **35p** per 500 **£1.15**
0.052" dia for 0.15" matrix per 100 **40p** (Both types double ended)
VEROBOX STANDARD BOXES
High Impact polystyrene light grey top, dark grey bottom section.

Type	L	W	H	
2514F	100	50	25	£1.64
2516G	100	50	40	£1.86
2518H	120	65	40	£2.07
2520J	150	80	50	£2.35
2522K	188	110	60	£3.13

VEROBOX CASES
Constructed from ABS material light grey top & dark grey bottom section Anodised ali. front and rear panels Internal guides for PC boards

Type	L	H	D	
1237J	154	40	85	£2.56
1238D	154	60	85	£2.82
1239K	154	80	85	£3.38
1410J	205	40	140	£3.53
1411D	205	75	140	£3.96
1412K	205	110	140	£5.12

SLOPING FRONT PLASTIC CASES
The 1798k has white top and grey bottom section. the 2523E has light grey top and dark grey bottom section.
Both have anodised aluminium panels.

Type	W	H1	H2	D	Price
1798K	171	38	75	121	£4.19
2523E	220	52	100	156	£6.36

19" CARD/FRAME CASE SYSTEM
accepts plug-in modules and standard European size circuit boards.
Light blue with natural anodised aluminium end plates
Can be rack-mounted.

Type	Item	Price
3841L	Case	£20.71N
3842F	End plate angles (pr.)	83pN
3843A	8" Module	£4.00N
3844G	4" Module	£3.05N
3845B	2" Front panel	£1.02N
3846H	1" Front panel	97pN
3979K	Board for module	£1.39
1034E	Veroboard, clad	£1.42
1041J	DIP-board	£3.59
0267H	31-way plug	97pN
0258C	31-way socket	£1.06N

EUROCARD CONNECTORS
2876D 64-way plug £2.47N
2874C 64-way socket £4.48N

NEW ANOTHER SPECIAL FROM ELECTROVALUE
WE ARE NOW NATIONAL DISTRIBUTORS FOR
NASCOM 1 MICROCOMPUTER KITS
FOR DELIVERY FROM STOCK
NETT PRICES FROM £197.50 + V.A.T.
QUANTITY DISCOUNTS
TRADE ENQUIRIES INVITED

TRANSFORMERS
All mains transformer primaries suitable for 240V input except for 50TS2A
GP302 30V 2A tapped at 12, 15 20, 24V £4.60
GP501 50V 1A tapped 19,25,33,40V £4.30
GP502 50V 2A tapped 19,25,33,40V £6.30
GP601 60V 1A tapped 24,30,40,48V £4.60
GP602 50V 2A tapped 24,30,40,48V £6.70
50TS 50V 2A tapped 25,45V Pri/sec shield £6.55
50TS2A 50V 2A (110/120V pri) tapped 25,45V Pri/sec shield £6.55
28T05 12V,12V,2-0-2V 0.5A £3.85
28T1 12V,12V,2-0-2V 1A £4.90
28T2 12V,12V,2-0-2V 2A £5.30
12T05 6V,6V,0.5A (Split primary 120, 120V) £3.30
CT1 17V 1A charger duty tapped 9V £2.95
CT2 17V 2A charger duty tapped at 9V £3.25
CT4 17V 4A charger duty £3.85
FT1 6 3V 1.5A £2.45
GP12 12V 1.5A £2.30
606/1 6-0-6V 100mA £1.00
MT280 6V,6V, 250mA £1.40
909/1 9-0-9V 75mA £1.00
GP909 9-0-9V 0.5A £2.10
12012/1 12-0-12V 50mA £1.00
1200 12-0-12V 100mA £1.20
MT150 12V, 12V, 150mA £1.70
151A 15-0-15V 1A £3.20
GP202 20-0-20V 0.75A £2.30
301A 30-0-30V 1A £3.80
Miniature L S. transformer
LT700 Pri 1K2 C T. Sec 3.2n 39p

PRINTED CIRCUIT MATERIALS
COPPER CLAD BOARD 300 x 150mm
Single Sided
SRBP **85p**; Fibreglass £1.65
Double sided SRBP £1.00
UNCLAD SRBP 300 x 150mm 56p
FERRIC CHLORIDE, Lab. grade 100gm pack **47p**; 500gm jar £2.30
POSITIV-20 Aerosol, 75cc with instructions £1.30
ETCH RESIST PEN
Decon with spare tip 85p
73.00 63.00
SILVER CONDUCTIVE PAINT
3gm vial Elecolit 340
£1.92 £1.68 £2.20

RELAYS
MINIATURE CONTINENTAL TYPE
Type R42 12V 185n 2 C/O £1.80
Type R44 12V 185n 4 C/O £2.00
PC socket type P40 . . . . 97p
Ordinary wiring skt. W40 . . 88p
Mounting strip 6 posn R40 . 26p
PIGMY MAINS RELAY 3 C/O 10 amp 6V 29n, 12V 110n, 24V 475n
all d.c . . . . each £2.30
240V a.c 8200n coil . £2.55

REED RELAYS open construction
5V 106n CSA5 single n/o 90p
12V 645n CSA 12 single n/o 90p
5V 57n CDA5 double n/o £1.28
12V320n CDA 12 double n/o £1.19
REED RELAYS enclosed type n/o
LPS12 single 590n 98p
LPD12 double 355n . . . £1.32
LATCHING RELAYS enclosed n/o
CLA5, 5V 400n . . . £2.30
CLA12, 12V 225n . . . £2.30

MEET US AT BREADBOARD '78 STAND D.8

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FERRITES
BOOKS
Latest price list of all ranges free on request

SWITCHES

ERG Dual in Line
One pole change over SDC1 **42p** Two-SDC2, **78p** 3—SDC3, **£1.08** On Off 2 pole SDC2 **42p** 4 pole SDS4 **75p. 6p** SDS6 **£1.08. 8p** — SDS8, **£1.32.**
Multiple — **1p**/8 way DS16A1—B **99p 2p**/4W DS 16A2-4 **£1.08**
ROTARY MAINS
Lorlin MS 4 amp 48p
WAVECHANGE
Lorlin CK series, MBB contacts
12W **37p 1p**
6W **37p 2p**
4W **37p 3p**
3W **37p 4p**
ROTARY SWITCH KIT Type RA
6 wafers 60p
RA Wafers MBB
1P 1W or 2P 5W 66p
RA Wafers BBM
1P 12W, 2P 6W, 3p 4W, 4P 3W, 6P 2W . . . 66p

RA Shorting wafer, MBB
Rotating open-circuit 66p

PUSH BUTTONS
Standard Size
SSP10, 250V 3A a.c. push on, push off panel hole 0.5" . . . 59p
SSP11, as SSP10 push to make . . . 52p
Sub-Miniature 250V 0.5A a.c.
8531 push to make 62p
8533 push to break 62p
(Panel hole 0.25")

CASTELCO RANGE 250V 1A a.c.
0.375" hole with long white fixing ring unless otherwise ordered.
No. 2644 SP make 18p
No. 3244 DP make 34p
No. 2648 SP break 18p
No. 3248 DP break 34p
No. 2634 SP on/off 17p
No. 3234 DP on/off 30p
No. 4434 as 3234 but switch sections reversed 30p
No. 4444 as 3244 but switch sections reversed 34p
Spare rings in black, red, yellow, green, blue, white or pink **each 1p**

TOGGLE 250V 1.5A a.c.
Chrome finish
1011C SPST 56p
1016C SPDT 61p
1019C SPDT centre-off 64p
409 DPDT 77p
Sub-Miniature 250V 2A a.c.
Panel hole 0.25"
S7101 SPDT 63p
S7201 DPDT 84p
S7203 DPDT centre-off 84p
S7205 DPDT biased each side £1.20
S7207 DPDT biased one side £1.51
S7211 SP 3-way £1.10
S7301 3PDT £1.42
S7401 4PDT £1.80

MICROSWITCHES SPDT
SSU01 button, lever or roller 85p
TIME SWITCHES (Smith's)
For electrical use, 13A rating
IMERSET for wired-in situations, 2 on & 2 off actions per day £11.60N
AUTOSET 13A socket outlet. Otherwise as Imerset . £10.95N

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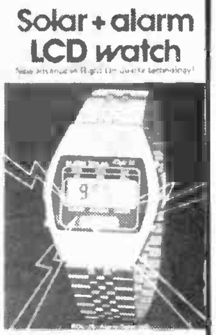
SAME AS ETI OFFER

5 FUNCTION LCD

Hours, mins, secs, month, date, auto calendar, back-light, quality metal bracelet.

£8.95

SPECIAL TO ETI READERS



SOLAR ALARM WATCH

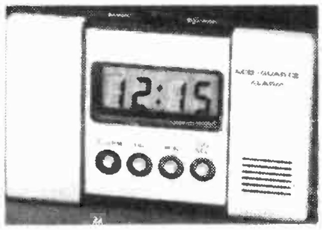
* Hours, mins, secs displayed.
* Day, date, day of week.
* 24 hour penetrating alarm.
* Quality metal bracelet.
* Powered from solar panel. With battery back-up.
* Back-light + auto calendar.

£29.95

'QUARTZ LCD ALARM'

Snooze + backlight. Batteries last 1 year approx. Includes batteries and travel pouch. Excellent value

£17.65



THOUSANDS SOLD 11 FUNCTION SLIM CHRONO

6 digit 11 functions

* Hours, mins, secs.
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* Back light, auto calendar.
* Only 8 mm thick.

This same watch is being sold for £22.00 in newspaper and magazine special offer ads.

Metac Price £12.65

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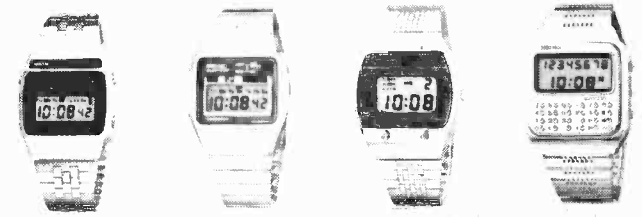
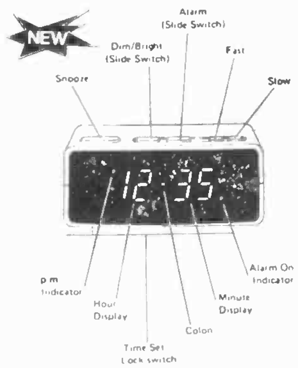
The Seiko Quartz Collection encompasses a wide and exciting range of quartz watches for men and women. Day/Date quartz. Ultra-thin quartz. Digital quartz watches with liquid crystal display for continuous readout. Even a digital quartz alarm chronograph. It's what you'd expect of Seiko. The first quartz watch ever sold was a Seiko. And Seiko's expertise in every phase of the watchmaking process makes it possible for Seiko to make any part of any Seiko watch, and to exercise a unique quality control system through every step from design to completion. Whichever Seiko Quartz model you select, you get more than just a technologically advanced timepiece.



List Price £130	List Price £85	List Price £120	List Price £165
Metac Price £105	**Metac Price £68**	**Metac Price £98**	**Metac Price £125**

HANIMEX Electronic LED Alarm Clock



Feature and Specification

* Hour minute display
* Large LED display with p m and alarm on indicator
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Size 5 15 x 3 93 x 2 36 (131mm x 100mm x 60mm)
Weight 1 43 lbs (0 65 kg)

£8.95 (Inclusive of VAT and Postage)

SOLAR

5 function LCD

* Solar panel with battery back-up.
* Back light + auto calendar.
* Hours, mins, secs, day, date.
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Only 25 x 20 mm and 6 mm thick. 5 function: hours, mins, secs, day, date. + back light and auto cal. Elegant metal bracelet in silver or gold. State preference.

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ALARM LCD

6 digit 7 function hours, mins, secs, day, date, day of week, 24 hour penetrating alarm. Back light + auto calendar

Only £24.95

THE METAC DIGITAL CLOCKS ★ COMPLETE KIT ★

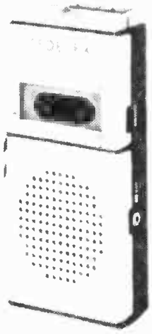
* Pleasant green display - 12/24 Hour readout
* Silent Synchronous Accuracy - Fully electronic
* Pulsating colon - Push-button setting
* Building time 1 Hr - Attractive acrylic case
* Easy-to-follow instructions - Size 10.5 x 5.7 x 8 cm
* Ready drilled PCB to accept components

PRICE £6.65

MICRO CASSETTE RECORDER

Hand-held only 2½ x 5 x 1½ inch. Identical to well known models being sold at £35

OUR PRICE £24



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+ free program library worth £4.00

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Shops open 9.30 to 6.00 daily.

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2N3055 transistors 50p
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green 15p
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DL 704 displays 80p
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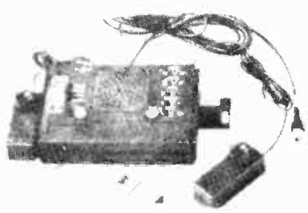
Also useful for sonic applications and sound transmitters (buzzers etc)

METAC EXCLUSIVE CALCULATOR WATCH + STOP-WATCH SEIKO STYLE

Calculator: X, ÷, +, −, K
Time: hours, mins, secs, day, date, day of week

PRICE £49

TV GAMES



Black & white **£9.95** Colour **£12.95**
4 games, 2 ball speeds, 2 ball angles, 2 bat sizes

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ETI 601R

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21L02 RAM (450ns)
1-15 @ 95p, 16-63 @ 92p, 64 up @ 89p
2114EMM RAM (300ns)
1-3 @ £6.25, 4 up @ £6
2708 EPROM (450ns)
1-3 @ £7.25, 4 up @ £7
16 PIN DIL SOCKETS
Gold 22p, 100 up 21p
Tin 12p, 100 up 11p
RAMS LIKE A SPARE BIT — 1.2mm bits for Antex CX17 and CCN soldering irons 45p
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AT LOW COST

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The experimenter and hobbyist needs

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Use the VIM by itself with its on board 28 double function keypad and 6 character LED display
Then expand to full mainframe via 3-44 way edge connectors
It comes to you assembled and tested
Just connect your +5V D1 5A power supply and

VIM-1 is operational in minutes
Three manuals provided enable you to MASTER MICROPROCESSOR TECHNOLOGY
Plus features include
- Hi speed cassette interface 185 bytes/sec
- IK user RAM with sockets for additional 3K
- Sockets for 20K ROM expansion
- ASII alpha/numerics direct to an oscilloscope.

- 4K SUPERMON MONITOR includes
- Single step with variable trace speed
- Register modify/inspect whilst in program
- Hex displacement calculator
- Black transfer plus much more

£199 plus 8% VAT = £15.92
TOTAL = £214.92

Plus full technical support and demonstrations from
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5-FUNCTION 13 AMP SOCKET TESTER
SAFELY SHOWS YOU!

Safety fast! Shows: **1,** If all wires correct, **2,** Live wire faulty, **3,** Live and Neutral wires reversed, **4,** Earth faulty, **5,** Neutral faulty. Shows exact fault instantly. British made. **£3.95** post free. Save time. Be sure. Be safe.

PERSONAL SAFETY CO.
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1.2V NICADS

For UK orders add 60p for post and packing
All prices include V.A.T.

BUTTON CELLS

	Dia.	Hgt.	Price/Cell
225mAh	25.0	7.5	0.65
600mAh	34.5	10.0	1.15

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(for fast charge)

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6.0V Pack 5x1.2 Ah nicads			7.50

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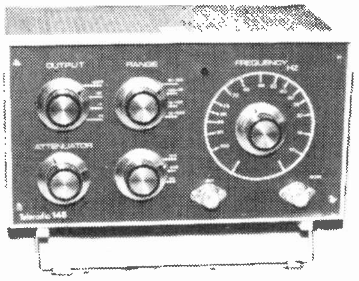

Illustration shows low distortion Audio Oscillator type A0146
Distortion 0015% Range 100hz to 100Khz Output 1v Sine & Square
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0.22	33	16	1.66	0.22-0.47	1.82	1 24	0.90
0.25	33	16	1.78	1.0	2.26	1.52	1.08
0.47	33	19	2.08	2.2	2.80	1.94	1.42
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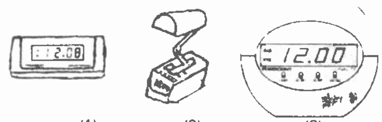

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ETI ADVERTISEMENT INDEX

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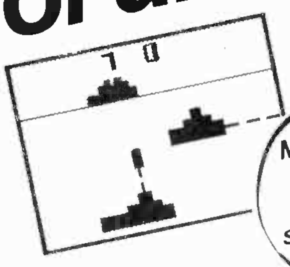
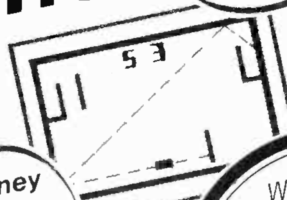
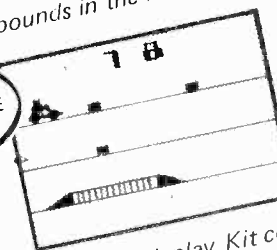
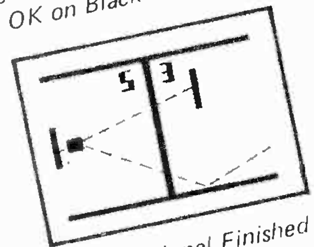

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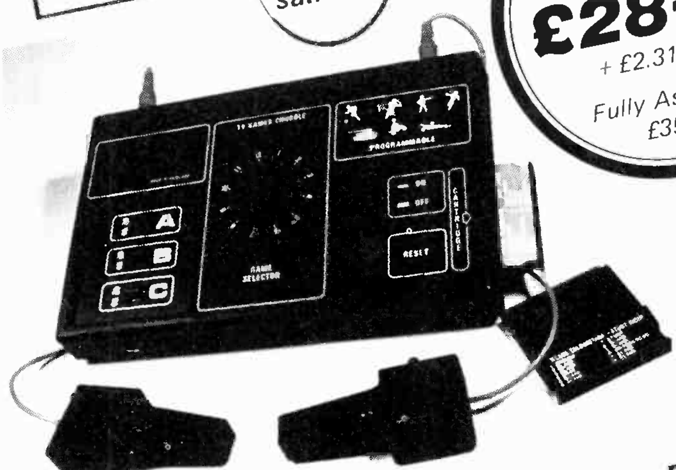
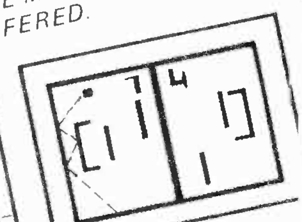
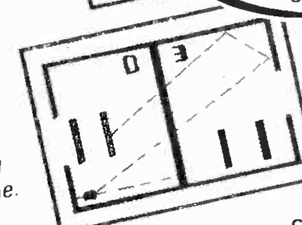
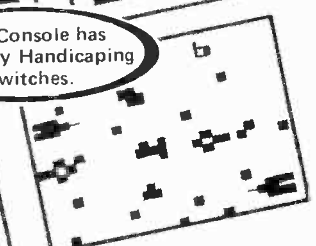




Main Console has 3 Facility Handicaping Switches.

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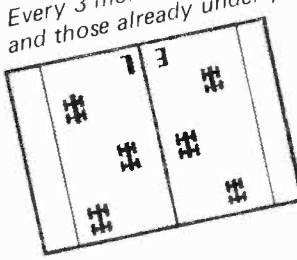

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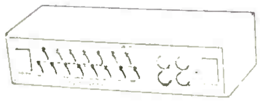

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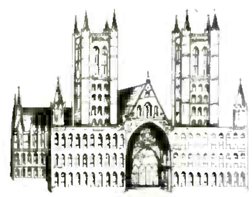

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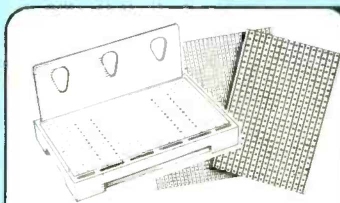

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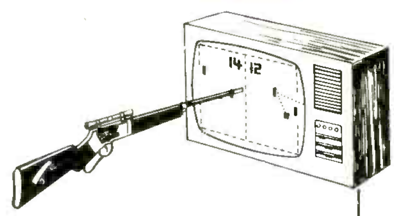

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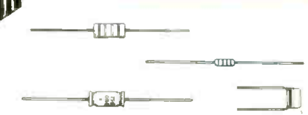

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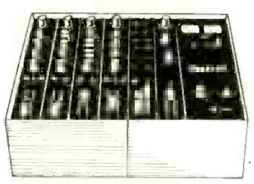

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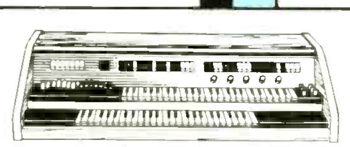

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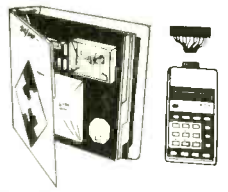

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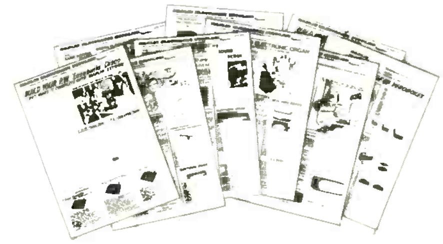

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