

electronics today

JULY 1978

INTERNATIONAL

45p

Single Board **SYNTHESISER**



TRANSCENDENT 2000

BUILD A

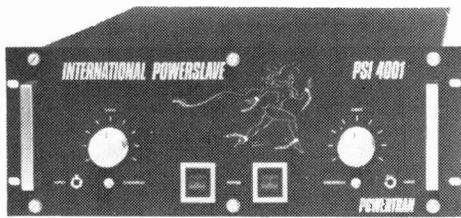
STEREO
10W AMP
£8-45!

VFETS For All
Oscillator Design
Brains & Computers
Temperature Meter

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

200 + 200W Dual Channel Amplifier

COMPLETE KIT AS FEATURED IN APRIL ISSUE OF E.T.I.



PSI 4001 SLAVE MODEL

**SPECIAL PRICES
FOR
COMPLETE KITS!**

PSI 4001 — £205.00 + VAT
PSI 4002 — £220.00 + VAT



PSI 4002 STUDIO MODEL

**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 incredibly 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 instructions suitable for both experienced constructors and newcomers to electronics
- * Value for money — quality and performance comparable with ready built amplifiers costing over £600!

Pack		Price
1	Fibre glass printed circuit board for power amp	£4.20
2	Set of capacitors, metal oxide resistors, thermistor, cornel pre-sets for power amp	£6.40
3	Set of semiconductors for power amp with mounting hardware, cooling tabs	£27.60
4	Pair of monster black drilled heat sinks, transistor mounting bracket	£6.90
5	Toroidal transformer: Primary 0-117V-234V. Secondaries 42-0-42V, 0-15V, 0-15V. Electrostatic screen	£19.20
6	Set of all parts for stabilised power supply including fibre glass printed circuit board, mounting bracket, semiconductors, resistors, capacitors, etc	£20.50
7A	Set of all parts for buffer/overdrive unit including fibre glass printed circuit board, semiconductors, resistors, capacitors, controls — required for PSI 4001 only	£3.80
7B	Set of parts for peak power meter including professional quality meter, fibre glass printed circuit boards, components, control — required for PSI 4002 only	£11.50
8	Set of all miscellaneous parts including sockets, illum. mains switches, fuse holders, fuses, cut-outs, cable, etc	£12.10
9	Cabinet including chassis, anodised silver on black panels, fixing parts, etc. Please state whether Slave or Studio model required	£27.50
10	Handbook £0.50 or free on request when ordering any of above packs. 2 each of packs 1-7 (A or B), 1 each 8, 9 and 10 are required for complete 200 + 200W professional amplifier	
	Total cost of individually purchased packs	PSI 4001 £216.80 PSI 4002 £232.20



TRANSCENDENT 2000

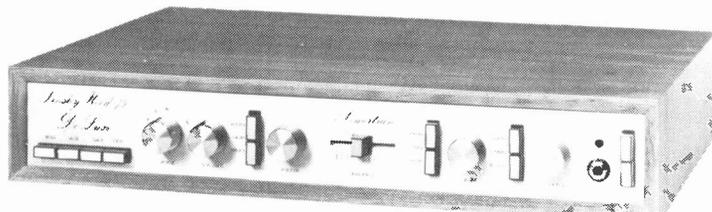
As featured in this issue

COMPLETE KIT ONLY £186.50 + VAT

We are producing a superb kit, at an irresistible price, for the latest and most practical design ever published. Kit includes fully finished metalwork, solid teak cabinet and really is complete — right down to the last nut and bolt! Virtually everything is on one P.C.B. 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-£700!

MANY MORE KITS ALSO AVAILABLE — ASK FOR OUR FREE CATALOGUE

Amplifiers (20-200W), Tuners, Cassette Deck, Quadrasonics, etc., etc.

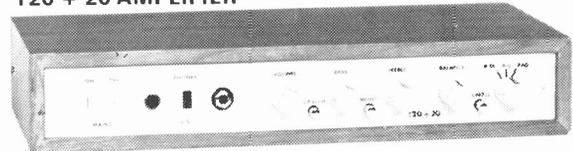


De Luxe Linsley-Hood 75w Amplifier

**75 + 75w AMPLIFIER
COMPLETE KIT ONLY £99.30 + VAT**

20 + 20w AMPLIFIER COMPLETE KIT ONLY
Based on P.W. TEXAN **£33.10 + VAT**
30w VERSION (T30+30) ONLY £38.40 + VAT

T20 + 20 AMPLIFIER



PRICE STABILITY: Order with confidence! Irrespective of any price changes we will honour all prices in this advertisement until August 31st, 1978 if ETI July 1978 issue is mentioned with your order. Errors and VAT rate changes excluded.

U.K. ORDERS: Subject to 12½% surcharge for VAT (i.e. add ½ 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

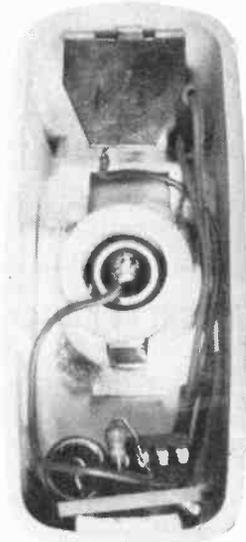
PORTWAY INDUSTRIAL ESTATE
ANDOVER, HANTS SP10 3NM

ANDOVER
(STD 0264) 64455

DON'T MISS OUR SPECIAL
SPECIAL OFFER — SEE PAGE
36.



Make music p.38



Strike a light p.31



Get in key p.59

FEATURES

DESIGNING OSCILLATORS	15	How to make sines
VFETS FOR EVERYONE	25	Insight into new technology
BRAINS AND COMPUTERS	33	How's your CPU?
MICROFILE	59	News for MPUs
RACE FOR THE BOMB	69	Atomic development
TECH-TIPS	81	Readers' own ideas

PROJECTS

TEMPERATURE METER	21	LCD module employed
TORCH FINDER	31	A flash in the dark?
MUSIC SYNTHESIZER	38	A revolutionary concept!
UFO DETECTOR	63	Magnetic principle unit

NEWS

NEWS DIGEST	7	What's on where
DATA SHEET	51	Memories are made of this!
ETI SEMINAR REPORT	73	If you missed it
ELECTRONICS TOMORROW	77	Where do we go now?

INFORMATION

SUBSCRIPTIONS	10	Trouble and strike avoided
SPECIALS	13	Details of our other publications
ETI MARKET PLACE	36	Unbelievable amplifier offer!!
ETI AUGUST PREVIEWED	49	And for our next issue
PANEL TRANSFERS	55	Finishing
ETI BOOK SERVICE	57	Read this fine print
ETI PRINTS	79	Why do it any other way?

<p>INTERNATIONAL EDITIONS</p> <p>AUSTRALIA Collyn Rivers Publisher Les Bell Acting Editor</p> <p>HOLLAND Anton Kriegsman Editor-in-chief</p> <p>CANADA Steve Braidwood Editor Graham Wideman Assistant Editor</p> <p>GERMANY Udo Wittig Editor</p>	<p>EDITORIAL AND ADVERTISEMENT OFFICE 25-27 Oxford Street, London W1R 1RF. Telephone 01-434 1781/2. Telex 8811896</p> <table border="0"> <tr><td>Halvor W. Moorshead</td><td>Editor</td></tr> <tr><td>Ron Harris B.Sc</td><td>Assistant Editor</td></tr> <tr><td>Gary Evans</td><td>Projects Editor</td></tr> <tr><td>Steve Ramsahadeo</td><td>Project Development</td></tr> <tr><td>John Koblanski</td><td>Project Design</td></tr> <tr><td>Jim Perry</td><td>Specials Editor</td></tr> <tr><td>Phil Cohen B.Sc, William King</td><td>Editorial Assistants</td></tr> <tr><td>Paul Edwards</td><td>Technical Drawing</td></tr> <tr><td>Margaret Hewitt</td><td>Administration</td></tr> <tr><td>Andrew Scott</td><td>Office Manager</td></tr> <tr><td>Kim Hamlin, Annette Main</td><td>Reader Services</td></tr> <tr><td>Tim Salmon, Brenda Goodwin</td><td></td></tr> <tr><td>Mark Strathern (Manager), Tom Moloney</td><td>Advertising</td></tr> </table>	Halvor W. Moorshead	Editor	Ron Harris B.Sc	Assistant Editor	Gary Evans	Projects Editor	Steve Ramsahadeo	Project Development	John Koblanski	Project Design	Jim Perry	Specials Editor	Phil Cohen B.Sc, William King	Editorial Assistants	Paul Edwards	Technical Drawing	Margaret Hewitt	Administration	Andrew Scott	Office Manager	Kim Hamlin, Annette Main	Reader Services	Tim Salmon, Brenda Goodwin		Mark Strathern (Manager), Tom Moloney	Advertising
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BOOKS AND COMPONENTS

BOOKS BY BABANI

Purchase books to the value of £5.00 from the list below and choose any 60p 1km from this page FREE.

BP2	Handbook of Radio, TV & Industrial & Transmitting Tube & Valve Equivalents	60p†
BP3	Handbook of Tested Transistor Circuits	40p†
BP6	Engineers and Machinists Reference Tables	40p†
BP7	Radio & Electronic Colour Codes Data	15p†
BP10	Modern Crystal and Transistor Set Circuits for beginners	35p†
BP15	Construction Manual of Electronic Circuits for the Home	50p†
BP16	Handbook of Electronic Circuits for the Amateur Photographer	60p†
BP18	Boys and Beginners Book of Practical Radio and Electronics	80p†
BP22	79 Electronic Novelty Circuits	75p†
BP23	First book of Practical Electronic Projects	75p†
BP24	52 Projects Using IC741 (or equivalents)	75p†
BP26	Radio Antenna Handbook for Long Distance Reception and Transmission	85p†
BP27	Giant Chart of Radio Electronic Semiconductor and Logic Symbols	80p†
BP29	Major Solid State Audio Hi-Fi Construction	85p†
BP32	How to Build Your Own Metal & Treasure Locators	85p†
BP34	Practical Repair & Renovation of Colour TVs	95p†
BP35	Handbook of IC Audio Preamplifier & Power Amplifier Construction	95p†
BP36	50 Circuits Using Germanium, Silicon & Zener Diodes	75p†
BP37	50 Projects Using Relays, SCRs and TRIACS	1.10†
BP39	50 (FET) Field Effect Transistor Projects	1.25†
129	Universal Gram-motor Speed Indicator	10p†
160	Coil Design and Construction Manual	75p†
161	Radio, TV and Electronics Data Book	60p†
196	AF-RF Reactance — Frequency Chart for Constructors	15p†
202	Handbook of Integrated Circuits (ICs) Equivalents and Substitutes	75p†
205	First Book of Hi-Fi Loudspeaker Enclosures	75p†
213	Electronic Circuits for Model Railways	85p†
214	Audio Enthusiasts Handbook	85p†
216	Electronic Gadgets and Games	85p†
217	Solid State Power Supply Handbook	85p†
219	Solid State Novelty Projects	85p†
220	Build Your Own Solid State Hi-Fi and Audio Accessories	85p†
222	Solid State Short Wave Receivers for Beginners	95p†
223	50 Projects Using IC CA3130	95p†
224	50 CMOS IC Projects	95p†
225	A Practical Introduction to Digital ICs	95p†
226	How to Build Advanced Short Wave Receivers	1.20†
RCC	Resistor Colour Code Disc Calculator	10p†

BOOKS BY NEWNES

No. 229	Beginners Guide to Electronics	Price £2.25†
No. 230	Beginners Guide to Television	Price £2.25†
No. 231	Beginners Guide to Transistors	Price £2.25†
No. 233	Beginners Guide to Radio	Price £2.75†
No. 234	Beginners Guide to Colour Television	Price £2.25†
No. 235	Electronic Diagrams	Price £1.80†
No. 236	Electronic Components	Price £1.80†
No. 237	Printed Circuit Assembly	Price £1.80†
No. 238	Transistor Pocket Book	Price £3.90†
No. 225	110 Thyristor Projects Using SCRs & Tracs	Price £2.50†
No. 227	110 COS/MOS Digital IC Projects for the Home Constructor	Price £2.75†
No. 226	110 Operational Amplifier Projects for the Home Constructor	Price £2.50†
No. 242	Electronics Pocket Book	Price £3.90†
No. 239	50 Photoelectric Circuits & Systems	Price £1.80†

NUTS AND BOLTS

BA BOLTS — packs of BA threaded cadmium plated screws slotted, cheese head.

Supplied in multiples of 50

Type	No.	Price	Type	No.	Price
1/16in OBA	839	£1.20	1/16in 4BA	846	£0.32
1/8in OBA	840	£0.75	1/8in 4BA	847	£0.25
1/4in 2BA	842	£0.65	1/4in 6BA	848	£0.40
1/2in 2BA	843	£0.45	1/2in 6BA	849	£0.21
3/4in 2BA	844	£0.42	3/4in 6BA	850	£0.25
1in 4BA	845	£0.64			

BA NUTS — packs of cadmium plated full nuts in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	855	£0.72	4BA	857	£0.30
2BA	856	£0.48	6BA	858	£0.24

BA WASHERS — flat cadmium plated plain stamped washers supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	859	£0.14	4BA	861	£0.12
2BA	860	£0.12	6BA	862	£0.12

SOLDER TAGS — hot tinned, supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
OBA	851	£0.40	4BA	853	£0.22
2BA	852	£0.28	6BA	854	£0.22

SWITCHES

Description	No.	Price
DPDT miniature slide	1973	£0.11*
DPDT standard slide	1974	£0.14*
Toggle switch SPST		
1/2 amp 250V a.c.	1975	£0.33*
Toggle switch DPDT		
1 amp 250V a.c.	1976	£0.42*
Rotary on-off mains switch	1977	£0.50*
Push switch — Push to make	1978	£0.13*
Push switch — Push to break	1979	£0.18*

ROCKER SWITCH	Colour	No.	Price
A range of rocker switches	RED	1980	£0.30*
SPST — moulded in high insulation material available in a choice of colours, ideal for small apparatus	BLACK	1981	£0.30*
	WHITE	1982	£0.30*
	BLUE	1983	£0.30*
	YELLOW	1984	£0.30*
	LUMINOUS	1985	£0.30*

Description	No.	Price
Miniature SPST toggle, 2 amp 250V a.c.	1958	£0.50*
Miniature SPST toggle, 2 amp 250V a.c.	1959	£0.55*
Miniature DPDT toggle, 2 amp 250V a.c.	1960	£0.70*
Miniature DPDT toggle, centre off, 2 amp 250V a.c.	1961	£0.85*
Push button SPST, 2 amp 250V a.c.	1962	£0.78*
Push button SPST, 2 amp 250V a.c.	1963	£0.83*
Push button DPDT, 2 amp 250V a.c.	1964	£0.98*

MIDGET WAFER SWITCHES
Single-bank wafer type — suitable for switching at 250V a.c. 100mA or 150V d.c. in non-reactive loads make-before-break contacts. These switches have a spindle 0.25in dia. and 30° indexing.

Description	Order No.	Price
1 pole 12 way	1965	£0.48*
1 pole 6 way	1966	£0.48*
3 pole 4 way	1967	£0.48*
4 pole 3 way	1968	£0.48*

MICRO SWITCHES	Order No.	Price
Plastic button gives simple on-off action		
Rating 10 amp 250V a.c.	1969	£0.20
Button gives 1 pole change over action		
Rating 10 amp 250V a.c.	1970	£0.25

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V-0-6V 100mA	90p*
2022	9V-0-9V 100mA	90p*
2023	12V-0-12V 100mA	95p*

MINIATURE MAINS Primary 24V with two independent secondary windings

No.	Type	Price
2024	MT280-0-6V, 0-6V RMS	£1.50*
2025	MT150-0-12V, 0-12V RMS	£1.50*

1-AMP MAINS Primary 240V

No.	Secondary	Price	P&P
2026	6V-0-6V 1 amp	£2.50*	P&P 45p
2027	9V-0-9V 1 amp	£2.00*	P&P 45p
2028	12V-0-12V 1 amp	£2.60*	P&P 55p
2029	15V-0-15V 1 amp	£2.75*	P&P 65p
2030	30V-0-30V 1 amp	£3.45*	P&P 85p

STANDARD MAINS Primary 240V

Multi-tapped secondary mains transformers available in 1/2 amp, 1 amp and 2 amp current rating. Secondary taps are 0-19-25-33-40-50V.

Volts available by use of taps
4, 7, 8, 10, 14, 15, 17, 19, 25, 31, 33, 40, 50, 25-0-25V

No.	Rating	Price	P&P
2031	1/2 amp	£5.50*	P&P 85p
2032	1 amp	£6.80*	P&P 85p
2033	2 amp	£8.40*	P&P £1.10

AUDIO LEADS

107	FM Indoor Ribbon Aerial	£0.60
113	3.5mm jack plug to 3.5mm jack plug, Length 1.5m	£0.75*
114	5 pin DIN plug to 3.5mm Jack connected to pins 3 & 5, Length 1.5m	£0.85*
115	5 pin DIN plug to 3.5mm Jack connected to pins 1 & 4, Length 1.5m	£0.85*
116	Car aerial extension. Screened insulated lead. Fitted plug and skt	£1.10*
117	AC mains connecting lead for cassette recorders and radios, 2 metres	£0.68*
118	5 pin DIN phone plug to stereo headphone jack socket	£1.05*
119	2+2 pin DIN plug to stereo jack socket with attenuation network for stereo headphones, Length 0.2m	£0.90*
120	Car stereo connector, variable geometry plug to fit most car cassette, B-track cartridge and combination units. Supplied with inline fused power lead and instructions	£0.60*
123	6.6m Coiled Guitar Lead mono jack plug to mono jack plug BLACK	£1.50*
124	3 pin DIN plug to 3 pin DIN plug, Length 1.5m	£0.75*
125	5 pin DIN plug to 5 pin DIN plug, Length 1.5m	£0.75*
126	5 pin DIN plug to tinned open end, Length 1.5m	£0.75*
127	5 pin DIN plug to 4 phono plugs, All colour coded, Length 1.5m	£1.30*
128	5 pin DIN plug to 5 pin DIN socket, Length 1.5m	£0.80*
129	5 pin DIN plug to 5 pin DIN plug mirror image, Length 1.5m	£1.05*
130	2 pin DIN plug to 2 pin DIN inline socket, Length 5m	£0.88*
131	5 pin DIN plug to 3 pin DIN plug, 1 & 4 and 3 & 5, Length 1.5m	£0.83*
132	2 pin DIN plug to 2 pin DIN socket, Length 10m	£0.98*
133	5 pin DIN plug to 2 phono plugs, Connected pins 3 & 5, Length 1.5m	£0.75*
134	5 pin DIN plug to 2 phono sockets, Connected pins 3 & 5, Length 23cm	£0.68*
135	5 pin DIN socket to 2 phono plugs, Connected pins 3 & 5, Length 23cm	£0.68*
136	Coiled stereo headphone extension lead, Black, Length 6m	£1.75*
178	A C mains lead for calculators, etc	£0.45*

FOR THE YOUNG ENTHUSIAST BI-PAK PROJECTS KIT

10 Projects including:
2 Octave, 24 Note Electronic Organ, 2 Trans Radio, Burglar Alarm, Quiz Timer, Morse Kit, Metronome, etc.
ONLY £8.50 P&P 40p

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Send for your copy of our revised catalogue and price list NOW! It contains 127 pages packed with literally hundreds of semiconductor components and our famous range of BI-KITS audio modules.

Only 65p POST FREE

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V.A.T. Add 12 1/2% to prices marked*. 8% to those unmarked. Items marked are zero rated
P&P: 35p unless otherwise shown.

BI-PAK

Dept. ET1 7, P.O. Box 6, Ware, Herts

COMPONENTS SHOP: 18 BALDOCK STREET, WARE, HERTS.

P.C.B. BOARDS

C26 4 pieces 8" x 3 1/4" (approx.) Single-sided fibreglass 80p

C27 3 pieces 7" x 3 1/4" (approx.) Double-sided fibreglass 60p

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	3.0µV
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 x 110mm x 32mm

The S450 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

£18.95
+ 40p p&p
+ 12½% VAT



7 + 7w R.M.S.

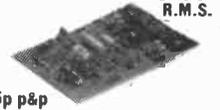
OUTPUT POWER	7 Watts RMS
LOAD IMPEDANCE	8 ohms
TOTAL HARMONIC DISTORTION	Less than 5% (Typically .3%)
FREQUENCY RESPONSE	50 Hz to 20 kHz ± 3dBs
TONE CONTROL RANGE	± 12dBs at 100 Hz and 10kHz
SENSITIVITY	190 mV for full output
INPUT IMPEDANCE	1 M ohms
TRANSFORMER REQUIREMENTS	22 V.A.C. rated at 1A
DIMENSIONS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

25 Watts RMS

£4.55 + 25p p&p
+ 12½% VAT



25w
R.M.S.

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 x 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm x 64mm x 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 AUDIO AMPLIFIER MODULE

£7.15* + 25p p&p
+ 8% VAT



35w
R.M.S.

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 x 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm x 64mm x 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 POWER AMPLIFIER

£17.25* + 40p p&p
+ 8% VAT



125w
R.M.S.

OUTPUT POWER	125 Watts RMS continuous
OPERATING VOLTAGE	50-80V
LOADS	4-16 ohms
FREQUENCY RESPONSE	25 Hz-20 kHz measured at 100 Watts

SENSITIVITY FOR 100 WATTS O/P AT 1 kHz	450mV
INPUT IMPEDANCE	33K ohms
TOTAL HARMONIC DISTORTION 50 WATTS into 4 ohms	0.1%
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 AUDIO AMPLIFIER MODULES

£3.75
+ 25p p&p
12½% VAT



10w
R.M.S.

MAXIMUM SUPPLY VOLTAGE	30V
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 kHz ± 3 dBs
SENSITIVITY	75 mV for full output
DIMENSIONS	74mm x 63mm x 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 + 25p 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 x 63mm x 30mm

Designed to power two AL60's at 15 Watts per channel simultaneously. Circuit Techniques include full short protection.

PA100 STEREO PRE-AMPLIFIER

£15.80
+ 40p p&p
+ 12½% VAT



FREQUENCY RESPONSE	20Hz to 20 kHz x 1dB
TOTAL HARMONIC DISTORTION	Less than 1% (Typically .07%)
SENSITIVITY 1. TAPE	100 mV / 100 K ohms) For an
INPUTS 1. RADIO TUNER	100 mV / 100K ohms) output
3. MAGNETIC P.U.	3.5 mV / 50 K ohms) 250mV
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz ± 15 dBs at 75 Hz + 10-20 dBs at 15 kHz
BASS CONTROL RANGE	Better than 65 dBs (All inputs)
TREBLE CONTROL RANGE	Better than 26 dBs (All inputs)
SIGNAL/NOISE RATIO	20 to 40 V
INPUT OVERLOAD	300x90x33mm (less controls)
SUPPLY	
DIMENSIONS	

A top quality stereo pre-amplifier and tone control unit, the PA100 provides a comprehensive solution for 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
25p 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 preamplifier/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	1B to 30 V — re earth
DIMENSIONS	110x50x25mm (inc DIN socket)

PA12

STEREO PRE-AMPLIFIER

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 included 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 Mhz
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 x 84mm x 35mm

£7.10
30p p&p
+ 12½% VAT

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 x 43mm x 26mm

£1.30
+ 12½% VAT
25p p&p

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 impedance 100 K. Output impedance less than 10 K. Frequency response 20 Hz-20 KH (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 + 12½% VAT p&p 25p

SG30 POWER SUPPLY BOARD FOR GE100 15-0-15 VOLT
£5.50 + 12½% VAT p&p 25p

Siren Alarm Module

American Police siren 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. **Only £3.50**

+ 8% VAT p&p 25p

MA60 HI-FI AMPLIFIER KIT

Build your own reliable top quality amplifier and save yourself pounds. The MA60 kit comprises the following BI-kits modules: 2x AL60 amps, 1x PA100 pre-amp 1x SPM80 stabilised power supply 1x BMT80 transformer, thus giving 17 watts RMS per channel STEREO. All modules are covered by the usual BI-PAK satisfaction or money back guarantee. Further details of all the above modules are in this advert. **PRICE £32.00** + 12½% + 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 and back panels, knobs, chassis, fuses, sockets, Noen, etc. Ideal for the MA60. Size 425mm x 290mm x 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. ET16, P.O. Box 6, Ware, Herts

Marshall's

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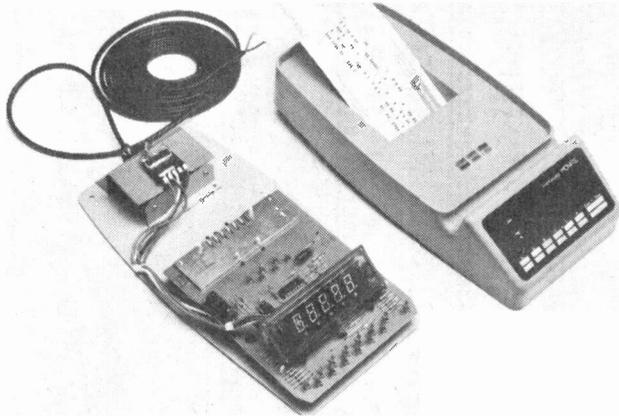
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TRANSISTORS	
2N696	0.39 2N2218 0.35
2N697	0.31 2N2218A 0.38
2N698	0.49 2N2219 0.38
2N699	0.58 2N2219A 0.39
2N706	0.30 2N2220 0.39
2N708	0.30 2N2221 0.25
2N710	0.30 2N2222 0.25
2N718A	0.54 2N2222A 0.25
2N720A	0.85 2N2369 0.27
2N722	0.45 2N2369A 0.27
2N727	0.50 2N2446 0.60
2N914	0.38 2N2947 1.55
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2N917	0.38 2N2904 0.31
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2N929A	0.37 2N2905A 0.31
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news digest.

at the third stroke



The cost will be . . . wouldn't it be nice if the telephone told you how much money you were spending. Devoted readers will remember the ETI STD timer published in Nov 76, well a firm called Monitel has latched onto a similar idea — and produced a neat unit to sit under the phone and provide the call cost, at a glance. Heart of the unit is a Rockwell MPU from their PPS4/1 range, the standard UK model uses a MM75 which has 600 bytes of ROM and 48 bits of RAM. The international model uses a MM77 with 1 300 bytes of ROM and 96 bits of RAM.

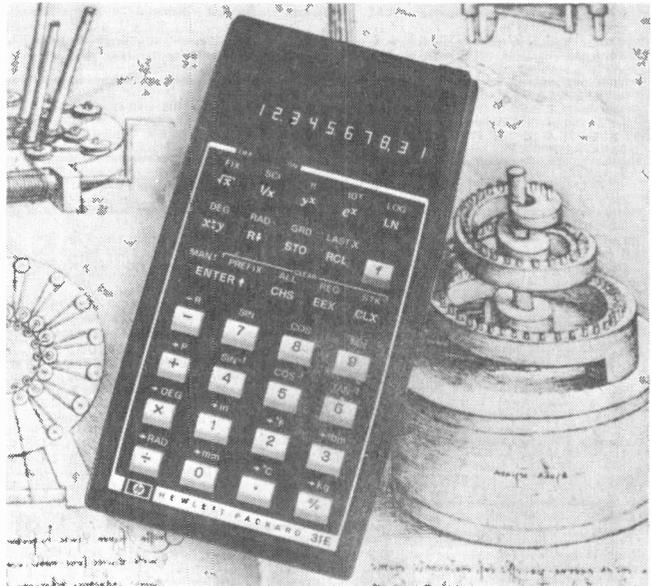
In use the unit calculates the cost, accounting for day of the week, time of day, how far you're calling and the current VAT rate. Any variations in the PO charges are fed into RAM via a punched card supplied by the manufacturers, for a nominal sum. The international model can cope with the overseas tariffs, or UK if you feed it a different card. To operate the unit you first touch the appropriate tariff switch (local, medium or long distance on the standard model), then as soon as you are connected touch the start/stop — when finished touch it again. Cost of call is displayed continuously as you

talk, can be quite frightening seeing all that money disappear!

When not in use as a charge calculator it is a digital clock, power from any 13A socket is all that is needed — no extra PO fees are incurred as it is totally isolated from the PO system. Seven colours are available to match all PO standard units. Price for the standard model is about £29, the international model will be about £39. Both should be available from most large chain stores W. H. Smith, Rymans etc. Monitel Limited, Berechurch Road, Colchester, Essex.



triplets from hp



Hewlett-Packard have just announced a new set of cheap (well relatively) scientific button boxes. The HP-31E is the baby of the litter, and is the lowest priced to ever have emerged from HP at £39 inclusive. As with all their calculators it uses Reverse Polish Notation, so called because it was thought to be as easy as Polish to learn — only backwards? Seriously though RPN is a very easy way to use calculator when performing scientific calculations, once you learn it you like it. Anyway RPN commercial over, the 31E is aimed at the budding scientific student and features include — 4 addressable registers, rectangular to polar co-ordinates, inches to millimetres, pounds to kilograms, degrees and radians plus all the usual math and trig functions.

The 32E has all the features of

the 31E, plus an extra 11 registers. Other features include hyperbolic functions, hours to hours — minutes and seconds, US gallons to litres and a whole bunch of statistical functions such as linear regression and x, y estimates. All this for £53 inclusive.

A 49 line fully-merged keystroke memory programmable completes the trio, it goes by the name 33E. Keycodes are displayed and 3 levels of subroutine are allowed, it also has maths, trig, log and statistical functions (of course, you say, it's HP after all!). Price for this beauty is £67. All of them come with detailed manuals, and the 33E has an applications book as well.

Further details from Hewlett-Packard Limited, King Street Lane, Winnersh, Wokingham, Berkshire RG11 5AR.

whoops

In the CCD Phaser R31 and R32 were transposed on the overlay diagram. The ICs were missed out of the Stars and Dots parts list — they are on the circuit diagram, also in this project the gremlins got at the IC labels on the overlay — IC5 should be marked IC1; and add 1 to the marked number of the other ICs ie IC2 becomes IC3 etc.

Lastly in the Chipmonk the

pot values were missed off the parts list RV1 is a 100 k log type, RV2 a 10k preset and RV3 a 120k preset.

In case you missed our previous announcement we have a recorded message service for errors and other information on 01-434 1781. This service is available outside normal office hours only.

problem solved

Lasers were once called the solution without a problem. Now they have lots of problems, the latest one to suffer from the fate of laser solution is that of aerial mapping. The US Geological Survey is using pulsed lasers and silicon photodiodes, with extremely accurate interval timers and delay/discrimination electronics, to produce a ground profile as an aircraft flies over it. A gallium arsenide laser, with a pulse

duration of 10 nanoseconds, is bounced off the ground and detected when it gets back to the aircraft. As long as the aircraft flies on a level path the distance to ground can be measured. With accurate position fixing and several runs, a 3 dimensional map can be produced. The technique is suited to computer analysis, unlike aerial photography or manual surveying.

WATFORD ELECTRONICS
(continued from opposite page)

ETI GAS MONITOR

All parts available.
Gas Sensors TGS109, 308,
812 & 813 **415p***
Sockets for above 25p*



DIGITAL PANEL METER

Intersil Evaluation Kit **£21.52***
plus 30p p&p.
All parts as per ETI **£23.85***
plus 30p p&p.
ICL7106 **£9.75***
LCD3901 3½ digit **£9.95***

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Build this fantastic T.V. Game with realistic battle sounds generated from your T.V. speaker, steerable tanks, controllable shell trajectory and minefields to avoid. A really exciting and skillful game simply constructed with our easy to follow instructions. Order now — avoid disappointments.
Basic Kit (just add controls) only **£19.50 inc. VAT**
Complete Kit including controls & Mains Power Supply No extras required. Only **£26.25 inc. VAT**.
IC AY-3-8710 **£10.50 inc. VAT**.
(Demonstration on at our shop)

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Build this PE (Jan. '78) Easybuild Low Cost Rhythm Generator. We are the sole suppliers of the complete Kit including the case, pre-drilled printed front panel and the Printed Circuit Boards send sae for leaflet.

Complete Kit price incl.
VAT **£49.95** only
Plus P&P **£1**
For ready built Units add **£15.00**.

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ETI PROJECTS: Parts available for the following ETI Projects.
Multi-option Clock. House Alarm, Hammer Throw, Race Track, Accentuated Beat Metronome, Porch Light, IB Metal Locator Mk. 2, Shutter Speed Timer, Ultrasonic Switch, True RMS Voltmeter, LCD Panel Meter, Gas Monitor, PHASER, Star Trek Radio, Tank Battle.
Please send SAE plus 5p per list.

JACK PLUGS		SOCKETS		SWITCHES*		SLIDE 250V	
Screened chrome	Plastic body	open metal	moulded with break contacts	in line	couplers	1A DPDT c/over	14p
2.5mm 12p	8p	13p	8p	DPST	11p	1/2A DPDT	15p
3.5mm 15p	10p	15p	13p	DPDT	38p	4 pole 2 way	24p
MONO 23p	15p	18p	20p	4 pole on/off	54p	PUSH BUTTON	
STEREO 31p	18p	15p	24p			Spring loaded	
				SUB-MIN TOGGLE		SPST on/off	60p
				SP changeover	59p	SPDT c/over	65p
				SPST on/off	54p	DPDT 6 Tag	85p
				SPST biased	85p	MINIATURE	
				DPDT 6 tags	70p	Non Locking	
				DPDT centre off	79p	Push to Make	15p
				DPDT Biased	115p	Push Break	25p
				ROTARY Make your own Multiway Switch		Adjustable Stop Shifting Assembly. Accommodate up to 6 Wafers	69p
						Mains Switch DPST to fit	34p
						Break Before Make Wafers. 1 pole / 12 way	
						2p/6 way 3p/4 way 4p/3 way 5p/2 way	47p
						Spacer and Screen	5p
				ROTARY (Adjustable Stop)		1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way	41p
						ROTARY Mains 250V AC, 4 Amp	45p

VOLTAGE REGULATORS		TRANSFORMERS* (Mains Prim. 220-240V)		ALUM. BOXES WITH LID*		PANEL METERS*	
TO3 Can Type	P	6-0-6V 100mA	90p	15 0 15V 1A	275p+	FSD	
1A +ve 5V, 12V, 15V, 18V	145	9 0 9V 75mA	95p	19 0 19V 1A	295p+	35mm	0-50mA
LM309K	135	12-0-12V 100mA	98p	30 0 30V 1A	295p+	60	0-100mA
LM323K	625	0-12 0-12V 150mA	140p	20-0-20 2A	340p+	68	0-500µA
MURS or 12	180	0-6-0-6V 280mA	160p	6-0-6V 1.5A	345p+	78	0-1mA
1A -ve 5V, 12V	220	0-15 0-15V 0.2A	160p	0-18 0-18V 1.5A		64	0.5mA
Plastic (T092)		0-4 5 0-4 5V 0.6A	260p+	9 0 9V 2A	379p+	82	0-10mA
+ve 0.1A 5V, 6V, 8V, 12V, 15V, 30V	30	12-0-12V 0.5A	280p+	12 0 12V 2A	315p+	88	0-50mA
+ve 1A (T022D)		0-12 0-12 0.5A	280p+	30-25-20-0-20	320p+	114	0-100mA
5V, 12V, 15V, 18V, 24V	99	0-12 0-12V 1A	260p+	25-30 2A	497p+	88	0-500µA
-ve 0.5A 5V, 6V, 8V, 12V, 15V, 95		0-12 0-12V 1A	295p+	0-6 0-6V 6VA	240p	114	0-100mA
-ve 1A 5V, 12V, 15V, 60		15-0 15V 0.5A	260p+	0-12 0-12A 6VA	240p	148	0-500mA
5V, 12V, 15V, 18V, 24V	99	0-9 0-9V 1A	260p+	0-15 0-15V 6VA	240p	172	0-1A
8V, 12V, 15V, 95		12-0-12V 1A	260p+	0-20 0-20V 6VA	240p	142	0-2A
-ve 1A 5V, 12V, 15V, 60		0-12 0-12V 1A	295p+	LT44	42p	165	0-25V
+ve 0.1A (T092)		0-12 0-12V 1A	295p+	LT700 Mia O/P Pri	42p	210	0-50V AC
5V, 12V, 15V, 18V, 24V	99	30-24-20-15-12-0 1A	1.2K Sec 3.2Ω	MOT Min. O/P Pri	38p		0-300V AC
-ve 0.5A 5V, 6V, 8V, 12V, 15V, 95		Multi tappings	360p+	MOT Min. O/P Pri	38p		'S' 'VU'
-ve 1A 5V, 12V, 15V, 60		30-24-20-15-12-0	1.2K Sec 8Ω				410p each
+ve 0.1A (T092)		12A multi tap	445p+				
5V, 12V, 15V, 60		(Please add 48p p&p charge to all prices marked + above our normal postal charge).					
LM320-12	165						
LM320-15	165						
LM304H	240						
LM317H	100						
LM317K	350						
LM325N	240						
LM326N	240						
LM723	45						

EARPHONES		LAMP HOLDERS AND LAMPS*		SPEAKERS		HEAT SINKS	
Magnetic		LES HOLDER Dome shaped Red, Blue, Green, White and Yellow	18p	8Ω 0.3W	9p	T092	8p
2.5mm	18p	LES BULBS 6v and 12v	11p	2" 2 1/4"	58	T05	9p
3.5mm	18p	MES HOLDERS Chrome cover Red or Amber Jewelled top	50p	40 0 2.5"	65	T018	8p
Crystal	33p	LES OR MES Batten Holders	10p	64 0 2.5"	65	T0220	125p
CRYSTAL MICROPHONE INSERT	46p	MES BULBS 3.5V, 6V, 12V	11p	8 0 5W	85	T03	22p
ULTRASONIC TRANS. DIJICERS		NEONS: Mains 240V Sealed with Resistor	24p	7" x 4"	190	T066	22p
Receiver and Transmitter		Red, Amber & Green	24p	8 0 3W	160		
40KHz	480p per pair	Open type 95V AC	11p	6" x 4"	160		
		KNOB'S to fit 1/8" shaft	90				
		K1 Black Pointer type	11p				
		K1a White Pointer type	11p				
		K2 Slim Silvered Aluminium	12p				
		K3 Satin Black Ribbed 22mm diam.	12p				
		K4 Black Serrated Metal top with line indicator 35mm diam.	22p				
		K4a As K4 but 25mm diam.	20p				
		K5 Black Fluted, metal top & skirt, calibrated 0-9, 37mm diam.	28p				
		K6 As K5 but with pointer on skirt	28p				
		K7 Black Knurled, tapered, metal top & skirt, Calibrated 0-9 30mm diam.	28p				
		K7a As above but pointer on skirt	28p				
		K8 Black or Silvered for Slider Pot	10p				
		K12 Aluminium plastic with line indicator 22mm diam.	16p				
		K19 Solid Aluminium Amplifier Knob, Etch line indicator, skirted 22mm	30p				

news... ...digest

nota bene

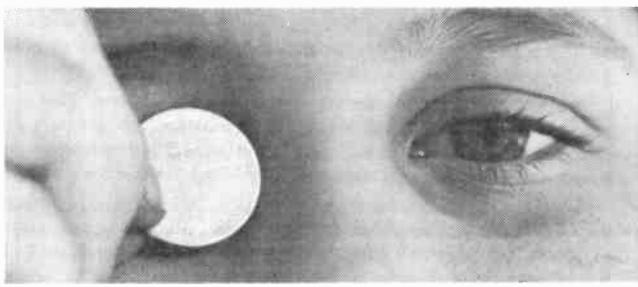


AN 'electronic notebook' is now available on the UK market. Made by Toshiba, it is claimed to be the first alphanumeric pocket calculator available.

made by depressing the LETTER key, followed by the appropriate letter keys, which are also number/function keys; depressing a further master key allows entry of figures. Automatic review of the 30 memories is provided. Accidental erasure is virtually impossible; and memory is retained for the duration of battery life, some 9000 (12 months) continuous operational hours. Suggested retail price is £59.95 plus VAT.

Called the LC836MN, it has 30 independent, large-capacity memories each able to hold a 6-digit alphabetic and 8-digit numeric input. Use of an extra memory can expand retention to 6 alpha plus 15 numeric. Alpha-numeric entries are

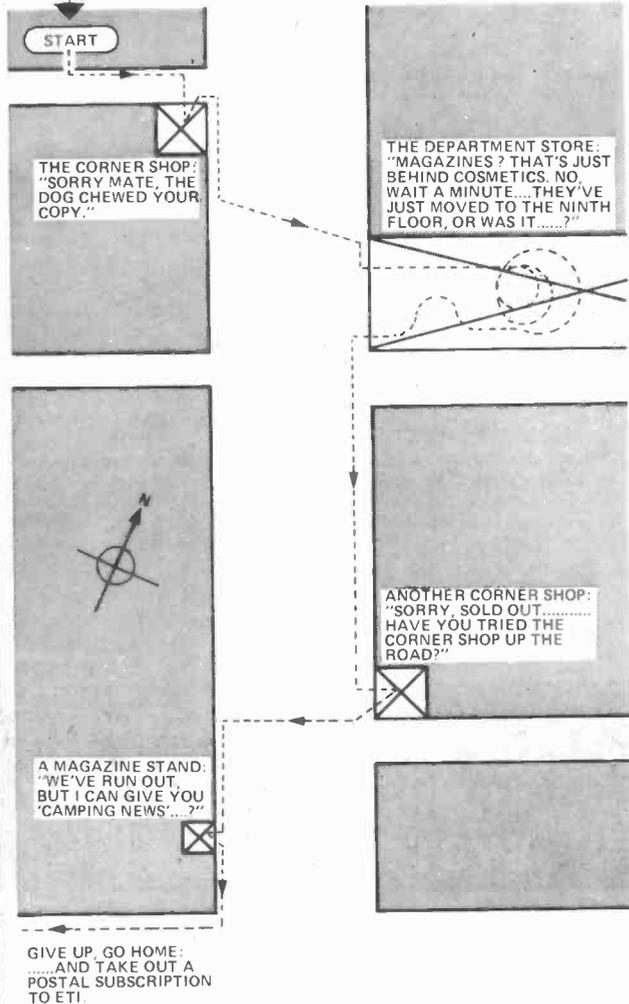
eye eye



What have we here? National Panasonic's new lithium cell is about the size of a 5p piece, but has enough power to run an electronic watch for between 5 and 10 years. It weighs just over 3 grams, and is only 2.5 mm thin. National Panasonic say that it will operate at temperatures as low as -20°C. Its name is the BR2325 and because it is

lithium has a voltage of 2V8, so less of them are needed to power most things (most cells have a 1V5 to 1V3 range). Some lithium cells are prone to emitting nasty gas and sulphur compounds, but this one is said to be completely stable. National Panasonic, Bath Road, Slough, Berks.

NON-SUBSCRIBERS START HERE



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

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

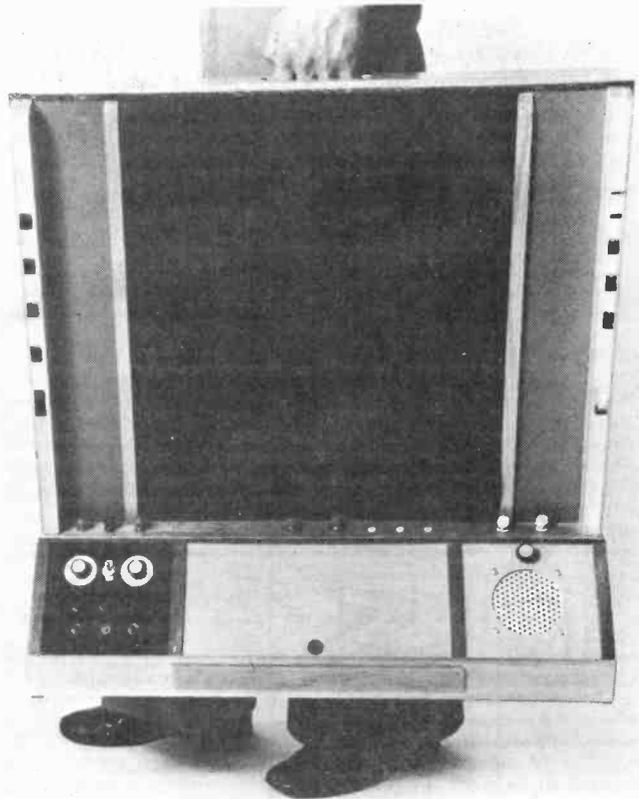
Do yourself, your newsagent and us a favour. Place a regular order for ETI; your newsagent will almost certainly be delighted. If not, you can take out a postal subscription so there's nothing for you to remember — we'll do it for you.

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Electronics Today International,
25-27 Oxford Street, London W1R 1RF.

... news

have bench, will travel



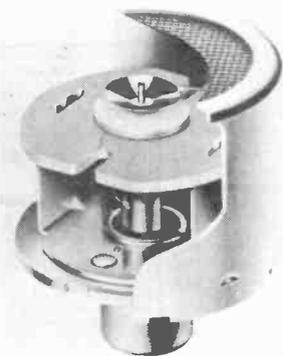
Nice idea from Home Radio is this portable workbench, instead of running riot on the kitchen table you can pack up and move your work bench when finished. Rather than try and make something with everything, they have just given it a 0-20V at 1A power supply plus a loudspeaker and mains outlet — so you can customise it to your own particular

needs (built in cigar lighter etc).

Tools and soldering iron can be kept in the sides or lockable compartment and the whole thing comes for £45 (unwired) or £54 (Wired) plus 8% VAT and £2.50 carriage. A vice is also available for £5.50 plus 8%. Full details from Home Radio, London Road, Mitcham, Surrey.

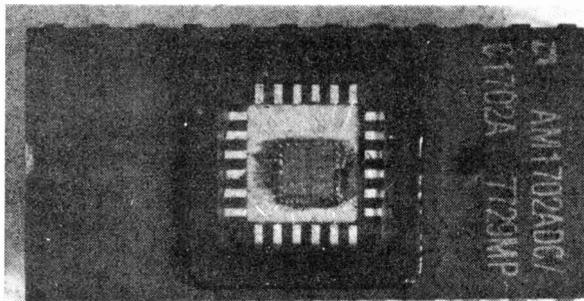
silent sound

Impectron Limited are now stocking Matsushita (try saying that after a liquid lunch) Ultrasonic Transducers. Three versions are available, the FR CRO1 range operates at 40 kHz (with a bandwidth of 3½ kHz) and is available in different sizes and with alternative mounting methods. Next is the FR CRO2 which has a bandwidth of at least 11 kHz, and is designed for multi-channel remote control applications. A totally sealed model completes the line-up, with a bandwidth of only 2 kHz, called logically enough the FR CRO3. Further information from Impectron Limited, 23-31 King Street, London W3 9LH.



digest..

wanted, probably dead



Advanced Micro Devices have been circulating this photograph of 'counterfeit' 1702A EPROMs. Some sharp operator has been emptying their dustbins and re-marking rejects — naturally he then sells them as genuine AI devices ("Just a bit cheap 'cos the lorry was

moving when they fell off guv"). AMD have nicknamed the duff devices 'IIGOs' (information in, garbage out). If the 7 has a slightly curved downstroke then it's an IIGO, and if you bought it then you're an IIGiOt.

thanx

WHEN we included a reader survey in ETI we expected a good response, but the response was in fact amazing, more than 3 000 of you replied. From the analysis it seems that if you are a 27.9 year old male with an income of £4 375 and let .93 people read your copy of ETI — then you are Mr Average ETI. Most of you think ETI is also better than a year ago, thank you. Sorry we could not reward everybody but 60 people have been sent an ETI T-shirt and car stickers — thanks again to all who replied.

deaf teletext

The IBA and BBC are independently helping research into the possibilities of using Teletext for subtitles for the deaf. The BBC is working with Leicester Polytechnic on the possibilities of using a computer to process the output from a Palantype shorthand machine (used a lot in courtrooms) speed is expected to be up to 200 words per minute.

The IBA and ITCA (Independent Television Companies Association) are supporting Southampton University in a 3 year project, expected to cost £50 000. The aims are of a more general nature than those at Leicester, and are to establish the optimum forms of subtitling — with a full study of the human factors involved.

gossip, gossip

Quite a lot of the time we overhear snippets that fall into the plain old fashioned gossip category, some is too good not to publish. Some of the very large semiconductor users are not as ethical as they would have people believe. When a company develops a super-duper new IC, after lots of research and investment, they usually give a few potential volume users samples to evaluate. Well it seems that some of the potential users were shipping the samples to the Far East, where some firms will slice any IC apart and use electron microscopes to produce a set of masks for the IC. They charge about £25 000 and have a turn-round time of 10 days, very cheap compared to possibly a year and a million pounds to design and develop from scratch.

So now the manufacturers that have had imitations flattering their product (sometimes even before it was on the market) are giving out samples on a sale or return (intact of course) basis — oh yes the sale price is usually about £300 000.

Now that Commodore and Tandy have dived into the personal computer lake, we keep hearing that amongst others I*M and T* are in the late stages of putting together their own personal systems — not to mention N*C and various others from the land of the rising sun. Going to be a lot of swimmers in the next year!

TECHNOLOGICS PROUDLY PRESENT THE "LOGISCAN Mk. II" COLOUR TELETEXT DECODER

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★ Kit is complete with case, psu ★ Header Switch ★ Freeze switch

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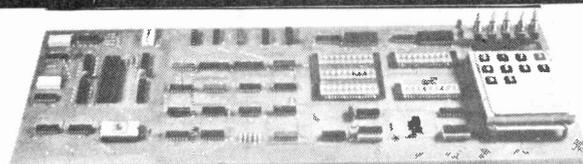
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We are also glad to announce that our decoders are available installed in either 26" or 22" colour televisions for just over £500 and are available for view or purchase from Colourvision, Smith-down Road, Liverpool L18.

KIT £205 + 12½% . BUILT £265 + 12½%
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Callers by appointment only

.. news digest..

book of the month club

We don't review books very often in ETI, usually so busy that we have no time to read any! Not quite the reason. Anyway, not one but three bits of recommended reading this month — all very good in their particular fields.

Video freaks, or anybody interested in the ins and outs of low cost portable video, are catered for in a Canadian book by Michael Goldberg. Called 'The Accessible Portapack Manual', it is just that, with a hundred and forty pages of practically orientated information. Everything you always needed to know about video for £6 inclusive from C.A.T.S., 42A Theobalds Road, London WC1X 8NW.

Second choice is a trifle more expensive at £45, but also value for money. It's a gigantic 2 200 page reference manual called 'IC Master', and contains more than 1 500 pages of manufacturers' data sheets. More than

40 000 ICs are cross-referenced (no we didn't count them!) and it's available from Eurosem International Ltd., Haywood House, Pinner, Middlesex HA5 5QA.

Last and by no means (you guessed) least is not one but eight from Fairchild. Send them £9.90 and they will send you a nice fat juicy data book on low power Schottky. This will be followed by ECL then Optoelectronics and finally by CMOS (probably worth the weight). The mathematicians amongst ETI's readership will leap up at this point and shout "But that adds up to four!" But Fairchild will reply "Ah yes but ... each copy will be sent with the latest issue of our journal 'Progress', that makes eight". So for eight of the best send your loot to Fairchild Subscription Service, c/o The Evan Steadman Group, 34-36 High Street, Saffron Walden, Essex.

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4007	23p	4017	1.14	4027	60p	4050	53p	4514	3.30
4008	99p	4018	1.32	4028	95p	4060	1.40	4516	1.44
4009	62p	4019	62p	4029	1.23	4069	30p	4518	1.26
4010	62p	4020	1.32	4030	51p	4070	50p	4520	1.26
4011	23p	4021	1.14	4041	84p	4071	26p	4543	1.30
4012	23p	4022	1.13	4042	96p	4072	26p	4583	1.45

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odds & ends

* Vero Electronics have introduced 3 more boxes in their familiar two tone, with metal front and back range. Called the type IV, they fill a gap in the existing range, being suitable for hand-held units. Should be available at most stockists in the near future.

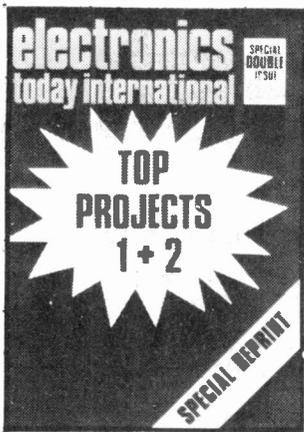
* The low cost colour camera is not far away. Fairchild, RCA and Sony all have working prototypes of CCD colour video cameras. As soon as the definition can be improved to match domestic video systems, probably within 9 months, expect the launch of the under £1 000 camera — watch this space.

* The British Amateur Electronics Club (BAEC) is holding its annual exhibition from the 15th of July to the 22nd of July. It will take place at the Shelter in the centre of the Esplanade, Penarth, South Glamorgan. Projects, games and the BAEC Computer will be on show so if you are in the area drop in and give some support. If you would like more information about the club drop them a line with an SAE — BAEC, 26 Forrest Road, Penarth, South Glamorgan.

* Ever wondered how torpedoes were powered? If not read another item! The Royal Navy has just placed an order with Chloride Industrial Batteries for £3 000 000 worth of silver-zinc batteries. The batteries are designed to power the Tigerfish wire-guided torpedo. Designed to blow anything afloat to kingdom come, the Tigerfish is designated as a 'heavyweight' torpedo. It is wire-guided from its submarine's central computer, and uses an inbuilt MPU to interpret the signals from its array of sonar transducers. Once a target is spotted its minutes are numbered. Wonder what happens if the wire breaks?

* The OK Machine & Tool company has introduced a new wire-wrap wire dispenser. It contains 3 separate 15.24m (50ft) reels of 30AWG (0.25mm) Kynar wire. The dispenser is pocket sized and has a notch for breaking and stripping the wire as it is dispensed. When supplied it comes filled with patriotic red, white and blue coloured wire and costs £3.77, refills are £2.66 a set. OK Machine & Tool (UK) Ltd, 48a The Avenue, Southampton SO1 2SY.

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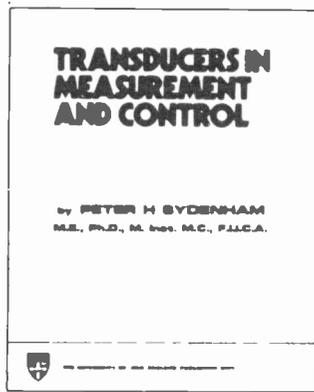
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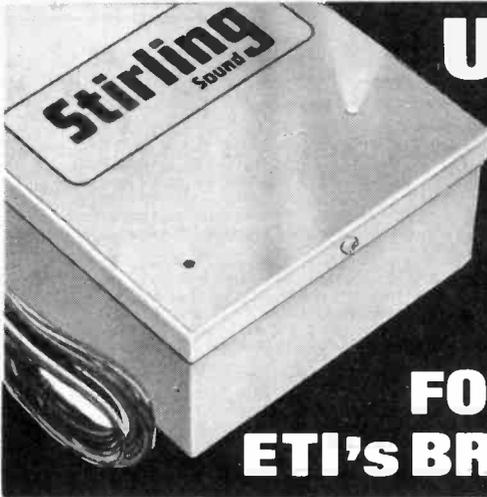
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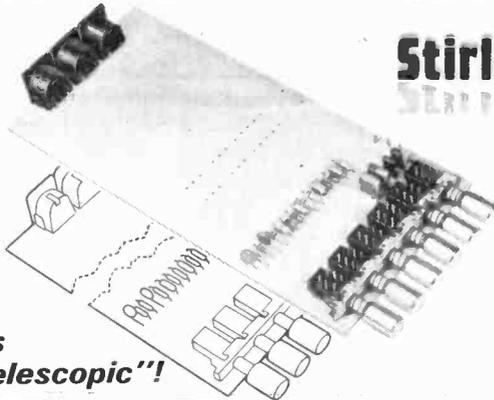
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DESIGNING OSCILLATORS

One of the problems in electronics is stopping amplifiers from oscillating, another problem is getting oscillators to oscillate . . . Tim Orr explains.

AN OSCILLATOR IS BASICALLY an amplifier with positive feedback applied around it. The feedback must be AC coupled otherwise a DC latch up condition would occur. Having got some sort of oscillation, one of two things can happen. The oscillation can build up in amplitude until clipping occurs due to the power supply voltage levels. At this point a stable, but truncated waveform will be generated. Alternatively if the gain of the amplifier is too low the oscillation will die away. To produce a pure sinusoidal oscillation the level of the signal in the system must be accurately controlled. There must be some amplitude limiting or automatic gain control such that when the peak signal level tries to exceed a reference voltage, the amplifier's gain is reduced. This is in fact what limiting does. To maintain stable oscillation, the overall gain of the system must be exactly unity. Any less and the oscillations will never start. If the gain is more than unity, the oscillations will occur, but amplitude limiting will cause gross distortion.

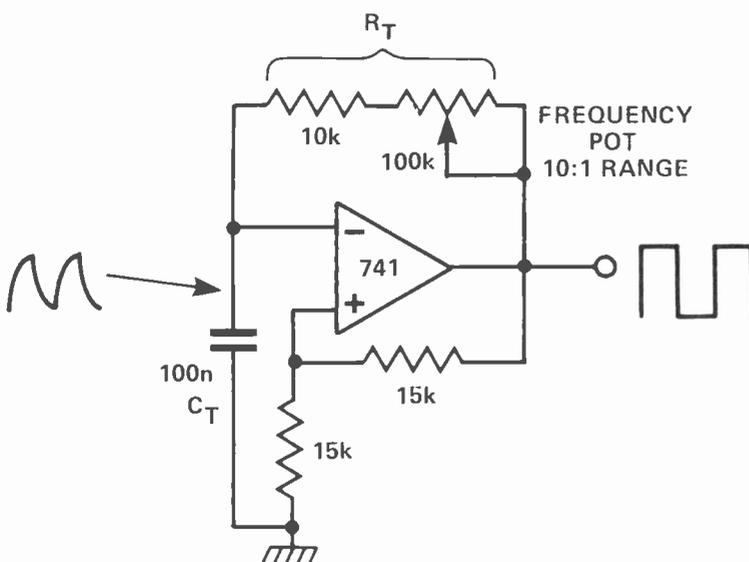
A very common method for stabilising the oscillations, which is often used in Wein bridge oscillators, is to employ a very sensitive thermistor as an AGC. However, the thermal time constant of this component often produces an annoying amplitude bounce which occurs

when changing to a new frequency.

Other methods are diode limiters (which tend to cause large amounts of distortion) and FET AGC circuits. The latter method can be used to generate super low distortion sinusoids by allowing the system gain to stabilise over tens of seconds.

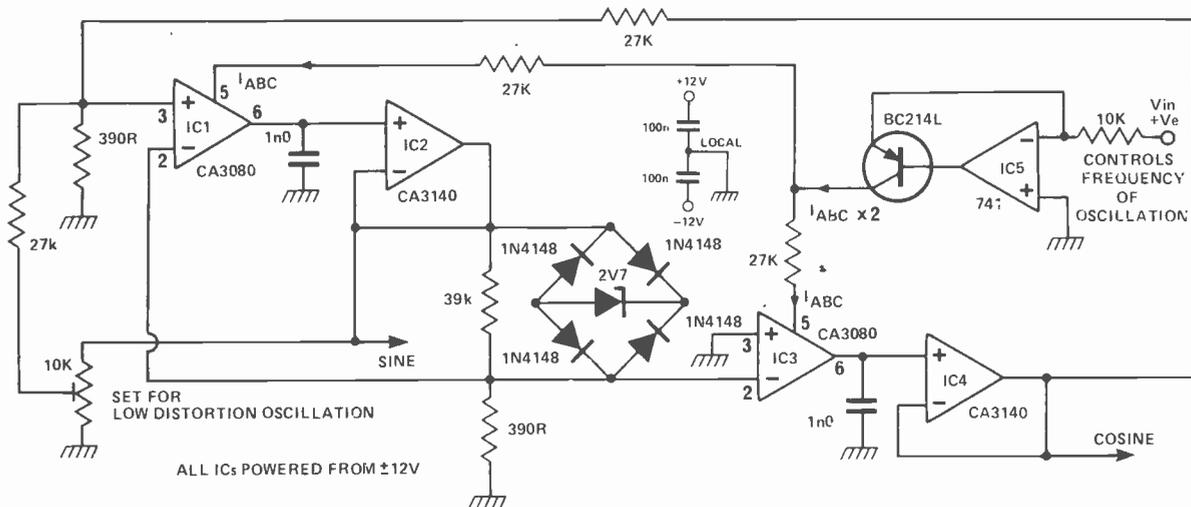
The oscillation frequency is mainly determined by the feedback around the amplifier. By making the feedback a reactive network, the phase of the feedback will vary as a function of frequency. Oscillations can only occur when the feedback is positive and thus the phase response of the feedback will determine the frequency of oscillation, assuming that the overall gain at this frequency is at least unity. By varying the phase response of the feedback, the oscillation frequency may be altered.

An oscillator should be thought of as being a circuit which continuously generates a waveform, no matter what the shape of the waveform. There are very many circuit techniques for generating these signals which range from relaxation oscillators to piece wise approximations using square waves. Some of these methods will now be illustrated.



Manually Controlled Oscillator

In this circuit there are two feedback paths around an op-amp. One is positive DC feedback which forms a Schmitt trigger, the other is a CR timing network. Imagine that the output voltage is +10V. The voltage at the non-inverting terminal is +15V. The voltage at the inverting terminal is a rising voltage with a time constant of $C_T R_T$. When this voltage exceeds +5V, the op amp's output will go low and the Schmitt trigger action will make it snap into its negative state. Now the output is -10V and the voltage at the inverting terminal falls with the same time constant as before. By changing this time constant with a variable resistor a variable frequency oscillation may be produced.



Dual Integrator Quadrature VCO

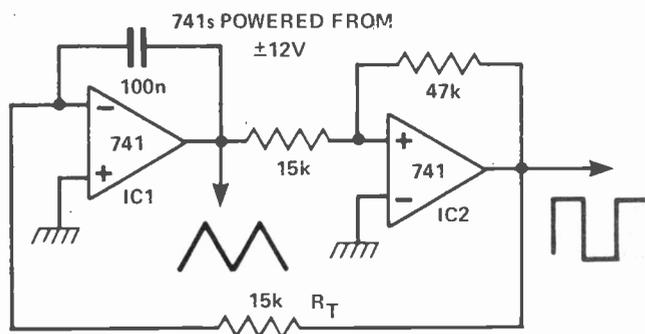
This is a sinusoidal oscillator which uses frequency dependent feedback and zener diode amplitude limiting. IC1,2,3&4 form a dual integrator circuit which is an analogue model of a second order differential equation! There is some positive feedback around IC1,2 which is analogous to having a zero damping factor in the equation. This means that the oscillations will build up. The positive feedback is controlled by the 10k preset. IC1,3 are integrators and IC2 and IC4 are voltage followers with high input impedance. The phase shift produced by an integrator is 90° so there is no overall feedback around the loop (IC1 is non-inverting, IC2 inverts). Thus we have all the conditions for oscillation, and in fact oscillations will occur when the preset is adjusted to give the correct phase shift around the IC1,2 stage. Amplitude limiting is produced by the 2V7 zener inside the diode bridge. By placing it inside the bridge the same diode is used for both positive and negative signals and the limiting is symmetrical. The integrators are two quadrant multipliers (CA3080s), so the gain of the loop can be controlled by the current I_{ABC} . In the solution of this second order differential equation, the gain

of the loop is proportional to the resonant frequency. Thus, by varying I_{ABC} or rather by varying V_{IN} , the frequency of oscillation may be altered.

As the integrators produce a 90° phase shift, the two sinusoid outputs are in phase quadrature, i.e. one is a sine wave, the other a cosine wave. The cosine output is lower in distortion than the sine wave, because the amplitude limiting (and hence the distortion) is produced at the IC1,2 stage.

The second stage (IC3,4), acts as a filter and hence produces a purer sinusoid. Using this circuit a 1000 to 1 continuous frequency sweep can be obtained. However, the inaccuracies in the CA3080's will cause some amplitude variations and it may be necessary to set the positive feedback a bit high (and hence attract more distortion), to maintain stable amplitude limiting over the sweep range. This circuit is an oscillating filter and if you turn down the positive feedback and inject a small signal through a 100k resistor into IC1 pin 3, a bandpass and low pass response is obtained from the sine and cosine outputs respectively.

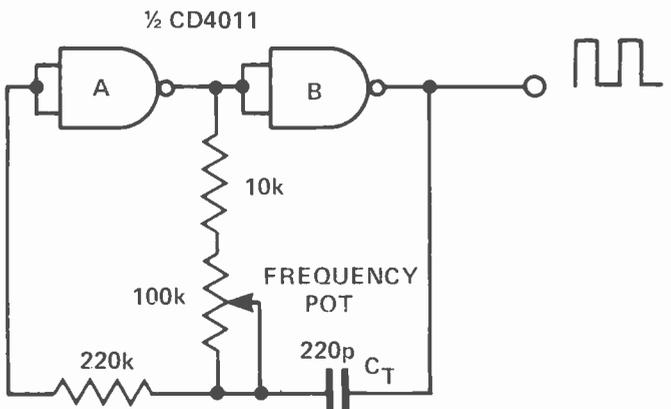
Simple Triangle Square Wave Oscillator



This circuit generates simultaneously a triangle and a square wave. The triangle could be 'bent' by a diode function generator to produce a sine wave. The circuit is always self starting and has no latch up problems. IC1 is an integrator with a slow rate determined by C_T and R_T and IC2 is a Schmitt trigger. The output of IC1 ramps up and down between the hysteresis levels of the Schmitt, the output of which drives the integrator. By making R_T variable it is possible to alter the operating frequency over a 100 to 1 range. Three resistors, one capacitor and a dual op amp is all that is needed to make a versatile triangle squarewave oscillator with a possible frequency range of 0.1Hz to 100kHz.

CMOS Oscillator

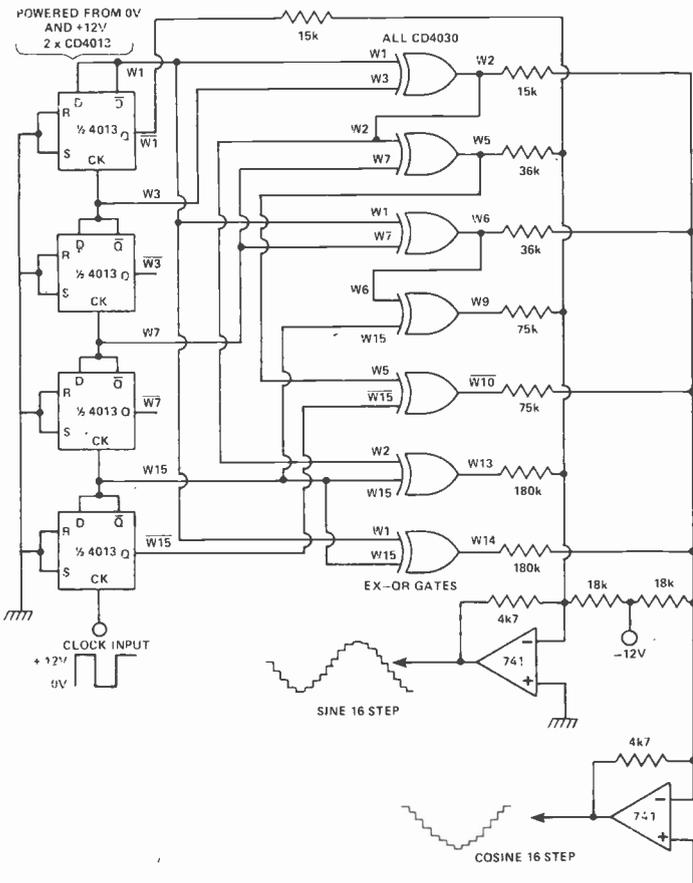
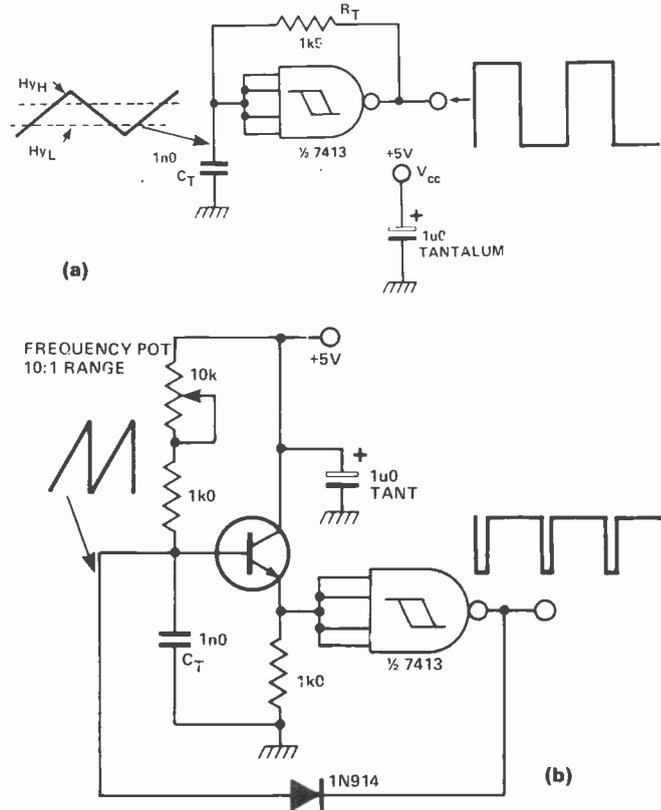
Two CMOS gates can be used to produce a simple oscillator. Imagine that output B is high. Then the input to A is also high due to it being coupled via the capacitor C_T to output B. Thus output A is low, input B is low and output B is high, which is as we would expect. However, capacitor C_T is being discharged via the 100k pot and 10k resistor to a logic 0. When this voltage reaches the crossover point for A, output A goes high, and thus output B goes low. Now the capacitor is charged up to a logic 1. Thus the process repeats itself. Varying the 100k pot changes the discharge rate of C_T and hence the frequency. A square wave output is generated. The maximum frequency using CMOS is limited to 2MHz.



TTL Oscillator

A simple relaxation oscillator can be made using a TTL Schmitt trigger. The circuit 'a' is the most simple version that can be produced. Imagine that the output is high. Capacitor C_T is charged up via R_T . when the upper hysteresis level (H_{yH}) is reached, the output goes low. C_T is now discharged until the low hysteresis level (H_{yL}) is reached whereupon the output goes high. Thus the oscillator generates a square wave, with an uneven mark to space ratio, due to the input current requirements of the 7413. The frequency can be set at any value up to several megahertz by varying C_T and R_T . C_T can be an electrolytic but R_T must not be more than about 1k5 or it will not be able to pull down the Schmitt trigger inputs. (If you use a CMOS Schmitt this does not apply). The output is a nice fast squarewave capable of directly driving several TTL loads. One problem to be encountered is frequency jitter. When the input is very near to a hysteresis level, noise in the system may cause the oscillator to prematurely trigger, thus making that period slightly shorter and producing a noise induced frequency jitter. Also using two Schmitt triggers from the same IC is sure to cause interaction and thus jitter. To reduce power supply noise effects the IC should be decoupled with a 1uF tantalum capacitor actually at the V_{CC} and GND pins of the package.

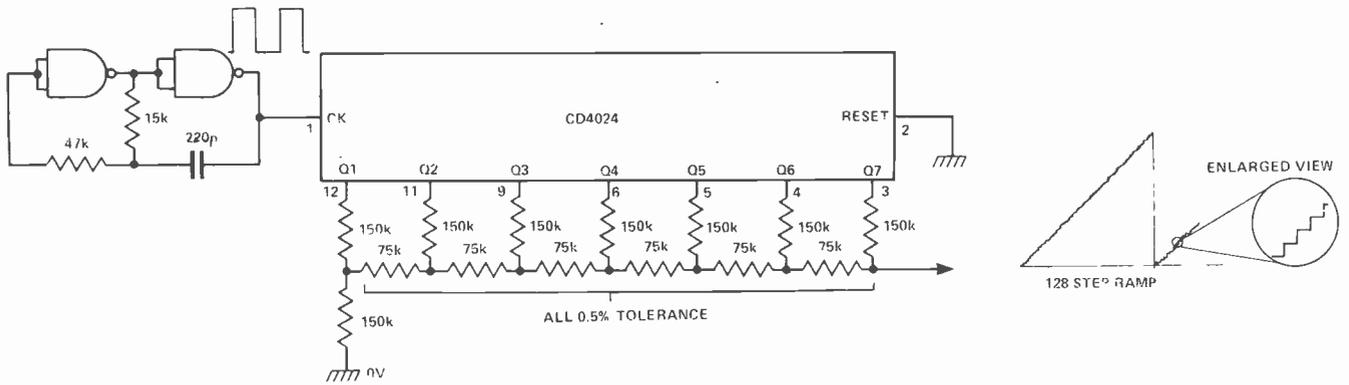
Diagram 'b' shows the same oscillator, but with a 10 to 1 manual control of frequency. The timing capacitor is charged up by the 10k pot and the 1k resistor. This voltage is then buffered by the emitter follower and fed to the Schmitt trigger. When the upper hysteresis level is reached the output of the Schmitt goes low and the capacitor is rapidly discharged via the diode until the lower level is reached. The process then repeats itself. As the discharge period is so fast, it can be as short as a few hundred nano seconds, the period can be thought of as being determined by the charging time, which is controlled by the 10k pot.



Walsh Function Generator

The mathematician, Fourier, said that any repeating waveform could be made up out of harmonic components. These components are sinusoids which are integrally related to the fundamental period of the waveform in question. This is a convenient conceptual approach, but as a way of practically synthesising waveforms it is not on. You would have to generate a whole series of harmonically related sinewaves which might prove a little difficult. However, a man called Walsh said that you could do the same thing as Fourier, but with square waves. So, instead of using sinusoidal Fourier sets, we can use square wave Walsh functions to synthesise waveforms. There are various techniques for calculating the Walsh function co-efficients for generating particular waveforms but these are beyond the scope of an article such as this. The diagram shows the circuit for generating a sine and cosine waveforms using 16 steps. Walsh functions are orthogonal functions, just as sine and cosine are orthogonal, and so the generation of these two waveforms is relatively simple using this technique. The 4013 dividers and the exclusive OR gates generate the Walsh functions, which in turn are converted into analogue waveforms by use of the correctly weighted resistor networks. Note that you only need 4 resistors to generate a 16 step sinewave approximation.

The resultant outputs can be easily filtered by fixed or tracking filters to produce pure sinusoids. The output frequency is 1/16th of the input clock frequency. The clock can be stopped and the outputs will remain fixed, try that with analogue techniques!

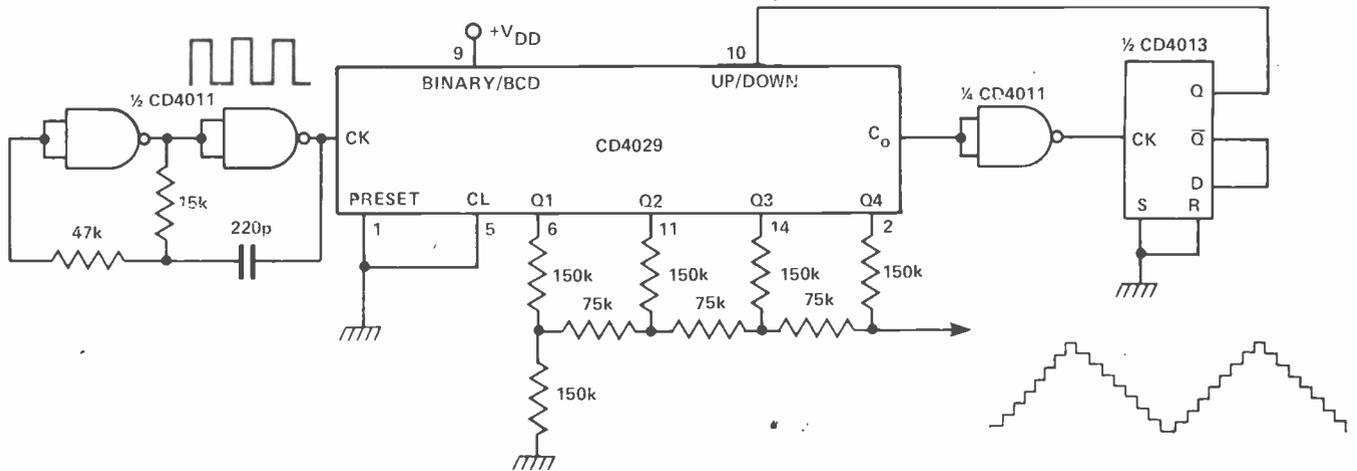


R-2R Staircase Generator

Waveforms can be constructed by building them up out of separate elements. In this case a linear ramp waveform is generated out of 128 steps. The CD4024 is a seven stage binary counter. It is being driven from a CMOS clock oscillator similar to that already described.

The Q1 to 7 outputs divide this clock frequency by

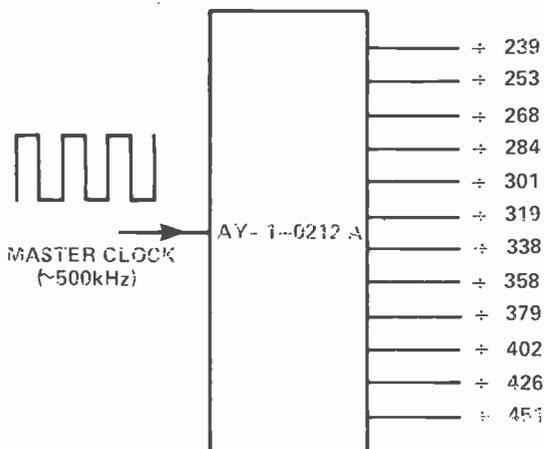
2,4,8,16,32,64 and 128 respectively and the divided outputs are then fed into an R,2R ladder network. This is in fact a Digital to Analogue Converter (DAC) and as the counter is merely counting up, then the converter will generate a linearly rising waveform made out of 128 steps. When the counter overflows, the ramp waveform resets and the process repeats itself.



R-2R Triangle Generator

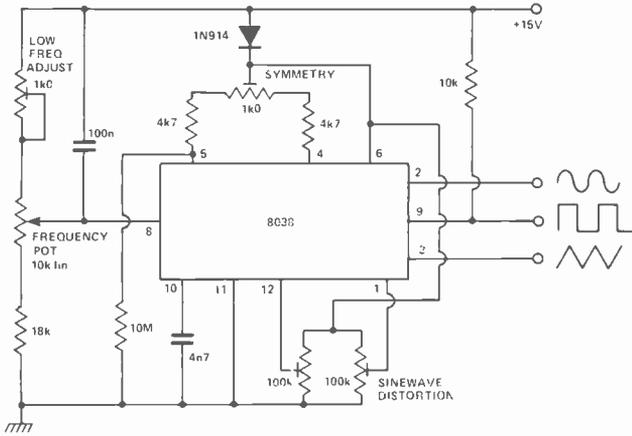
This circuit is similar to the previous except an up down counter is included. A clock signal is applied to the 4029 counter. When it has counted 16 clocks a Carry signal is generated. This clocks a D type flip-flop (4013), which changes state and reverses the up

down mode of the 4029. Thus the circuit counts up, down, up, etc. The counting is converted via an R,2R ladder into an analogue output, a triangle waveform made up out of several steps.



Master Tone Generator

If you have ever made an electric organ, piano or string machine you would have had to produce the top twelve notes for the top octave by some means or other. More expensive organs might use 12 master oscillators which would be tuned to the top twelve semitones on the keyboard. This gives a nice free phase quality to the sound. The notes in the octaves below are made by using binary dividers and filtering. Very expensive organs would use an oscillator per note. This allows every note to be individually tuned and produces a very good sound quality. However, there is an easy way of producing the semitones and this is with a master tone generator chip. This is a pre-programmed divider having one input and twelve or thirteen outputs. A high frequency master clock is put into the chip which is divided by numbers ranging from 239 to 451. These divisions produce the semitone outputs. Thus, by using one master oscillator and one master tone generator a lot of the work of making an organ is removed. It is possible to produce more accurate intervals using 12 oscillators, but the speed and efficiency of the chip usually wins in the lower price end of the market.

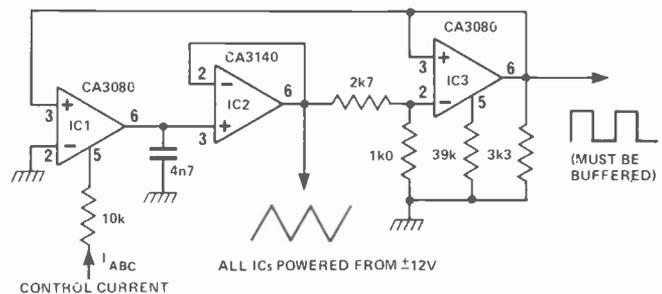


8038 Function Generator

There are several ICs available which perform some sort of oscillator function. One such is the Intersil 8038 which is a VCO with sine, triangle and squarewave outputs. The basic oscillator is a triangle squarewave device with a function generator to produce the sinewave. The frequency is voltage controllable but is not a linear function. The triangle symmetry and hence sinewave distortion are adjustable with a preset but change when the frequency is altered. Operation up to 1MHz is possible.

Triangle Squarewave ICO Using CA3080's

This circuit is very similar to that of the simple triangle/square oscillator, except that the operating frequency is controlled by a current IABC. (ICO stands for current controlled oscillator, as opposed to VCO, voltage controlled oscillator). Using this circuit, a sweep range of 10,000 to 1 is possible (for IABC 500 μ A to 50nA). The CA3080 is a two quadrant multiplier and the CA3140 is a MOS FET op-amp. IC1 is used as an integrator. IC2 is a high input impedance voltage follower and IC3 is a Schmitt trigger. The CA3080 has a current output which in the case of IC1 is used to charge up a capacitor. The voltage on this capacitor is buffered by the CA3140 and fed into the Schmitt IC3. The CA3080 (IC3) forms a very fast Schmitt trigger but as it has a current output, it cannot be loaded in any way without effecting the operating frequency. The output of the Schmitt is used to make the integrator inverting or non-inverting. Thus the operation is as follows. The integrator ramps upward until the positive hysteresis level is reached. The Schmitt flips over, the integrator then ramps downwards until the negative hysteresis level is reached. The Schmitt flips back and the process is

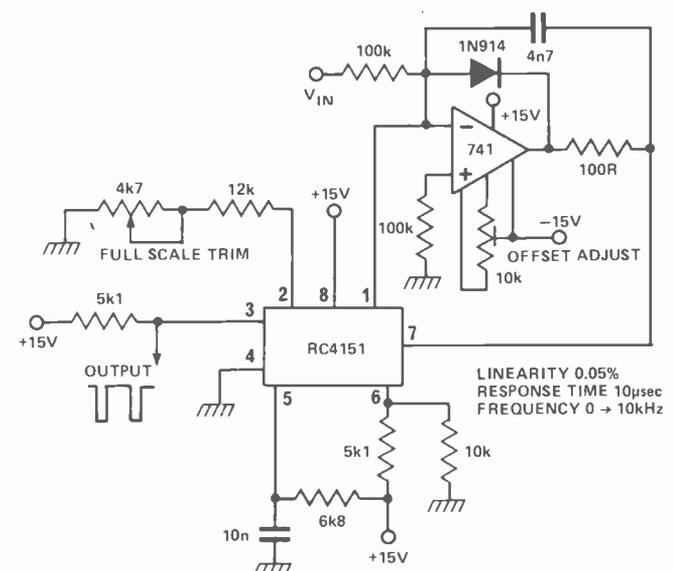


repeated. The ramp rate is determined by the size of the current IABC is linearly proportional to the oscillation frequency. At very low currents the triangle waveform may become very asymmetrical. This is due to current mirror mismatches inside IC1 and this device may have to be specially selected for continuous symmetry.

Precision Voltage Controlled Oscillator

The RC 4151 is a precision voltage to frequency converter. It generates a pulse train output which is linearly proportional to the input voltage. The linearity for the circuit shown is 0.05%. The IC compares the input voltage with an internally generated one. It dumps controlled pulses of charge into a Parallel RC network and compares this generated voltage with the input. If the input is greater it puts more pulses of charge into the RC network until the two are balanced. To get a larger sustained voltage in the RC network the frequency of the pulses must be increased. Thus the frequency of the pulses generated is made to be proportional to the input voltage.

The output is a pulse waveform and is intended to drive some sort of counting system, the chip being used as simple analogue to digital converter. It can also be used as a frequency to voltage converter. A maximum frequency of 10kHz has to be observed.



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7403	.12	74102	.40	74199	1.48	74LS156	.80	4027	.50	4520	2.00	.80 for 10: 3.50 for	BD140	.48	TIP42B	.76	2N4125	.16	2.2 .045 .05 .055 .06
7404	.13	74103	.28	74201	1.50	74LS157	.47	4028	.67	4521	1.95	50: 6.50 for 100	BD141	.90	TIP42C	.86	2N4133	.16	3.3 .045 .05 .055 .06
7405	.13	74104	.45	74202	2.15	74LS158	.53	4029	.96	4522	1.80	(Any mil.)	BF241	.24	TIP3055	.90	2N4136	.16	4.7 .045 .05 .055 .06
7406	.13	74110	.46	74203	1.25	74LS160	.22	4030	.48	4523	1.60	S.C.I.'s	BF242	.24	TIP3055	.90	2N4142	.18	6.8 .05 .055 .06 .07
7407	.28	74111	1.80	74204	6.85	74LS161	.89	4031	2.34	4524	1.80	1Amp 200V .30	BF243	.85	TX107	.10	2N4458	.28	10 .05 .06 .07 .09
7408	.14	74112	.82	74205	1.35	74LS162	1.22	4033	1.25	4529	1.10	4Amp 200V .40	BF246	.23	TX130A	.20			22 .06 .07 .09 .13
7409	.14	74113	1.30	74206	1.92	74LS164	1.20	4035	1.00	4533	4.20	8Amp 400V .50	BF247	.22	TX1502	.20			33 .07 .085 .10 .15
7410	.18	74122	.25	74303	2.12	74LS168	2.00	4036	2.40	4535	.80	7Amp 100V .50	BF248	.22	TX1504	.25			68 .09 .12 .16 .22
7411	.21	74123	.45	74304	1.78	74LS169	2.00	4037	.90	4536	.85	10amp 200V .60	BF249	.20	TX1506	.20			100 .10 .15 .18 .25
7412	.21	74124	.45	74305	1.92	74LS170	1.78	4038	1.80	4538	1.25	10amp 400V .80	BF251	.20	1N823	.20			150 .11 .15 .20 .28
7413	.25	74125	.44	74LS00 TTL		74LS171	1.85	4039	2.80	4540	1.40	10amp 100V .75	BF252	.18	1N823	.30			220 .12 .16 .22 .32
7414	.27	74126	.62	74LS01	.19	74LS174	1.12	4040	.88	4543	.75		BF254	.20	1N914	.06			330 .14 .18 .26 .36
7415	.27	74127	.62	74LS02	.19	74LS175	1.05	4041	.77	4545 LINEAR	1.83		BR100	.26	1N914	.07			470 .16 .20 .29 .40
7416	.27	74128	.62	74LS03	.19	74LS176	1.05	4042	.77	TA6500	.35		BR100	.26	1N914	.07			680 .18 .24 .33 .48
7417	.27	74129	.62	74LS04	.19	74LS177	1.05	4043	.82	TA6518	1.40		BR100	.26	1N914	.07			1000 .20 .29 .41 .56
7418	.27	74130	.62	74LS05	.19	74LS178	1.05	4044	.82	TA6518	1.40		BR100	.26	1N914	.07			2200 .28 .46 .65 .95
7419	.27	74131	.62	74LS06	.19	74LS179	1.05	4045	1.40	TA6518	1.40		BR100	.26	1N914	.07			4700 .47 .80 .90
7420	.27	74132	.62	74LS07	.19	74LS180	1.05	4046	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7421	.27	74133	.62	74LS08	.19	74LS181	1.05	4047	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7422	.27	74134	.62	74LS09	.19	74LS182	1.05	4048	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7423	.27	74135	.62	74LS10	.19	74LS183	1.05	4049	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7424	.27	74136	.62	74LS11	.19	74LS184	1.05	4050	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7425	.27	74137	.62	74LS12	.19	74LS185	1.05	4051	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7426	.27	74138	.62	74LS13	.19	74LS186	1.05	4052	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7427	.27	74139	.62	74LS14	.19	74LS187	1.05	4053	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7428	.27	74140	.62	74LS15	.19	74LS188	1.05	4054	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7429	.27	74141	.62	74LS16	.19	74LS189	1.05	4055	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7430	.27	74142	.62	74LS17	.19	74LS190	1.05	4056	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7431	.27	74143	.62	74LS18	.19	74LS191	1.05	4057	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7432	.27	74144	.62	74LS19	.19	74LS192	1.05	4058	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7433	.27	74145	.62	74LS20	.19	74LS193	1.05	4059	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7434	.27	74146	.62	74LS21	.19	74LS194	1.05	4060	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7435	.27	74147	.62	74LS22	.19	74LS195	1.05	4061	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7436	.27	74148	.62	74LS23	.19	74LS196	1.05	4062	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7437	.27	74149	.62	74LS24	.19	74LS197	1.05	4063	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7438	.27	74150	.62	74LS25	.19	74LS198	1.05	4064	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7439	.27	74151	.62	74LS26	.19	74LS199	1.05	4065	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7440	.27	74152	.62	74LS27	.19	74LS200	1.05	4066	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7441	.27	74153	.62	74LS28	.19	74LS201	1.05	4067	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7442	.27	74154	.62	74LS29	.19	74LS202	1.05	4068	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7443	.27	74155	.62	74LS30	.19	74LS203	1.05	4069	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7444	.27	74156	.62	74LS31	.19	74LS204	1.05	4070	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7445	.27	74157	.62	74LS32	.19	74LS205	1.05	4071	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7446	.27	74158	.62	74LS33	.19	74LS206	1.05	4072	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7447	.27	74159	.62	74LS34	.19	74LS207	1.05	4073	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7448	.27	74160	.62	74LS35	.19	74LS208	1.05	4074	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7449	.27	74161	.62	74LS36	.19	74LS209	1.05	4075	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7450	.27	74162	.62	74LS37	.19	74LS210	1.05	4076	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7451	.27	74163	.62	74LS38	.19	74LS211	1.05	4077	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7452	.27	74164	.62	74LS39	.19	74LS212	1.05	4078	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7453	.27	74165	.62	74LS40	.19	74LS213	1.05	4079	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7454	.27	74166	.62	74LS41	.19	74LS214	1.05	4080	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7455	.27	74167	.62	74LS42	.19	74LS215	1.05	4081	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7456	.27	74168	.62	74LS43	.19	74LS216	1.05	4082	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7457	.27	74169	.62	74LS44	.19	74LS217	1.05	4083	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7458	.27	74170	.62	74LS45	.19	74LS218	1.05	4084	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7459	.27	74171	.62	74LS46	.19	74LS219	1.05	4085	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7460	.27	74172	.62	74LS47	.19	74LS220	1.05	4086	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7461	.27	74173	.62	74LS48	.19	74LS221	1.05	4087	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7462	.27	74174	.62	74LS49	.19	74LS222	1.05	4088	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7463	.27	74175	.62	74LS50	.19	74LS223	1.05	4089	1.32	TA6518	1.40		BR100	.26	1N914	.07			
7464	.27	74176	.62	74LS51	.19	74LS224	1.05	4090	1.32	TA6518	1.40		BR100	.26					

TEMPERATURE METER

A simple yet accurate temperature meter based on the LCD panel meter published in our March issue.

THE RELIABILITY of electronic circuits in the days of valves was, to say the least, poor by today's standards. The introduction of transistors and integrated circuits increased reliability dramatically. One of the main reasons for this is the reduction of power dissipation and the resultant lowering of temperature. Devices and circuits are now designed to minimise power dissipation as this allows a higher component density while increasing reliability. However, some circuits by their nature must dissipate high power and the semiconductor devices used must be kept within their temperature limits.

This temperature meter will allow transistor temperatures to be measured and the appropriate heatsink chosen. It is just as useful outside the electronic scene measuring liquid or gas temperature especially where the readout needs to be physically separate from the sensor.

Use and Accuracy

The accuracy of the unit depends on the calibration; provided it has been calibrated around the temperature at which it will be used, accuracy of 0.1 degree should be possible. We could not accurately check linearity but it appeared to be within 1° from 0° to 100°C.

However, other errors will affect this reading. If measuring the surface temperature i.e. a heatsink temperature, there will be a temperature gradient between the surface and the junction of the diode. Silicon grease should be used to minimise the surface-to-surface temperature difference. Also when measuring small objects, e.g. a TO-18 transistor, the probe will actually cool the device slightly. At high temperatures these effects could give an error of up to 5% (the reading is always less than the true value). If the probe is in a fluid (eg water) or air this problem does not occur.

Construction

Assemble the panel meter as previously described but omitting the zener diodes and R6 and R7. The value of R1 has also been changed. The decimal point drive should be connected to the righthand decimal point. The additional components can be assembled on a tag strip as shown.

We mounted our unit on a tag strip as shown in the photo. While we have not given any details, knocking up a case should be no problem. For a power supply we used eight penlight Nicad cells giving a 10 V supply. If dry batteries are used six penlight cells are recommended although a 216-type 9 V transistor battery will give about 300 hours of operation.

The sensor should be mounted in a probe as shown in Fig. 1 if other than air temperature will be measured. This provides the electrical insulation needed for working in liquids etc. It should be noted however that the quick dry epoxies are not normally good near or above 100°C and if higher temperatures than this are expected one of the slow dry epoxies should be used.

Calibration

To calibrate this unit two accurately known temperatures are required, one of which is preferably zero degrees and the second in the area



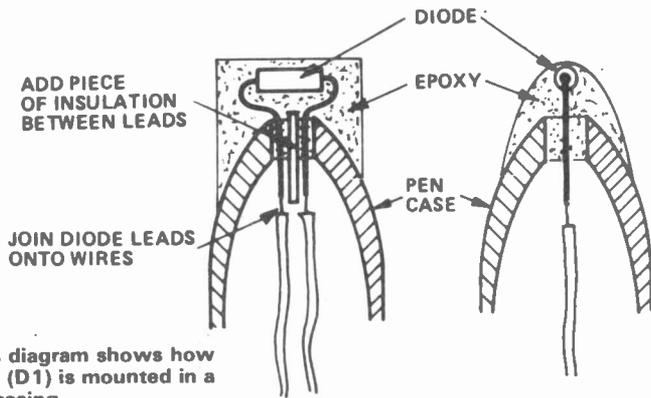


Fig. 1. This diagram shows how the sensor (D1) is mounted in a ball-point casing.

HOW IT WORKS

While the voltage across a silicon diode is nominally about 600 mV it is dependent upon the ambient temperature and current in the device. The temperature coefficient is negative, i.e. the voltage falls with increasing temperature but fortunately is linear in the region of interest. The actual value varies with current and from device to device, but is typically $-2.2 \text{ mV}/^\circ$ at $250 \mu\text{A}$.

By measuring the voltage across the diode with a suitable offset voltage to balance the voltage at zero degrees an accurate temperature meter results. The digital panel meter described in October has a stable reference voltage available (between pins 1 and 32) of about 2.9 V; with the 10k resistor R11 this provides a constant current for D1 (the sensor). The offset voltage is also derived from this reference voltage by R12, RV2 and RV3. The panel meter is used as a differential voltmeter and measures the potential difference between the offset voltage and the diode. We have used two trimpots in series in the offset adjustment to give better resolution. If desired a 10-turn trimpot can be used (2k2). Adjustment of the three potentiometers allows the meter to be calibrated in either $^\circ\text{C}$ or $^\circ\text{F}$ with the upper limit of 199.9°F due to the panel meter over-ranging.

The power supply is simply a 9 V battery, and so the zener diodes and dropping resistors described in the panel meter article should be omitted.

BUYLINES

The original LCD meter was based on the Intersil evaluation kit but since then a number of advertisers have put together kits for our project. Such a kit is probably the best place to start although the ICL7106 and suitable displays, the only components likely to prove difficult to find, are now available from most of the larger mail order firms advertising in ETI.

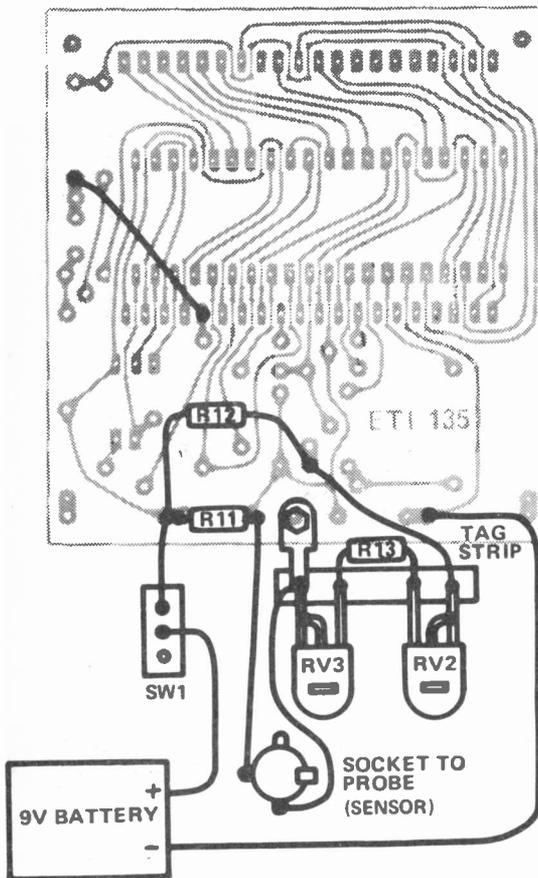


Fig. 2. The external components associated with the panel meter to form the thermometer. For full details of the panel meter (foil pattern etc.) see the March 78 issue of ETI.

PARTS LIST

RESISTORS

R1, 11	10k
R2	47k
R3, 9	100k
R4	not used
R5	1M
R6, 7	not used
R8, 10	4M7
R12	27k
R13	5k6

POTENTIOMETERS

RV1	1k 10 turn trim
RV2	2k preset
RV3	200R preset

CAPACITORS

C1	100n polyester
C2	470n polyester
C3	220n polyester
C4	100p ceramic
C5, 6	10n polyester

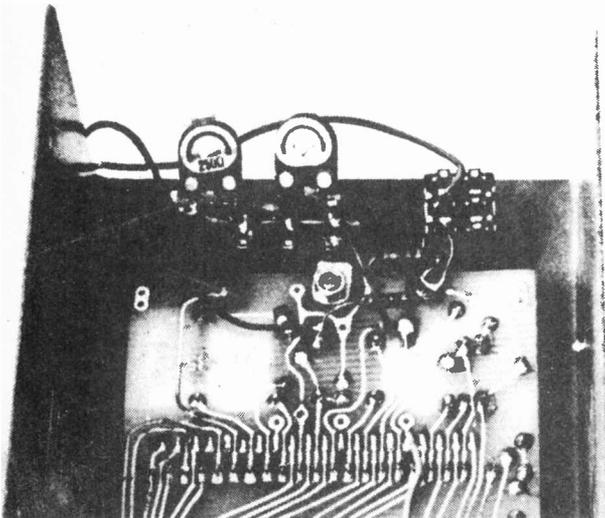
SEMICONDUCTORS

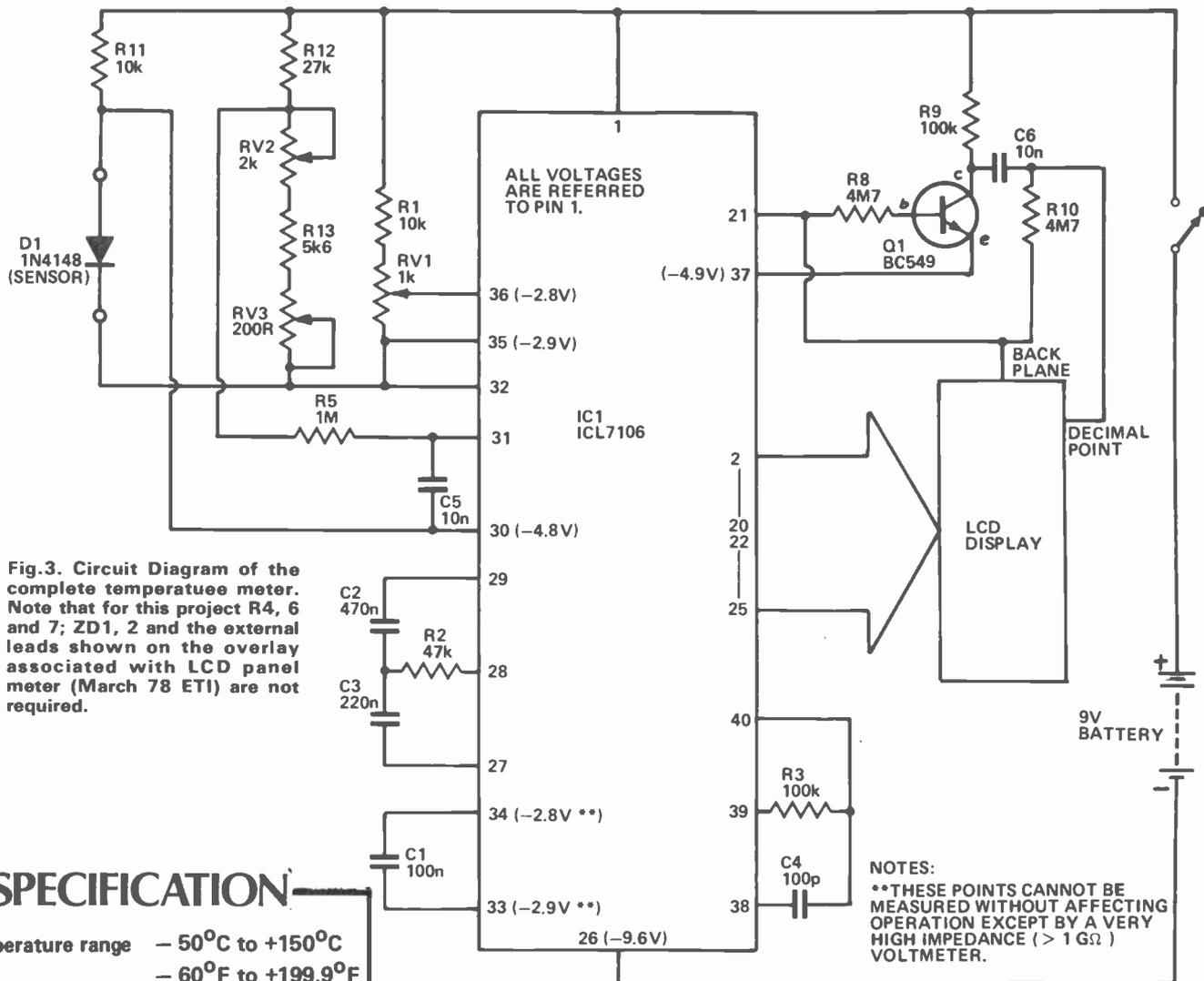
IC1	ICL7106
Q1	BC549
D1	1N914

MISCELLANEOUS

PCB as LCD Panel Meter (March 78 ETI), tag strip, LCD display, socket for display, box, switch and 9 V battery.

The photograph (left) shows the external components, detailed in Fig. 2, in position.





SPECIFICATION

Temperature range	- 50°C to +150°C - 60°F to +199.9°F
Resolution	0.1°C or F
Sensor	silicon diode
Power consumption	1.5mA @ 9 V dc

where the meter will normally be used and highest accuracy is required. For a general-purpose unit 100° C is suitable. The easiest way of obtaining these references is by heating or cooling a container of distilled water. However temperature gradients can cause problems, especially at zero degrees.

One method of obtaining water at exactly zero degrees is to use a test tube of distilled water in a flask of iced water and allowing it to cool to near zero. Now by adding salt to the iced water its temperature can be lowered to below zero. If you are very careful, the test tube water will also drop below zero without freezing (you should be able to get to about -2°C). However, the slightest

disturbance at this temperature will instantly cause some of the water to freeze and the remaining water to rise to exactly zero, providing an ideal reference.

For a hot reference the boiling point of distilled water is very close to 100° C especially if the container has a solid base and is evenly heated e.g. on an electric hotplate.

The actual calibration is done as follows:

1. In the 0° C reference adjust RV2 and RV3 until the unit reads zero.
2. In the hot reference adjust RV1 to give the correct reading.

This should be all the adjustment required.

If zero degrees is not available, e.g. if setting up for ° F, the following method can be used:

1. In the cold reference use RV2 and RV3 to adjust reading to zero.
2. In the hot reference use RV1 to adjust the reading to indicate the temperature difference between the two standards. If freezing and boiling points are used, this will be 180°F.
3. Now, back in the cold bath, adjust RV2 and RV3 to give the correct reading.

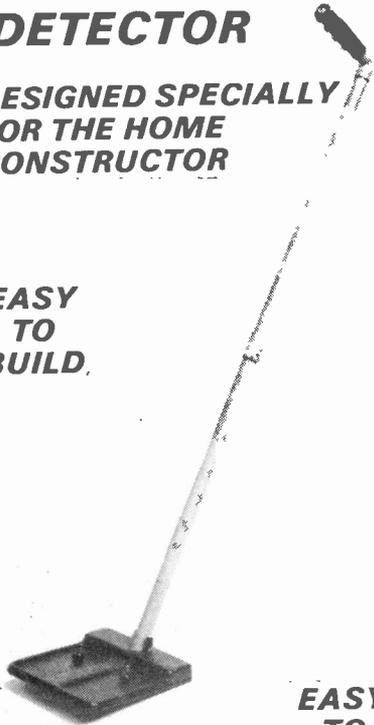
No further adjustment should be required.

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V-FETS FOR EVERYONE!

This article, by Wally Parsons, first appeared in our Canadian edition. We think that V-FETs represent a large step forward in power amplifier technology and so we have reprinted it, starting this month.

The first part of 'V-FETs for Everyone' covers the theory behind V-FETs and what their specifications mean. Next month, part two will describe how V-FETs are used at present and how to design V-FET circuitry.

SINCE THE SEMI-CONDUCTOR is precisely that, a battery across the ends of a p-type or an n-type bar will cause current to flow through the material, just as it does through a vacuum tube. If a p-type material is joined to the surface of an n-type bar, located between the battery terminals, a pn junction is formed, and if this junction is reverse biased, a space charge or field is produced of opposite polarity which will inhibit current flow, just as the control grid inhibits current flow in vacuum tube. Changing this reverse voltage causes a large current change, and therefore amplification results.

A simple FET (J-FET) is shown in Fig. 1. With a given drain — source voltage, maximum current flows under zero gate voltage conditions and at some reverse levels, no current will flow. Also, as in the vacuum tube, load characteristics are not reflected to the input circuit, because current is not controlled by carrier injection as in bipolars, but by voltage levels.

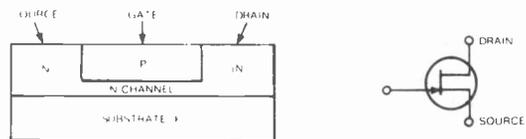
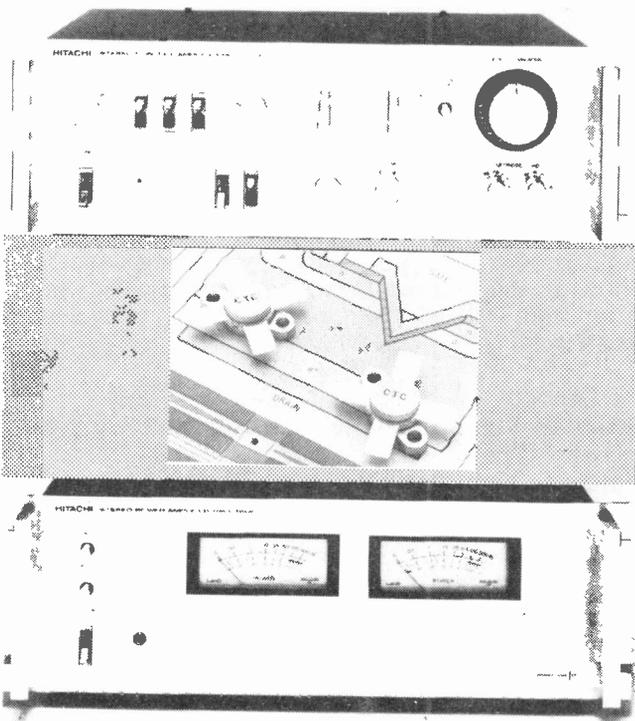


Fig 1: N-channel JFET construction and symbol

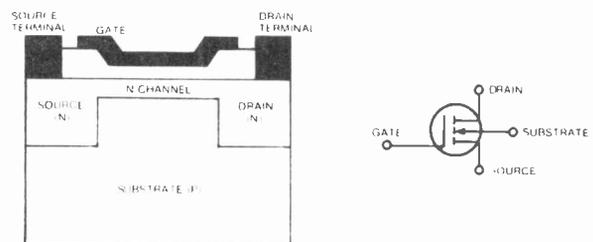


Fig 2: N-channel depletion horizontal MOSFET construction and symbol

A variation is the Metal Oxide Semi-conductor Field Effect Transistor. (MOSFET) (Fig. 2) a far more versatile device whose technology is virtually the cornerstone of modern computer technology, ▶

although it has had less use to date in linear applications such as audio amplification.

MOSFETs come in two basic types. In both types the gate consists of a metal electrode separated from the channel by a thin oxide layer. In the depletion type current flow is controlled by the electrostatic field of the gate when biased. Voltage relationships are the same as for the J-FET, except that when the J-FET is forward biased current will flow through the junction (after all, it is a *pn* junction). This does not contribute to amplification, and may even destroy the device. When a depletion MOSFET is so biased it may result in increased current flow and, provided current, dissipation, and breakdown ratings are suitable, the device may be driven on both sides of the zero volts point as with vacuum tubes. Unlike vacuum tubes under these conditions, the gate draws no current and therefore does not require the driver to deliver power.

The enhancement type MOSFET shown in Fig. 3, is more widely used. The source and drain are separated by a substrate of opposite material, and under zero gate volts no current flows. However, when sufficient forward bias is applied to the gate the region under the gate changes to its opposite type (e.g. *p*-type becomes *n*-type) and provides a conductive channel between drain and source. Carrier level and conduction are controlled by the magnitude of gate voltage. Although J-FETs, and especially MOSFETs, have certainly delivered on their original promise, in one area they are particularly conspicuous by their absence, and that is in the area of power. Unfortunately, the channel depth available for conduction is limited by the practical limits on gate voltage. The lower current density has been the primary limitation due to the horizontal current flow.

VMOS

Recent years have seen the introduction and commercial use of Vertical Channel J-FETs, notably by Sony and Yamaha (Fig. 4). The vertical channel permits a very high width-length ratio, permitting a decreased inherent channel resistance and high current density. Unfortunately it exhibits the same disadvantages as the small signal J-FET, plus, in available devices, a very high input capacitance, ranging from 700pf to around 3000pf, limiting high frequency response. In addition, since they must be biased into the off condition, bias must be applied before supply voltage and removed after the supply if it is to be operated anywhere near its maximum ratings. This problem doesn't exist with vacuum tubes because of heater warm-up time, although some "instant-on" circuits impose heavy turn-on surges.

This necessitates a complex power supply, and indeed Yamaha, for example, uses more devices in the supply than it does in its amplifier circuits. However, the construction does make possible the design of complementary types and Nippon Electric and Sony both have high power devices available. Unfortunately, neither company seems anxious to make detailed information available, so there is little to disclose here beyond the fact that they are said to have characteristics similar to those of triode tubes.

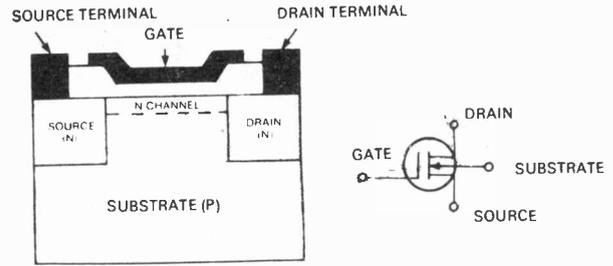


Fig 3: N-channel enhancement horizontal MOSFET construction and symbol

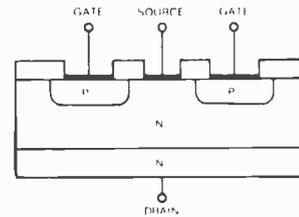


Fig 4: Vertical junction FET construction

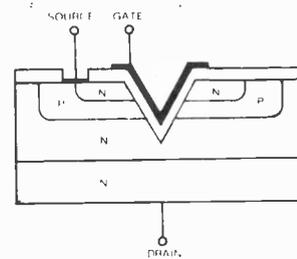


Fig 5: Vertical MOSFET construction (Siliconix)

However, the Vertical MOSFETs by Siliconix are readily available, at reasonable prices, and the manufacturer most generous in providing data. The following information is extracted from their application note AN76-3, Design Aid DA 76-1, plus device data sheets.

The Device

Notice in Fig. 5 that the substrate and body are opposite type materials separated by an epi layer (similar to high speed bi-polars). The purpose of this structure is to absorb the depletion region from the drain-body junction thus increasing the drain-source breakdown voltage. An alternative would have involved an unacceptable trade-off between increasing the substrate-body depth to increase breakdown voltage but increasing current path resistance and lengthening the channel. In addition, feedback capacitance is reduced by having the gate overlap n-epi material instead of *n+*.

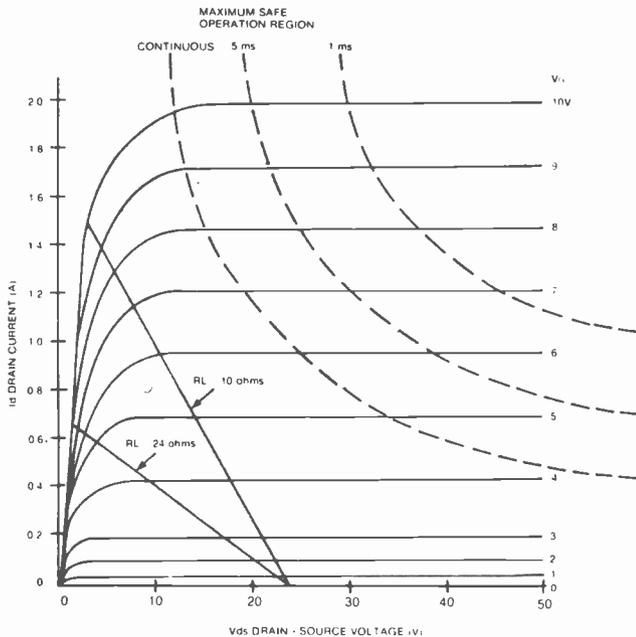


Fig 6: Output characteristics VMP1

In manufacture, the substrate-drain and epi layer are grown, then the *p*-body and *n*+ source diffused into the epi layer, in a similar manner as the base and emitter of a diffusion type transistor. A V groove is etched through the device and into the epi layer, an oxide layer grown, then etched away to provide for the source contact and an aluminium gate deposited. It is apparent that this type of device allows current flow in one direction only; this is not always so with a similar type of horizontal FET, where source and drain may be identical in structure and of the same material. Therefore, no reverse current flows (we hope!) when used in switching applications, as was also the case with vacuum tubes.

In-circuit operation is refreshingly simple: Supply voltage is applied between source and drain, with the drain positive with respect to the source, under which conditions no current flows, and the device is off. This is an enhancement type device and is turned on by taking the gate positive with respect to the source and body. The electric field induces an *n* channel on both surfaces of the body facing the gate, and allows electrons to flow from the negative source through the induced channel and epi and through the substrate drain. The magnitude of current flow is controlled almost entirely by the gate voltage, as seen in the family of curves (Fig. 6 and 7) with no change: resulting from supply voltage changes above 10V.

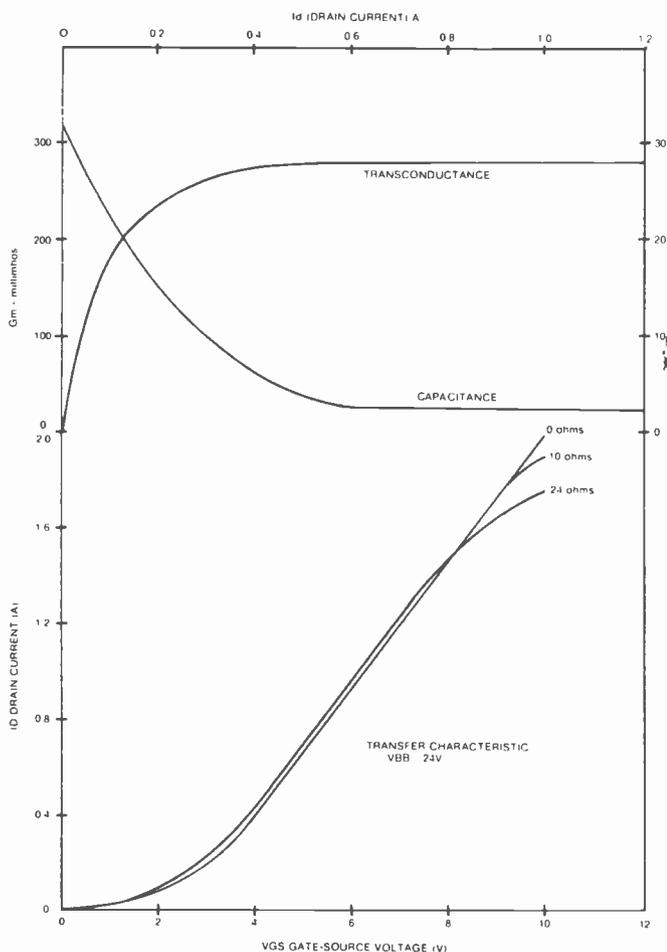


Fig 7: Other VMP1 characteristics

Advantages

The vertical structure results in several advantages over horizontal MOSFETS.

1) Since diffusion depths are controllable to close tolerances, channel length, which is determined by diffusion depth, is precisely controlled. Thus, width/length ratio of the channel, which determines current density, can be made quite large. For example, the VMP1 channel length is about 1.5 μ s, as against a minimum of 5 μ s in horizontal MOSFETS, due to the lower degree of control of the shadow masking and etching techniques used in such devices.

2) In effect, two parallel devices are formed, with a channel on either side of the V groove, thus doubling current density.

3) Drain metal runs are not required when the substrate forms the drain contact, resulting in reduced chip area, and thus reduced saturation resistance.

4) High current density results in low chip capacitance. Also, unlike horizontal MOSFETS, there is no need to provide extra drain gate overlap to allow for shadow mask inaccuracies, so feedback capacitance is minimized.

In comparison with bi-polars, especially power devices, the advantages are even more impressive.

1) Input impedance is very high, comparable to vacuum tubes, since it is a voltage controlled device, with no base circuit drawing current from the driver stage. A 7 V swing at the gate, at virtually 0 A, represents almost 0 W of power, but can produce a swing of 1.8 A in output current. This represents considerable power gain and will interface directly with high impedance voltage drivers.

2) No minority carrier storage time, no injection, extraction, recombination of carriers, resulting in very fast switching and no switching transient in

Characteristics			VMP 11			VMP 1			VMP 12			Unit	Test Conditions	
			Min	Typ	Max	Min	Typ	Max	Min	Typ	Max			
S T A T I C	1	BV _{DS}	Drain-Source Breakdown	35			60					V	V _{GS} = 0; I _D = 100 μA	
	2	V _{GS(th)}	Gate Threshold Voltage	0.8		2.0	0.8		2.0	0.8	2.0		V _{GS} = V _{DS} ; I _D = 1 mA	
	3	I _{GS}	Gate-Body Leakage			0.5			0.5			0.5	μA	V _{GS} = 15 V; V _{DS} = 0
	4	I _{D(off)}	Drain Cutoff Current			0.5			0.5			0.5		V _{GS} = 0; V _{DS} = 24 V
	5	I _{D(on)}	Drain ON Current*	1	2.0		1	2.0		1	2.0		A	V _{DS} = 24 V; V _{GS} = 10 V
	6	I _{D(on)}	Drain ON Current*	0.5			0.5			0.3				V _{DS} = 24 V; V _{GS} = 5 V
S W I T C H	7	r _{DS(on)}	Drain-Source ON Resistance*	2.0	2.5		3.0	3.5		3.7	4.5		Ω	V _{GS} = 5 V; I _D = 0.1 A
	2.4			3.0		3.3	4.0		4.6	5.5			V _{GS} = 5 V; I _D = 0.3 A	
	1.2			1.5		1.9	2.5		2.6	3.2			V _{GS} = 10 V; I _D = 0.5 A	
	1.4			1.8		2.2	3.0		3.4	4.0			V _{GS} = 10 V; I _D = 1 A	
11	g _m	Forward Transconductance*	200	270		200	270		170			mΩ	V _{DS} = 24 V; I _D = 0.5 A	
D Y N A M I C	12	C _{iss}	Input Capacitance		48		48			48			pF	V _{GS} = 0; V _{DS} = 24 V
	13	C _{rss}	Reverse Transfer Capacitance		7		7			7				f = 1 MHz
	14	C _{oss}	Common Source Output Capacitance		33		33			33				
	15	t _{ON}	Turn ON Time**		4	10		4	10		4	10		ns
16	t _{OFF}	Turn OFF Time**		4	10		4	10		4	10			VMC

*Pulse Test **Sample Test
Pulse Test Pulse Width = 80 μsec, Duty Cycle = 1%

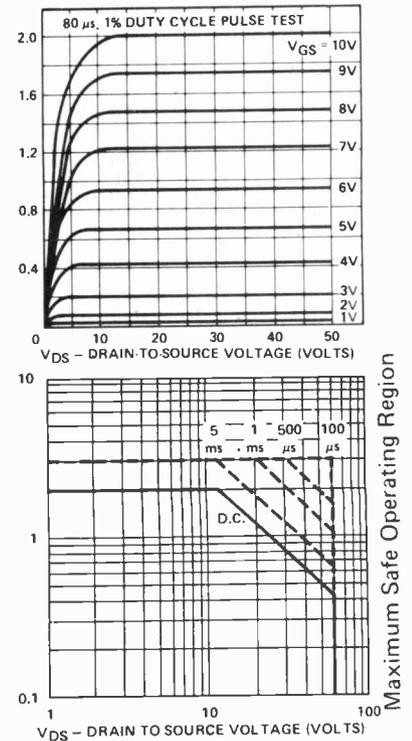


Fig 8, 9 & 10: Electrical characteristics of the VMP devices from Siliconix, a freely available VFET.

class B and AB amplifiers. Switching time for a VMP1 is 4 ns for 1 A, easily 10-200 times faster than bi-polars, and even rivalling many vacuum tubes.

3) No secondary breakdown, and no thermal runaway. VMOS devices exhibit a negative temperature coefficient with respect to current, since there is no carrier recombination activity to be speeded up with temperature. Thus, as current increases so does temperature, but the temperature rise reduces current flow. It is still possible to destroy the device by exceeding its maximum ratings, but a brief near-overload does not result in an uncontrollable runaway condition. Usually, simple fusing and/or thermistor protection is sufficient for maximum safety, and even this may be unnecessary with conservative design. Absence of secondary breakdown means that full dissipation can be realized even at higher supply voltages. In this respect they resemble vacuum tubes.

Available Devices

Seven devices representing three families are available. Types VMP-1, VMP-11, and VMP-12 are 2 A, 25 W dissipation devices intended for switching and amplifier use and differ only in voltage rating (60 V, 35 V, 90 V, respectively). Types VMP-2, VMP-21, VMP-22, are 1.5 A, 4 W devices rated at 60 V, 35 V, 90 V respectively, and are intended mainly for high speed switching, but would also be useful for low power amplifiers and as linear drivers for bi-polars, where the latter offer advantages. And finally, type VMP-4, 1.6 A, 35 W, specifically intended for VHF amplifier use. All except VMP-4 devices feature gate protection to withstand static discharges and over-voltages, and all are currently available except the VMP-4. All are n-channel. One hesitates to pass premature judgement, but if the millennium hasn't arrived yet, at least it might just be on the way.

Conditions

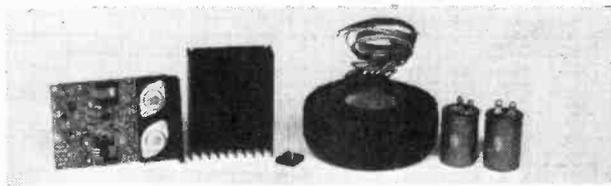
V-MOS Power FETs like signal MOSFETS, may be used in a variety of circuit arrangements to perform many different functions. However, no matter what the circuit, certain conditions, common to all applications, must be provided. These are supply power, loading, drive signal, and establishment of appropriate operating points. These are conditions necessary for amplification and since all active devices function as amplifiers, no matter what the total circuit function, the in-circuit performance of any device depends on the establishment of these conditions.

The electrical characteristics of the VMP1, VMP11, and VMP12, are shown in Fig. 8, and Fig. 9 and 10 shows them in graphic form. Since these are unidirectional devices, the source and drain are not interchangeable, and as they are n-channel devices conduction can occur only if the drain is positive with respect to the source, and high enough to ensure operation in the linear region, as with a vacuum tube, bi-polar transistor, or signal FET.

Like the vacuum tube, the absence of secondary breakdown allows realization of the full dissipation at any voltage supply up to maximum voltage and current ratings. Thus, where two different designs require the same dissipation but different voltage/load current, no derating is required. This is shown in the "safe operating area" curves. The only bi-polar transistor possessing this characteristic is the single-diffused type, which is also the least suitable for any application requiring wide bandwidth and/or high speed.

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0-8-9-0-8-9	1A 1A	208	3.50	55
0-15-0-15	200 200	236	1.95	40
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3.0	105	7.85		100
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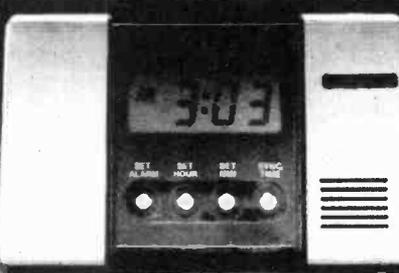
A1, A2, A3 Boards still available.

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TRULY PORTABLE, CORDLESS, ELECTRONIC ALARM CLOCK
 at only £19.78 inc. VAT (+£1 P&P).

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PORTABLE ALARM CLOCK
 Use in the home, in offices and travel also would make an excellent car clock.

- Computer-type 1/2" (12.7mm) LCD readout
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- Simple time setting procedure. Time zone changes easily made
- Time synchronizing switch for exact time setting
- Clear, pleasant sounding piezo-electric alarm
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Dimensions: 120 x 74 x 19mm (4 3/4" x 2 5/16" x 3/4")
 Weight: 120 grams (4.2 ounces) including gift box and packing.
 Finish: Metal with black inset

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- * **HAVE THE RIGHT PART** — No guesswork or substitution necessary!

ALL PACKS CONTAIN FULL SPEC. BRAND NEW MARKED DEVICES — SENT BY RETURN OF POST. VAT INCLUSIVE PRICES.

K001 50V ceramic plate capacitors. 5%. 10 of each value 22pF to 1000pF. Total 210. **£3.35.**

K002. Extended range, 22pF to 0.1µF. 330 values. **£4.90.**

K003. Polyester capacitors. 10 each of these values 0.01, 0.015, 0.022, 0.033, 0.047, 0.068, 0.1, 0.15, 0.22, 0.33, 0.47µF. 110 altogether for **£4.75.**

K004 Mylar capacitors min 100V type. 10 each all values from 1000pF to 10,000pF. Total 130 for **£3.75.**

K005. Polystyrene capacitors. 10 each value from 10pF to 10,000pF. E12 series, 5%, 160V. Total 370 for **£12.30.**

K006 Tantalum bead capacitors. 10 each of the following 0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1, 2.2, 3.3, 4.7, 6.8, all 35V; 10/25, 15/16, 22/16, 33/10, 47/6, 100/3. Total 170 tants for **£14.20.**

K007 Electrolytic capacitors 25V working, small physical size. 10 each of these popular values 1.2, 2, 4.7, 10, 22, 47, 100µF. Total 70 for **£3.50.**

K008 Extended range, as above, also including 220/470 and 1000µF. Total 100 for **£5.90.**

K009. Extended mylar pack. Contains all values from 1000pF to 0.47µF total 290 capacitors to **£11.25.**

K021 Miniature carbon film 5% resistors. CR25 or similar. 10 of each value from 10R to 1M. E12 series. Total 610 resistors. **£6.00.**

K022 Extended range, total 850 resistors from 1R to 10M **£8.30.**

K041 Zener diodes. 400mW 5% BZY88 etc. 10 of each value from 27V to 36V, E24 series. Total 280 for **£15.30.**

K042. As above but 5 of each value **£8.70.**

VEROBOARD

Our packs of vero offcuts are one of our biggest sellers — and no wonder, they are amazing value!! Each pack contains 7 or 8 pieces to make up a total area of 100 sq. ins. All packs are the same price, **£1.30 each** and are available as follows:

- Pack A, all 0.1" pitch
- Pack B, all 0.15" pitch
- Pack C, mixed 0.1 & 0.15"
- Pack D, all 0.1" plain

Also available by weight: 1lb **£3.95** 10lbs **£32.50**

Regular size vero:
17x34x0.1" **£2.00**, 10 strips **£15**
17x34x0.15 **£1.76**; 0.1" plain **£1.63**

DIP Breadboard, size 6.15x4.5", can accommodate 20 x 14 pin ICs **£2.35**

VQ Board, size 128 x 75mm 0.1" pitch. Copper strips in rows of 4 to facilitate construction with ICs. Layout sheet provided **85p**

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Plastic top and bottom, ally panels front and back.		
1237	154x85x40	£2.53
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3009	180x120x90	£3.74
1410	205x140x40	£3.51
1411	205x140x75	£4.05
1412	205x140x110	£5.12

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Professional quality two tone grey polystyrene with threaded inserts for mounting PCB boards

2518	120x65x40	£2.17
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1798	171x121x75/37.5	£4.19
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Potting box, 71x49x24mm black or white **40p**
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Spot face cutter for 0.1 or 0.15 pitch **75p**
0.1" pins single sided **30p/100**
0.1" pins double sided **35p/100**
0.15" pins single sided **30p/100**
0.15" pins double sided **35p/100**

We keep a very large range of VERO products — inc. their recently introduced G range of cases, and Series II boxes. SAE for their catalogue.

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	80x62x40 mm black	58p
V213	100x75x40mm black	72p
V216	120x100x45mm black	86p
V219	120x100x45mm white	86p

SEMICONDUCTORS

Diodes, 1N4001/2 **5p**; 4004/5 **7p**; 4006 **8p**; 4007 **9p**; 1250V 1A **10p**; 1250V 1.5A **12p**; 50V 3A **10p**; 100V 3A **12p**; 400V 3A **15p**; 200V 10A stud **40p**; 400V 10A stud **48p.**

400mW Zeners 2V 7 to 36V **10p each**.
1.3W Zeners 3V3-200V **20p**.
10 watt zeners from 4V3 to 200V **93p**.
OAB1, **5p**; OA91 **8p**; 1N4148, **4p**.

Bridge Rectifiers

50V 1A **26p**; 200V 1A **32p**; 400V 1A **36p**; 100V 2A **48p**; 400V 2A **58p**; 100V 4A **65p**; 400V 4A **80p**; 40V 4A **80p**; 100V 6A **74p**; 400V 6A **98p.**

74 SERIES

7400	12p	7447	84p	74107	37p
7401	14p	7450	15p	74121	36p
7402	14p	7451	14p	74122	51p
7404	17p	7453	14p	74123	64p
7405	23p	7454	14p	74132	56p
7406	28p	7460	14p	74141	63p
7408	14p	7472	29p	74150	173p
7410	14p	7473	29p	74151	79p
7413	28p	7474	29p	74154	144p
7414	62p	7475	51p	74155	73p
7420	14p	7476	29p	74157	66p
7427	36p	7483	91p	74159	206p
7430	14p	7485	132p	74164	126p
7432	28p	7486	40p	74174	116p
7437	36p	7490	46p	74179	120p
7438	36p	7491	75p	74180	120p
7440	15p	7492	52p	74190	188p
7442	65p	7493	52p	74191	158p
7445	88p	7495	73p	74192	120p
7446	88p	7496	85p	74193	120p
				74367	120p

C-MOS

4000	18p	4018	84p	4054	100p
4001	18p	4022	90p	4055	110p
4002	18p	4023	18p	4060	96p
4007	18p	4024	64p	4071	18p
4011	18p	4027	48p	4081	18p
4012	48p	4028	78p	4510	132p
4013	48p	4040	110p	4511	212p
4016	48p	4047	78p	4528	124p
4017	84p	4049	48p	4588	256p

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741 25p, *MC3302 Quad comp **120p**. 555 **40p**. *710 diff comp (T099) **40p**. 556 **100p**. *7105 LED digit driver 8 for **£1**. LM380 **100p**. *ZN1034E Precision timer **£2.25**. M301 30p. SLD2128 Dual 128 bit static shift register **£1.50**.
*Supplied with data.

All prices quoted except "Bulk Buyers Corner" include VAT. Just add 25p UK/BFPO postage. Most orders despatched on day of receipt. SAE with enquiries please. **MINIMUM ORDER VALUE £1**. Official orders accepted from schools, etc. (Minimum invoice charge £5). Export/Wholesale enquiries welcome. Wholesale list now

TRANSISTORS

AC127	18p	BC548	10p	BRY56	40p
AC128	18p	BC549	11p	OCF71	120p
AC176	18p	BCV70	15p	TIP41A	56p
AC187	20p	BCV71	15p	TIP42A	66p
AD149	70p	BCV72	14p	TIP2955	86p
AD161	40p	BD131	38p	TIP3055	42p
AD162	40p	BD132	40p	TIS43	35p
AF279	75p	BD133	48p	2N2646	60p
BC107	12p	BD137	40p	2N2905	21p
BC108	10p	BD138	40p	2N2926	12p
BC108C	12p	BD139	42p	2N3053	28p
BC109	12p	BD140	44p	2N3054	52p
BC109C	15p	BF173	20p	2N3055	50p
BC147	10p	BF181	30p	2N3442	1.30
BC148	10p	BF194	10p	2N3702	10p
BC149	10p	BF195	10p	2N3703	10p
BC157	10p	BF196	10p	2N3704	10p
BC158	10p	BF197	12p	2N3705	10p
BC182	12p	BFR39	24p	2N3706	10p
BC183	12p	BFR79	26p	2N3708	10p
BC184	12p	BFX29	22p	2N3710	10p
BC212	14p	BFX48	32p	2N3819	28p
BC213	14p	BFX84	22p	2N3904	15p
BC214	14p	BFY88	22p	2N3906	15p
BC441	32p	BFY50	18p	2N6027	55p
BC481	32p	BFY51	18p	2N6028	60p
BC547	10p	BFY52	18p	40673	60p
		BRY39	40p		

VOLTAGE REGULATORS

78L12	T092	12V	150mA	75p
723	14di1	2-37V	150mA	50p
MC1469R	T066	2½-37	500mA	150p
78M05	T05	5V	500mA	85p
78M12	T05	12V	500mA	85p
1405	T0126	5V	600mA	85p
1412	T0126	12V	500mA	95p
7715	T0220	15V	750mA	120p
7805	T0220	5V	1A	150p
7812	T0220	12V	1A	150p
LM309K	T03	5V	1.2A	150p
LM323	T03	5V	3A	650p

SCRs

0.8A	60V	T092	35p
1A	400V	T05	60p
4A	200V	T0220	52p
4A	400V	T0220	70p
6A	200V	T0220	56p
6A	400V	T0220	75p
6A	400V	T066	80p
10A	100V	T0220	82p
10A	200V	T0220	87p
10A	400V	T0220	120p
10A	600V	T0220	148p
Triacs			
6A	400V	T0220	98p
8A	600V	T0220	135p
15A	200V	Stud	135p
15A	400V	Stud	220p

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These silicon cells size 19x6.5mm will give 50µA @ ½V in sunlight, and can be banked for greater power. Prices: 3 for £1, 10 for £3, 25 for £7, 100 for £25. Ideal for powering small CMOS projects, etc.

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POWER PACK

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Antex model C — 15W gen. purpose iron. Our bestseller at **£3.50**.
Antex model CCN — 15W element with ceramic shaft. Very low leakage **£3.90**
Antex MLX12. This is a 12V iron, ideal for car and boat use. 25W rating. Comes complete with large crocodile clips fitted + booklet "How to solder" and strong PVC carrying case **£4.29**

DARLINGTON COMP PAIR

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High quality 0.1" pitch double sided, gold plated. Selling at less than 1/3 their original price.			
1B way	41p	21 way	47p
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available for bona fide traders. Surplus components always wanted.
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ETI MASTERMIND

As featured in this issue. All parts available from us separately, or buy the complete kit of components including the case and PCB for only **£20.50 inc. VAT and post.**

ETI TORCHFINDER

All parts for this project inc. PCB and torch for only **£2 inc. post and VAT.**

COMING SOON

Look out for details of the GREENWELD 100W amplifier kit — and an IC amplifier kit and some incredible component bargains!!

SPECIAL TRANSISTOR OFFERS

PN108 (BC108)	18 for £1
PN109 (BC109)	16 for £1
PN70 (BCY70)	14 for £1
PN71 (BCY71)	14 for £1
PN72 (BCY72)	15 for £1
MSPS1218 (2N3702)	20 for £1

TORCH FINDER

A simple circuit which will help you find your torch in an emergency.

HAVE YOU EVER groped for the light of your life in the dark? Bow before you get any ideas about the type of project this is let's say that the light we refer to is your torch and in the dark this worthy can indeed save life and limb.

However, when the lights go out suddenly, it's often impossible to locate the torch because it's dark but you wouldn't be looking for the torch if it weren't dark . . . If this seems like a vicious circle it's here that ETI can help with our torch finder

The torch finder is designed to flash a LED that should be fitted within the body of the torch. The circuit consumes a minute amount of power and so can be left operational at all times. Using a high efficiency green LED means that in spite of the low power demanded by the circuit, the light output is quite adequate to locate the torch, quickly, in the dark.

Construction

Our photographs show how our circuit was fitted to the 'flat' torch we chose for the project.

With so few components construction of the PCB is straightforward, pay attention to the orientation of C1 and IC1.

Tuck the circuit out of the way within the torch, drill a hole to accommodate the LED and epoxy the device in place.

Insert the batteries and start hoping for a power cut so that the device can be put to the test.

ETI

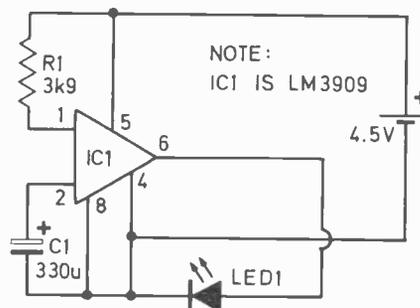
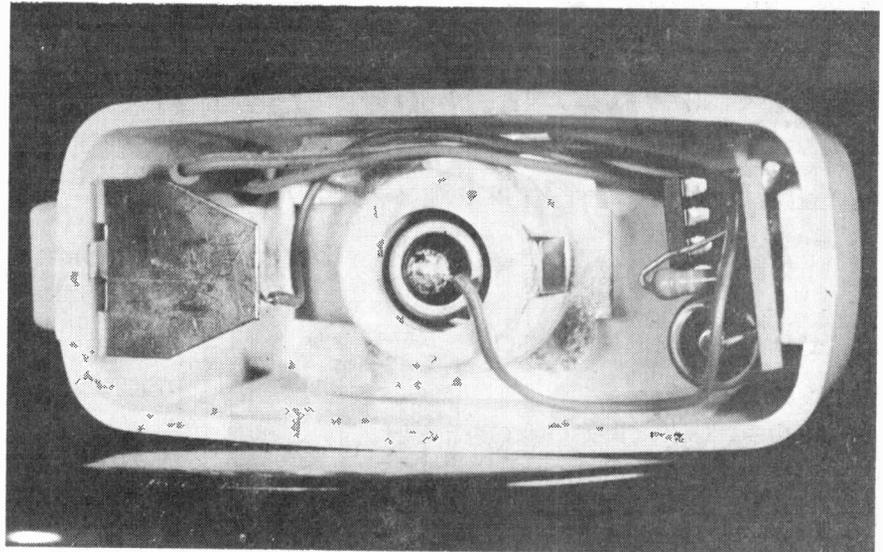


Fig. 1. Circuit diagram of the Torch Finder.

HOW IT WORKS

With only four components it's obvious that most of the action takes place within IC1. This is an LM3909, a device specifically designed to flash LEDs.

In operation the IC will supply current to the LED, via an internal 12R current limit resistor, for only 1% of the time.

For the rest of the time the LM3909 draws only about 50µA while the capacitor C1 charges up via an internal network of resistors.

When the voltage on C1 reaches a preset level (this point can be modified by a resistor between pin 1 and supply), the LM3909 will supply a high current pulse to the LED; C1 is discharged.

For further details of the LM3909 consult the National Semiconductors data sheet on the device or the ETI data sheet in the September 76 issue.

BUYLINES

The most important aspect of this project is the torch. We used a flat type but any torch providing the 4.5 volts required by the torch finder could be used.

The rest of the components should be available from many local shops.

PARTS LIST

RESISTOR (¼w 5%)	
R1	3k9
CAPACITOR	
C1	330u 4 V Electrolytic
SEMICONDUCTORS	
IC1	LM3909
LED1	Minature green type
MISCELLANEOUS	
PCB	as pattern, torch to suit

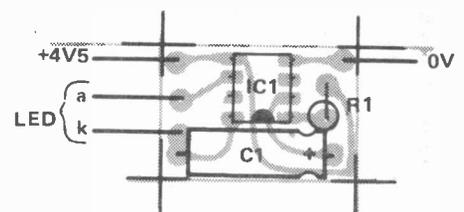


Fig. 2. Component overlay of the Torch Finder.

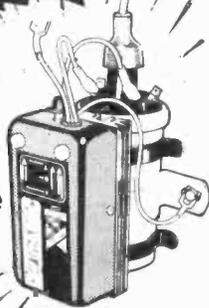


The latest kit innovation!

from **Sparkrite**

Sparkrite is featured by Shaw Taylor in "DRIVE IN"

the quickest fitting
CLIP ON
capacitive discharge
electronic ignition
in KIT FORM



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- Longer coil/battery/plug life
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- Optimum fuel consumption

Sparkrite X4 is a high performance, high quality capacitive discharge, electronic ignition system in-kit form. Tried, tested, proven, reliable and complete. It can be assembled in two or three hours and fitted in 1/3 mins. Because of the superb design of the Sparkrite circuit it completely eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current to about 1/50th of the norm. It will perform equally well with new, old, or even badly pitted points and is not dependent upon the dwell time of the contact breakers for recharging the system. Sparkrite incorporates a short circuit protected inverter which eliminates the problems of SCR lock on and, therefore, eliminates the possibility of blowing the transistors or the SCR. (Most capacitive discharge ignitions are not completely foolproof in this respect). The circuit incorporates a voltage regulated output for greatly improved cold starting. The circuit includes built in static timing light, systems function light, and security changeover switch. All kits fit vehicles with coil/distributor ignition up to 8 cylinders.

THE KIT COMPRISES EVERYTHING NEEDED

Die pressed epoxy coated case. Ready drilled, aluminium extruded base and heat sink, coil mounting clips, and accessories. Top quality 5 year guaranteed transformer and components, cables, connectors, P.C.B., nuts, bolts and silicon grease. Full instructions to assemble kit neg. or pos. earth and fully illustrated installation instructions.

NOTE—Vehicles with current impulse tachometers (Smiths code on dial RV1) will require a tachometer pulse slave unit. Price £3.35 inc. VAT. post & packing.

Electronics Design Associates, Dept. ET 7
82 Bath Street, Walsall, WS1 3DE. Phone: (9) 614791

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Address

Phone your order with Access or Barclaycard

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Inc. V.A.T. and P.P.

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I enclose cheque/PO's for

X4 KIT £14.95

TACHS PULSE SLAVE UNIT £3.35

£

Cheque No.

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DM2



SWR

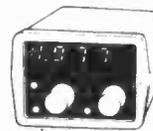
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OPEN 6 DAYS A WEEK 9 am-6 pm

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4S6 Scope x 6MHz single beam	129.50
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PROBES x 17 x 10 12.95. x 10 9.95 x 1 7.95	

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(Mains adaptors 3.95. DM2 carrycase 6.48)	
LM3A 3 Digit	79.50
LM3.5A 3 1/2 Digit	92.50
LM40A 4 Digit	136.00
LM300 3-digit	79.50
LM350 3 1/2-digit	93.50



LM3.5A

MULTI-METERS — GENERAL PURPOSE & ELECTRONIC

Multi-Range Instruments featuring AC/DC volts, DC current, Resistance Ranges all with mirror scales except T1/IT1-2/T12/TM3A (TM3 AC volts only), some with AC current etc.		
TM11 incredible 120 Range Electronic Multi-meter	AC Microvoltmeter	130.00
TM3A 33mm Scale	3MHz > 4 Megohm	105.00
TM3B 127 Scale	23 Range (plus transistor checker). Large scale	117.50
360TR 100k/volt	26 Range. Large scale	32.50
PROE 20k/volt	36 Range Multi-meter	29.95
7081 50k/volt	22 Range Multi-meter (plus Continuity Buzzer)	22.50
TMK500 30k/volt	52 Range Pocket Multi-meter	19.95
680R 20k/volt	22 Range Double Multi-meter	27.27
7200 20k/volt	26 Range Pocket Multi-meter	16.95
Micro80 20k/volt	16 Range Popular Multi-meter	16.15
IT1-2 20k/volt	19 Range Pocket Multi-meter with carry case	10.95
LT22 20k/volt	13 Range Pocket Multi-meter	14.50
T12 5k/volt	12 Range Pocket Multi-meter	7.95
T1/TLT01 1k/volt	Multi-meter 38 Ranges 3MHz	6.95
K200 FET	Transistor Checker/Continuity Checker	72.80
GT101, 20K/Volt 23 Ranges/Transistor Checker/Continuity Checker	Large range of replacement tests leads in stock	18.95

GENERAL EQUIPMENT

SWR50 SWR/Power 1kW	19.50
TE20D 500MHz RF Gen	49.50
LP30 30MHz Low Pass Filter	4.95
CX3A 150Watt 3-way AE Switch	7.50
DC25kV 100 Meg HV Probe	11.95
9 Value CAP Subs Box	2.95
FX2000 Xial Marker	11.95
LC1 Univ Logic Checker	26.00
CT1 Continuity Checker	21.00
M0D63 Signal Injector	7.50
TT189 in Circuit TR Checker	48.80
LB1 Transistor/Diode Checker	18.95
3101 Clamp Meter 0/1 K ohm. 0/150/300/600 AC Volts 0/300 Amp	29.50
C3042 SWR & FS Meter	9.95
MS319 2x100 Watt Audio Watt Meter	17.50
*500V Megohmmeter 500 Megohms	48.00
*1000V Megohmmeter 1000 Megohms	55.00
*2 1/2 Amp Variable Transformer	18.00
*5 Amp Variable Transformer	29.00
*10 Amp Variable Transformer	40.00
*TM12 Multi-range Transistor / Diode checker. Adjustable Volts etc.	130.00
100 Range Capacitance Decade	48.60
1 ohm - 11 Meg Resistance Decade	48.60

LEVELL OSCILLATORS/GENERATORS

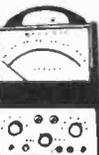
TG152 Series RC Oscillators	
Sine/Square output. 3Hz-300KHz	
TG152D	69.95
TG152 Dm (with meter)	89.95
TG200 Series RC Oscillators	
Sine/Square output. 1Hz-1MHz	
TG200D	93.95
TG200 Dm (with meter)	112.60
TG200 Dmp (Meter & Fine control)	117.50

LOGIC PROBES MONITORS

LM1 Monitor	31.00
LP1 Probe	33.48
LP2 Economy	19.44

ALL PRICES INCLUDE VAT
Correct at time of preparation

EXPORT AND QUANTITY DISCOUNTS E & OE



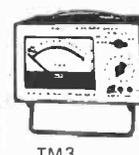
TM11



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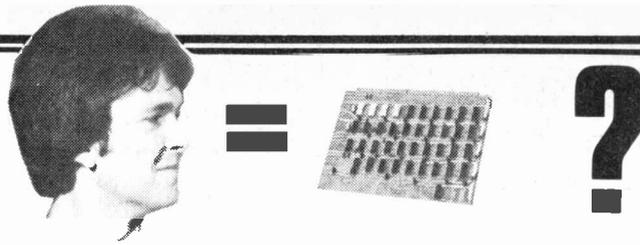
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BRAINS AND COMPUTERS

BY S. McCLELLAND

Man is just a machine, or is he? Is his brain the ultimate mechanism or could it be improved by bio-engineering techniques? How can we develop artificial intelligence to match the abilities of our own brains and what do we have to learn from it?

EVEN IF THE HUMAN BRAIN is regarded as being a digital computer it must be considered to be far more complex than anything man can devise — or is likely to devise in the foreseeable future. In a volume of tissue far less than that of a football it packs some 10^{10} (that's 10 000 000 000) active elements, the nerve cells. In computer terms, its capacity to store information must run onto the 10 thousand megabit range *at least*.

Its organisation matches its abilities — on average in a normal human being it's been estimated that 1 nerve cell dies every 10 seconds throughout our lives. It is never replaced, for brain cells alone in the body cannot reproduce, and yet we never notice the loss since the brain is so well organised that many of its circuits are redundant and can be replaced by alternative channels should they fail — this has been the case even after serious injuries have been inflicted on the brain.

How much power does all this require? It's enough to make an engineer cringe — a meagre few watts!

What about the brain's higher capabilities — such as its capacity for inventiveness or 'original' thought? What was special about Mozart's brain circuits that enabled him to start composing music before he was 5 years old, or in Leonardo da Vinci's case, to design flying machines 500 years ahead of his time?

Sadly as yet we have no idea since so little is known about the brain!

Inputs and Outputs

All this uncertainty has not stopped a growing number of systems engineers and scientists from looking at the brain's organisation and operation (possibly with the idea of wanting to copy techniques in future systems!).

We can certainly find some aspects of central nervous system operation in common with computers. Both systems have of course what might be loosely termed 'input' and 'output' peripherals, for example. In the case of the brain the inputs are from the senses of the body, not only the primary ones of sight, hearing, smell and taste but also from many thousand of receptors near the surface of the body for various parameters such as temperatures and pressure.

Its outputs go to activate all the muscles in the body. This flow of information demands an enormous number of nerve fibres to convey it — up to a million nerve fibres are estimated to be associated with each major limb alone.

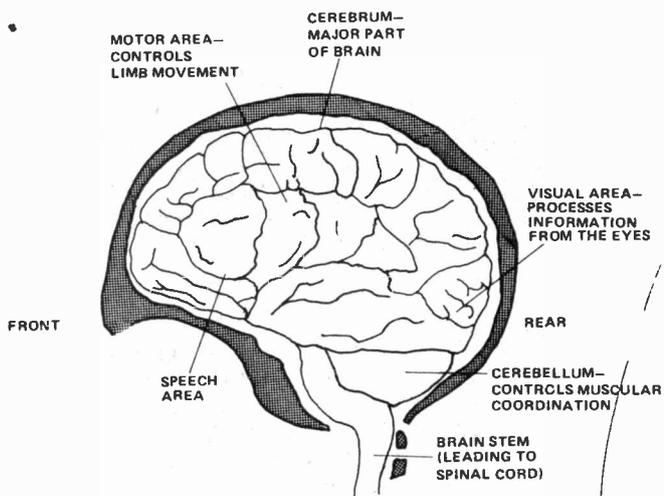
All of this of course prompts the question: "How does this information transfer take place?" To understand this we have to look at the most basic component of the whole system — the nerve cell itself.

Neurons

If we could remove a typical nerve cell from our bodies and look at it under a high power microscope, it would look something like Fig 1. Remember, this cell is probably only a few micrometres in diameter so what we're about to describe is a microscopic system-within-a-system.

The cell picks up signals from the other cells in its vicinity and these are fed down to the main part of the cell (containing the nucleus) and propagated along the long transmitter branch (axon) to the next cell.

It's along the inside of these long membranous



This is what your CPU looks like with the cover off. Note the I/O bus at the bottom (not S-100). The power supply connections have been omitted for clarity. The case is of a sturdy polymeric material and the main PCB fits it nicely.

branches that the electric impulses (or action potentials) are transmitted by the nerve.

The axon is no mere passive wire, however. If it was, the signals would soon be drastically attenuated by the leakage of the membrane to the outside after a very short travel. The cell membrane instead acts as its own signal booster to maintain the impulse at constant amplitude (about 100 mV) at any point on the axon. The action potential is either there or it isn't — there is no in-between state. A digital system? Perhaps. In fact, it's the frequency at which the action potentials are signalled that carries the information. We can now see why so many nerve fibres are needed to carry information. Each cell — and probably many others for the sake of redundancy — carries one 'bit' of information. The importance of this information depends on the frequency it is being signalled and it is likely that a high frequency signal establishes a higher priority than a lower frequency signal in a particular context — rather like signalling an 'interrupt' in a computer system.

Simple as it is, a frequency-dependent system carries its own problems. The sense organs must make amplitude-to-frequency code conversions for transmission down the fibre and at the other end, the brain must find a way of coping with a frequency-dependent signal.

A secondary point is that all the nerve cells concerned with a particular function or sub-function work in parallel. The advantages of parallel processing are fairly evident. It's faster than serial and has a higher signal-to-noise ratio (even if it does need more channels).

So we can visualise action potentials — small spikes of voltage — being flicked up and down all the nerve fibres in the body at varying frequency, but not nearly as fast as electrical impulses through cables. However, even in this, nature squeezes all the performance it can out of the human nervous system. Each nerve cell is wrapped in several layers of fatty tissue with 'nicks'

or 'breaks' in the fat at intervals along the axon. The effect of these 'breaks' or 'nodes of Ranvier' as they are known is to increase the speed of transmission of the action potentials down the nerve axon to about 100 metres per second.

Delaying Tactics and Logic Gates

If neurons propagate the action potentials, then it's the junctions between neurons (synapses) that route them. It's the synapses which work out if the incoming signals are of the right type and frequency to trigger the following cell to produce an action potential. From the point of view of the system, the synapses are the delay lines, one-way valves, triggers and gates all rolled into one.

It takes an electron microscope to even see the synapse regions and even then they don't look very special — they're merely bulbous terminations where nerve cells meet each other. Except that they don't meet each other — they're always separated by the absolutely microscopic distance of about 200 Å — so the action potential never gets across even the gap, let alone down the other side.

What actually crosses the gap is not the electric signal itself but very small quantities of hormones which are released from the transmitter bulb. The hormone crosses to the receptor membrane where (by a process that's not fully understood) it causes the generation of another action potential. Even across so small a gap the chemical transmission takes a finite time and is susceptible to interference by foreign chemicals (drug addicts please note — your synapse may be switched off!).

Some synapses, instead of generating an action potential in the receptor membrane actually inhibit it from doing so — so we've found the on-off switches for the nervous system. Can we identify Boolean logic gating arrangements in the nervous system? It's possible to speculate in those terms and certainly the basic mechanisms seem to be there, but unfortunately not enough is known about even simple neuron groups to permit an answer to this question.

Don't Believe Your Eyes!

The nervous system can do some very sophisticated things to the input signals it receives by way of data processing. It can, for example, selectively inhibit the triggering of neurons that carry no useful information in favour of ones that do.

This so-called 'lateral inhibition' not only cleans up potentially noisy channels by making them more 'contrasty' but in some animals is known to help the eye resolve very efficiently the boundaries between dark and light edges in an image. It probably occurs in the human nervous system as well where it is thought to give rise to some of the more common optical illusions as a by-product.

So much processing sophistication backing up the senses means that the brain can work on far less sensory information than it usually gets. For example, the brain really only requires a few per cent of the data it receives from the eyes in order to form a valid judgement as to the nature of the image. The same applies to the ear — speech has to be very badly distorted before the brain cannot recognise it. There is obviously a very close and

complex interaction between the senses and the memory, which is continually generating possible 'best-fit' models to match the latest information received. Each model is discarded until the brain is satisfied with the result.

Our senses show a fantastic sensitivity to the world around us — we *can* hear a pin drop in a quiet room. More staggering still, the vibration amplitude of the ear drum which the minimum audible sound creates is less than *the diameter of one hydrogen atom . . . !*

Down Memory Lane

Digital computers have clearly-defined memory locations which are usually addressed under the control of a clocked pointer in the system. The human brain on the other hand seems to have no all-powerful organ of memory — attempts to find one have so far proved inconclusive. Rather, memory is a property of the system as a whole.

Secondly, data storage on a computer tape or disc is permanent until deliberately erased but information flow through the brain is far more dynamic and its retention more selective. Information floods into our brains from our senses at every living moment. Seen in this light it is neither desirable nor even possible to store it all. 'Store only the information that is important' the brain says to itself — but what is counted as being important?

Basically, we pick out the information about the *changes* in our environment, because it's the changes in it which may be threatening our immediate survival.

On a motivated level, we can store items deliberately. We remember by repetition (e.g. a telephone number). Most importantly we store information which is associated with something which has caused us great pain or pleasure in the past. How do we recall information once stored? It's clear that association plays a critical role. After all, we store not isolated events but connected ones — 'trains of thought' if you like. The memories are recalled when the right key of stimulus is provided. This stimulus may well be a piece of information associated with the group.

For example, the question 'What do you remember about November 22nd 1963?' would probably elicit a blank reply from most people until (as various commentators have pointed out) that they are told its the day when the President John F. Kennedy was assassinated. Many people can recall where they were or what they were doing — it's a memory that persists over 14 years because it is associated with such a traumatic incident.

In this way we can visualise the human memory almost as 'conglomerates' of memories — pieces of information tied together in some fashion only requiring the right input trigger to push it all out.

Some very intriguing hypothesis about how the memory operates have been suggested. One exciting and topical suggestion is that it records information as a hologram records 3-D images in laser light. A particular part of the image is not localised to a particular part of the hologram — in fact even a fragment of the hologram can theoretically recreate the entire image, a property which makes it very similar to the brain.

We must wait for more basic information on the brain to confirm or disprove this.

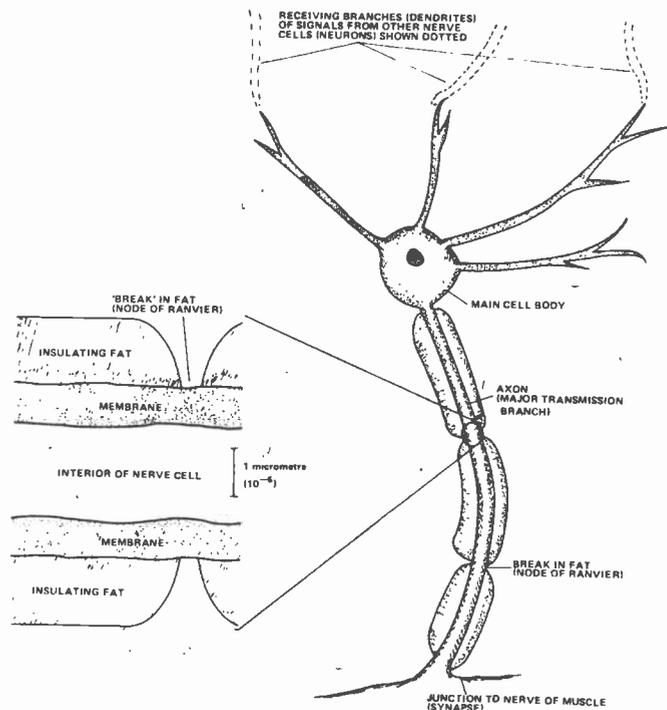


Figure 1: What a nerve! A typical nerve cell examined.

Tuning into Brain Waves

We can get some idea of what all this electrical activity is like by strapping electrodes — connected to a sensitive amplifier and chart recorder — to the skull.

We will obtain a rather confusing output of signals — referred to as an *electroencephalogram* or EEG. The EEG is usually a very weak signal — a few tens of μV amplitude at a range of frequencies mostly under 30 Hz, although higher frequency components are present.

The most well-known component of the EEG is the α -wave. Present in about 90% of all individuals, this signal (with a frequency between 8 Hz and 13 Hz) is at its most active when the subject is relaxed and his eyes closed. It disappears as soon as the subject opens his eyes or starts to concentrate on something like mental arithmetic.

What does it mean? Basically, we don't know. Nor do we know where or how it's generated, although its source (there may be more than one) *seems* to be located to the upper rear of the brain. Correspondingly little is known about the other EEG components.

Although the EEG doesn't give a great deal of information about the working of the brain (indeed we'll probably have to wait until further studies of the brain explain the EEG!), it has found great use in diagnosis of brain disorders such as epilepsy. But could the EEG have a more fundamental significance than that? My own pure piece of speculation — for what it's worth — is that it's the brain's clock, although it's too low in frequency to cope with many of the fast muscular actions of the body. Even so the 'ticking' of a brain might have a biological significance similar to a digital system's 'clock frequency'!

FURTHER READING: For those who would like to read more fully about the brain, Professor Steven Rose's book 'The Conscious Brain' (Penguin paperback edition £1.25) offers a very readable account.

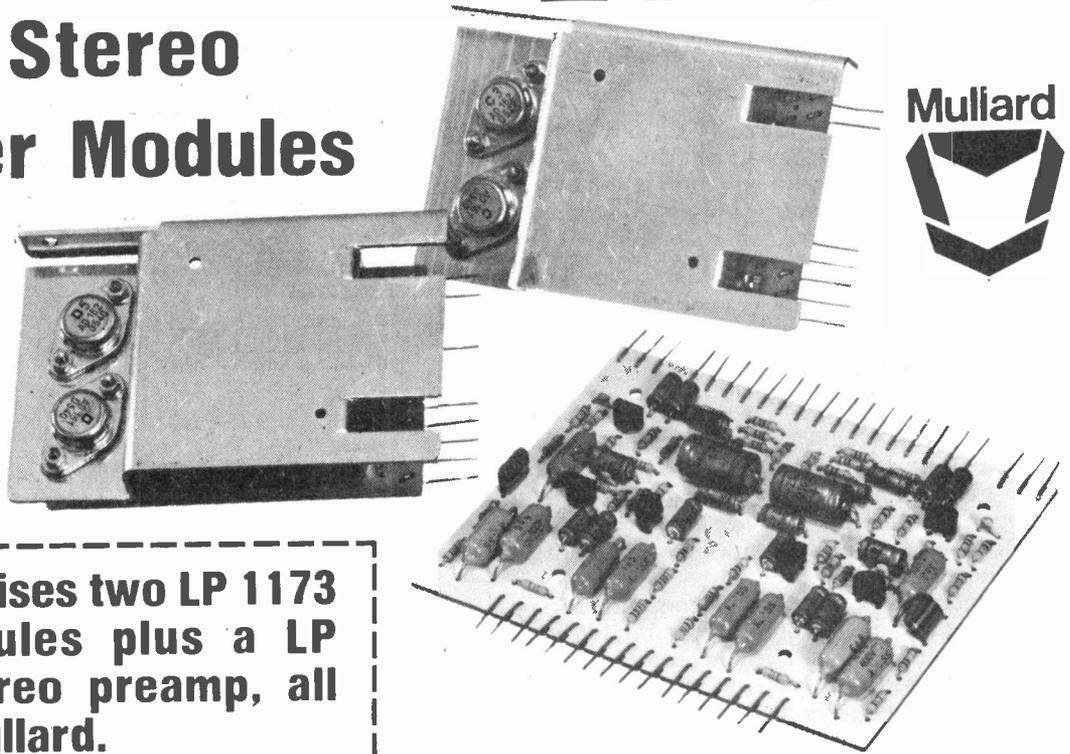
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KET PLACE

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THE SYSTEM BLOCK DIAGRAM is shown in Fig 1. The system is pre-patched, but is capable of generating a vast variety of different effects by virtue of its 9 switch functions, 22 pots and 6 input jacks.

The VCO is the primary sound source. It produces either a ramp or a square waveform. A ramp waveform has both odd and even harmonics, the square wave has only the odd ones.

However, the VCO has a shape modulation circuit which can turn the ramp into a triangle or the square wave into a thin pulse. Thus, a wide range of harmonic structures is available. Also, this shape modulation can be controlled by a sine wave produced by the slow oscillator. By dynamically modulating the shape of this waveform, it is possible to greatly enrich the sound quality of the VCO. (For instance, if the mark space ratio of the squarewave is modulated at about 1HZ, the output can sound like two VCO's.)

Pitch It Well

The pitch of the VCO can be controlled by several sources. A 'pitchbend' pot enables notes to be bent up or down by about 1/2 an octave. A dead band in the centre of the motion enables the turning to be restored. An external input socket with a sensitivity of 1V/octave allows a sequencer to be connected.

A manual tuning pot, (screwdriver adjustment), is provided so that the synthesiser may be tuned to the pitch of other instruments. Vibrato may be added, the speed being that of the slow oscillator. The squarewave also from this oscillator can be used to produce 'two tone' effects.

The VCO pitch can be controlled by the ADSR envelope or by random pitches generated by the noise sample and hold circuit. All these controls can produce a wide variety of interesting sounds but the machine really comes alive when it is controlled by the keyboard. This keyboard is a 3 octave, (37 note), C to C device.

It is monophonic, that is it only plays one note at a time, this being the highest note selected. It generates two outputs, a pitch signal and a gate voltage. The gate controls the AD and ADSR sections, the pitch, the VCO and the VCF.

The pitch voltage is a transitional piece of information which has to be remembered in an analogue memory, a sample and hold device. The droop rate of this S & H is about 15 minutes per semitone. This is quite good.

MUSIC SYNTHESIZER

Designed for ETI by Tim Orr, late of EMS and father of some of their range, our new Transcendent 2000 is a new concept in DIY synthesizers — a single board design! Apart from the PSU all the circuitry is contained on one easily assembled PCB. Ideal as on-stage machine, the 2000 has plenty to offer the experimenter as well.



Gliding In

A portamento circuit has also been included into the sample and hold so that glides, as opposed to abrupt changes, between notes can be produced. A transpose switch, ± 2 octaves operates on the VCO. This gives an effective keyboard control range on the VCO of 7 octaves. The keyboard S & H can be controlled by either the keyboard gate or by a pulse from the slow oscillator. This latter mode of operation makes the VCO pitch move in a series of exponentially decreasing steps between the notes played on the keyboard.

Noisy Output

The output of the VCO is mixed with a noise signal and an external audio signal and fed into the VCF. This is a voltage controlled state variable filter, with both bandpass and lowpass outputs. The resonance is manually controllable from a Q of 1 to infinity, (self oscillation).

The resonant frequency may be controlled by either a manual pot, a sweep voltage from the slow oscillator, an external footpedal control, the keyboard voltage or a random voltage or an attack decay envelope.

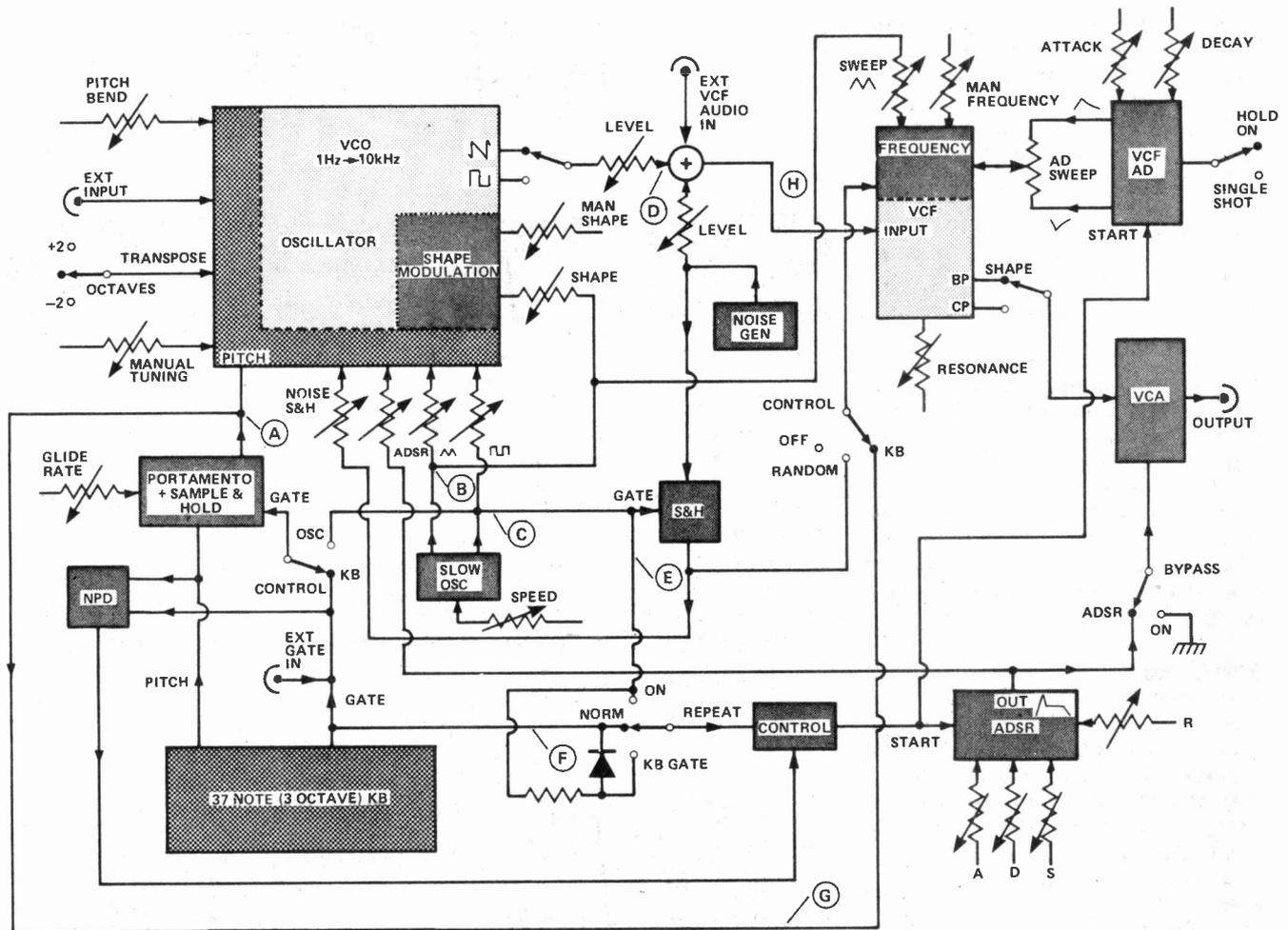


Fig 1. Block diagram for the Transcendent 2000 synthesiser. Each of the separate circuit blocks is described in detail in the appropriate section. The letters in circles correspond to the points where we broke up the circuit to make it easier to

understand. These references are also given on each of the block circuits where appropriate. So if you wish to stick the whole thing together you can do so. All the components which make up this block diagram are assembled on a single PCB.

There are very few musical instruments that have any sort of dynamic filtering. The Attack/Decay envelope can be used to produce a rising or falling frequency sweep in the VCF, and by varying the AD time constants, a wide variety of sounds may be generated.

The output of the VCF passes through a voltage controlled amplifier to the output socket. This can be on all the time, or it can be controlled by an ADSR envelope. This in turn amplitude modulates the VCF signal so that the output has the envelope of the ADSR voltage.

Sustaining Interest

The ADSR is a waveform generator, and is initiated by the arrival of a gate voltage. When this arrives it generates a rising RC exponential waveform with a time constant determined by the Attack pot.

When it reaches a predetermined level it then begins a RC decay towards a sustain voltage. The 'decay' rate is controlled by the 'Decay' pot and the sustain level is set by the 'Sustain' pot.

It sits there until the gate voltage is removed, (when the keyboard is released), whereupon it decays towards ground with a release time constant, this being determined by the 'Release' pot.

If at any time the gate is removed the ADSR goes into its release mode. Time constants of 5 mS to 2 S and sustain levels of full on to completely off are obtainable.

On Key

The ADSR can be started by the keyboard, or it can be continuously repeated by the slow oscillator, or it can be repeated by the slow oscillator gated by the keyboard, as can the

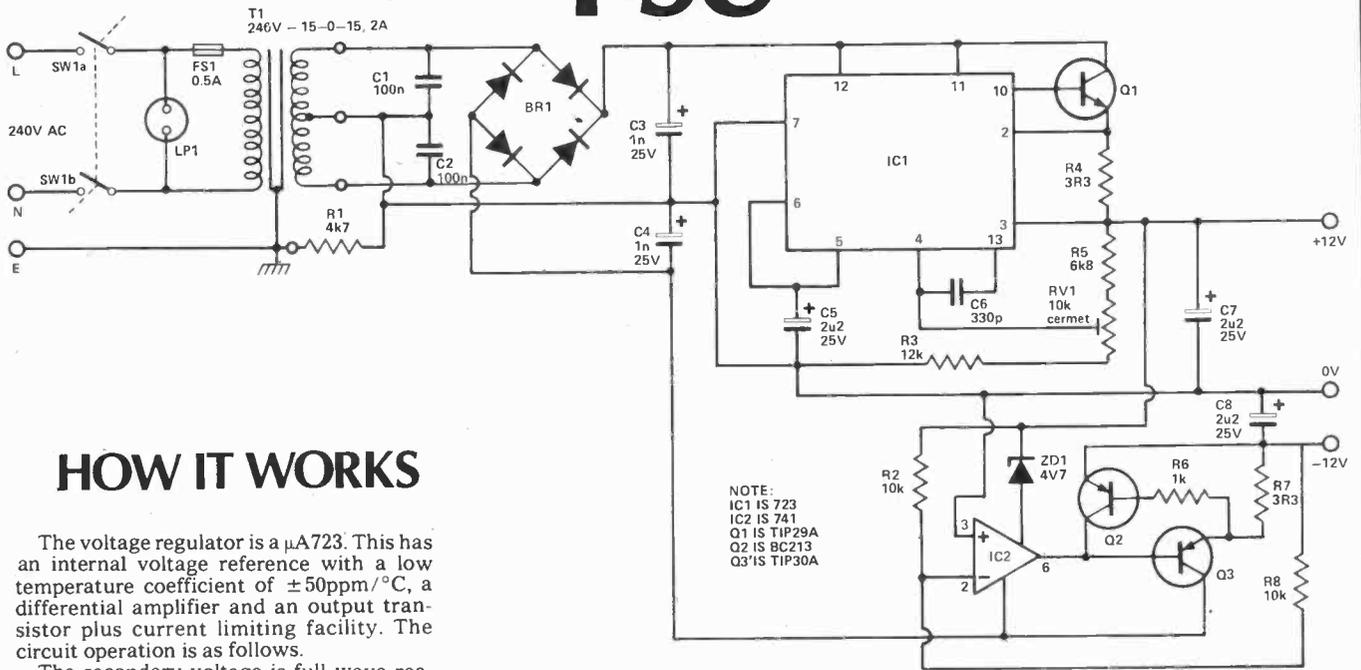
Attack Decay, (AD), circuit.

This has two modes of operation: single shot, whereby it attacks to a predetermined level and then decays on its own to ground, or HOLD ON, whereby it only decays upon the removal of the gate signal. Sometimes when playing pieces, it may be necessary to release a key before a new note can be generated. If the piece is particularly fast then errors, in the form of missing notes can occur. However, a device called the New Pitch Detector (NPD), can help eliminate this. When a new pitch is detected, it generates an additional gate signal which is used to reset both the AD and the ADSR.

Repeating?

Both the AD and ADSR circuits can be controlled by the REPEAT function. This is a single piece of electronics to enable repeating envelopes to be

PSU



HOW IT WORKS

The voltage regulator is a μ A723. This has an internal voltage reference with a low temperature coefficient of $\pm 50\text{ppm}/^\circ\text{C}$, a differential amplifier and an output transistor plus current limiting facility. The circuit operation is as follows.

The secondary voltage is full wave rectified and smoothed by C3 and C4. This provides positive and negative unregulated rails.

IC1 is the voltage regulator. A reference voltage of about +7V5 is fed into the noninverting terminal, pin 5.

An external power transistor Q1 is used to regulate the positive supply rail so that IC1 remains cool. Short circuit current limiting at 200 mA is provided by R4. Either or both output rails may be shorted out without damage.

Negative feedback to the inverting terminal pin 4, IC1 sets the output voltage. C5 reduces noise on the supply, C7 reduces the impedance at high frequencies. RV1 sets the output voltage and this should be set to +12V000! (or as near as you can measure) VR1 is a cermet preset, which has a low temperature coefficient.

Fig. 2. The circuit diagram for the synthesiser PSU. This is capable of supplying a higher current than is really needed here, in order that it is not 'stretched'. A stable supply is essential in a synthesiser design with any pretensions to quality at all.

The components for this are made up onto their own PCB, and will not appear on the main overlay.

The negative rail tracks the positive rail. The power is handled by Q3, the current limiting by Q2 and the feedback by IC2. Resistors R2, 8 determine the negative rail voltage. As they are both 10k, 0.5% tolerance, the negative rail should be the same magnitude as the positive rail to within 0.5%.

A very stable power supply is needed for a synthesiser. A small power supply voltage variance can produce alarming effects on the oscillator pitch. Also, if the machine gets hot inside, the oscillator will drift in

pitch. The current drain per rail is only 80 mA and the heat dissipated by Q1 and Q2 is 0.9 watt each. This will not cause any heating problems.

On load the unregulated rail is 23 V (at 250 VAC input), and so the mains can drop to about 190 VAC before PSU drop out occurs. The unregulated ripple is 500mVpp and so the output will be less than 0.5mVpp.

When there is no load on the power supply, a small high frequency sawtooth can be seen on the -12 V output, but this goes away completely when loaded.

generated. The outputs from this circuit then drive the AD and ADSR. With the repeat switch in the ON position, the slow oscillator square wave output continuously gates the AD and ADSR.

In the NORM position, the Keyboard gate is the control. In the KB GATE position, the slow oscillator is only allowed through when the keyboard is pressed. Using the REPEAT function it is possible to simulate a fast plucking 'banjo' effect.

A DeeEssAhh?

The ADSR is similar in operation to the AD circuit except that it has two more parameters to play with.

Upon receipt of the keyboard gate the waveform attacks until it reaches a predetermined level. Then it decays to a level known as the sustain level, which is manually controllable. When the keyboard gate is removed, the

release mode occurs. The A, D, R are all time constants, the S is a level. Whenever the keyboard gate is removed the device goes into its release mode.

This type of envelope is particularly useful and versatile. With the sustain level at 10, there is no DECAY phase and so an ATTACK, HOLD ON, RELEASE envelope is generated. When the sustain is set at 4, there is an attack and a decay to the sustain level, which is held as long as the keyboard is held down and then a release. Using this setting it is possible to simulate a piano sound, by using a fast attack moderately slow decay and a faster release.

The faster release simulates the damping of the strings as the piano keyboard is released. When the sustain level is set at 0, then the unit becomes an attack decay envelope which can be used to produce short sharp plucked sounds. To get a new

envelope it is necessary to get a new keyboard gate signal. This either means lifting your finger off of one note before pressing the next, or a new gate can be automatically generated by switching to the NPD mode.

Moving On

The pre-patched nature of the design is intended to suit stage and other performance applications. The resulting sound from the synthesiser can be quickly and easily modified once the function of the controls and their effect has been mastered. Take a look at the diagram on page 44 for starters.

Another helpful aid to using a synthesiser is a 'program sheet'—simply a way of recording clearly but instantly a particular set of control settings to allow you to reproduce that sound again at a later date. Such sheets will be available for the Transcendent 2000—details next month.

VCO

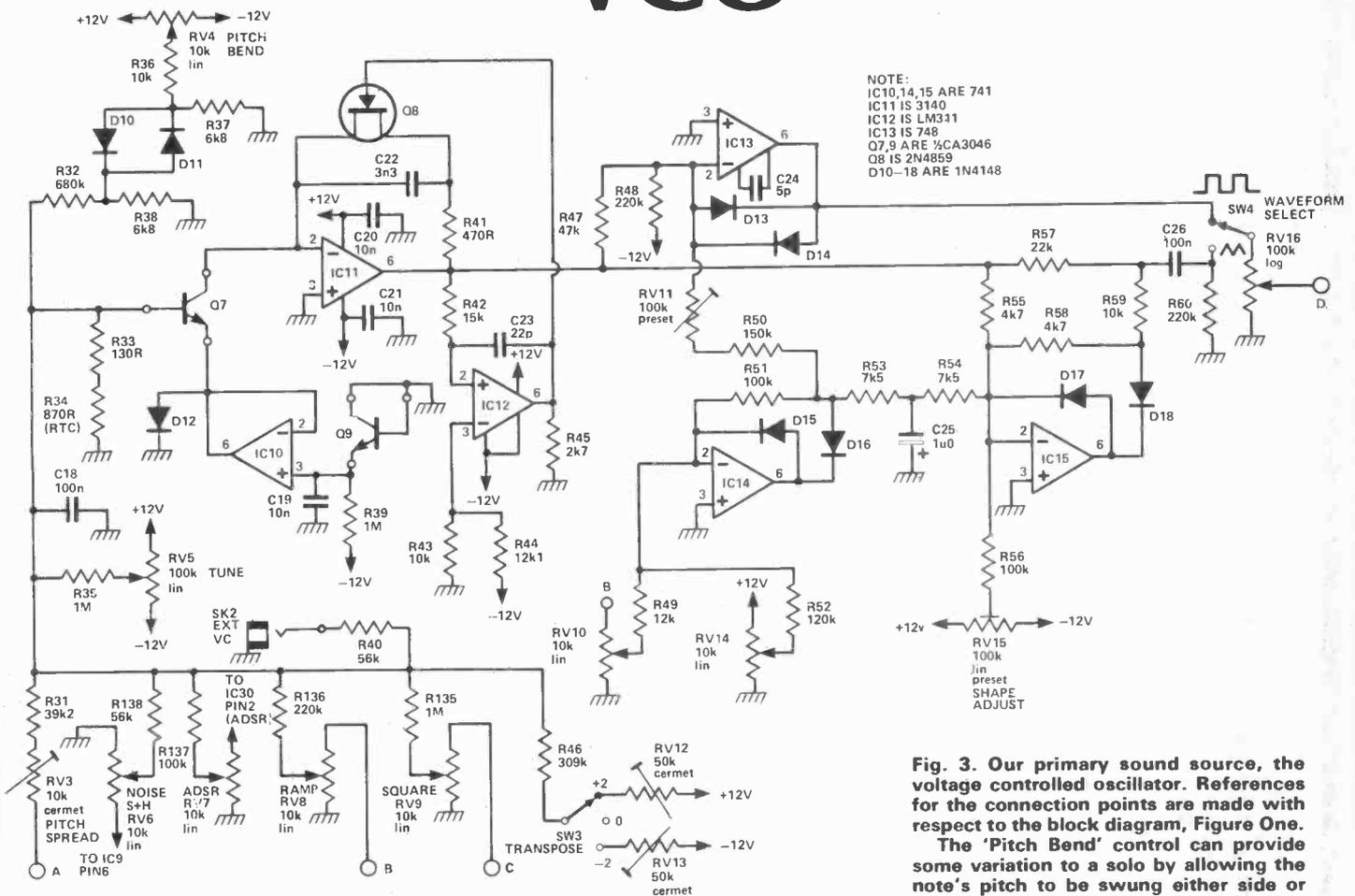


Fig. 3. Our primary sound source, the voltage controlled oscillator. References for the connection points are made with respect to the block diagram, Figure One.
 The 'Pitch Bend' control can provide some variation to a solo by allowing the note's pitch to be swung either side or correct during playing.

HOW IT WORKS

The VCO is a logarithmic relaxation oscillator generating a ramp waveform. This waveform is then modified to give a square wave or a triangle wave output. The oscillator section is IC10, Q9, IC11, IC12 and Q8.

The voltage coming out of IC11 pin 6 is fed into IC12. This is an LM311, a fast voltage comparator. A voltage of +5V43 is set up on its inverting input, (pin 3) and the ramp from IC11 is fed into its non-inverting input, (pin 2). When the ramp voltage exceeds +5V43, the comparator's output, (which was at -12 V) leaps up to 0 V.

This voltage turns on the FET switch Q8 which shorts out C22 and discharges it to almost 0 V. Q8 has a very low ON resistance and hence the discharge time is relatively short, about 800 ns.

However, once the discharging has started, you would expect the comparator output to drop back to -12 V. Well it would do if it wasn't for the monostable built around it, (C23, R42). This monostable makes Q8 turn on for a fixed period of time, sufficient for the discharge process to be completed.

Note that the power supply to IC11 is locally decoupled to help protect the VCO from pitch jitter caused by fluctuating power supplies. The reset period causes the VCO to go flat at high frequencies.

As the frequency of the VCO increases then so does the C22 charging current. But this current has to flow through R41. This makes the voltage of the ramp, (IC11 pin 6) increase in size as the ramp speed is in-

creased. This in turn means that the ramp is reset prematurely and so the pitch of the VCO will tend to go sharp at high frequencies.

If we get the size of this tendency to sharpness correct, then it can be used to cancel out the reset tendency to flatness. The overall effect will be to maintain the tuning of the keyboard up to a frequency which it could not do without R41.

The current that drives the VCO is sunk by the transistor Q7. This is used to produce the logarithmic law necessary to convert the linear voltage intervals from the keyboard into musical intervals which are logarithmically spaced. A V_{be} increase of about 18 mV will cause the collector current to double, (the VCO goes up an octave), so therefore the voltage per semitone is about IV5. This is a very small voltage indeed.

IC10 is a voltage follower and merely buffers the bias voltage to the emitter of Q7. Should IC10 go berserk, during the power up say, it might try to reverse bias the emitter of Q7 and cause it to zener. This process would corrupt the logarithmic characteristic of the transistor and so destroy its ability to produce musical intervals. D12 prevents this zenering. Q7 has to be run at relatively low currents for two reasons.

Firstly, the log law goes flat at high currents, (1 mA). This is due to the effect of the intrinsic emitter bulk resistor in the transistor. The effective voltage drop across this bulk resistor is subtracted from

the V_{be} voltage and so the net effect is less collector current than was expected. Therefore to get a good musical performance, the collector current must be kept as low as possible.

Secondly, large currents will cause self-heating, which will make the VCO pitch drift, although in this circuit the collector voltage is a virtual earth and so the power dissipation is relatively small anyway.

Even though the second transistor compensates for the temperature change V_{be} problems there is another temperature effect to be dealt with. The pitch spread, that is the number of millivolts per octave, is temperature dependent. To compensate for this effect, the resistor pair R33, 34 must have a temperature coefficient, (TC) of +3400ppm/°C. There is no element with this coefficient, although an alloy could be concocted to produce it.

However, it just so happens that copper has a TC of +3900ppm/°C. Therefore a 870R copper wire wound resistor in series with a 130R metal oxide resistor looks like a 1k resistor with a +3400ppm/°C TC. There is an American company, (Tel Labs) that makes a Q81 resistor, 1k 1% made just for the job and this could be used instead of R33, 34, that is if you can obtain them.

This resistor with the special TC is mounted close to the transistor pair so as to be at the same temperature. Some manufacturers actually glue the resistor to the transistor for best thermal contact.

VCF & VCA

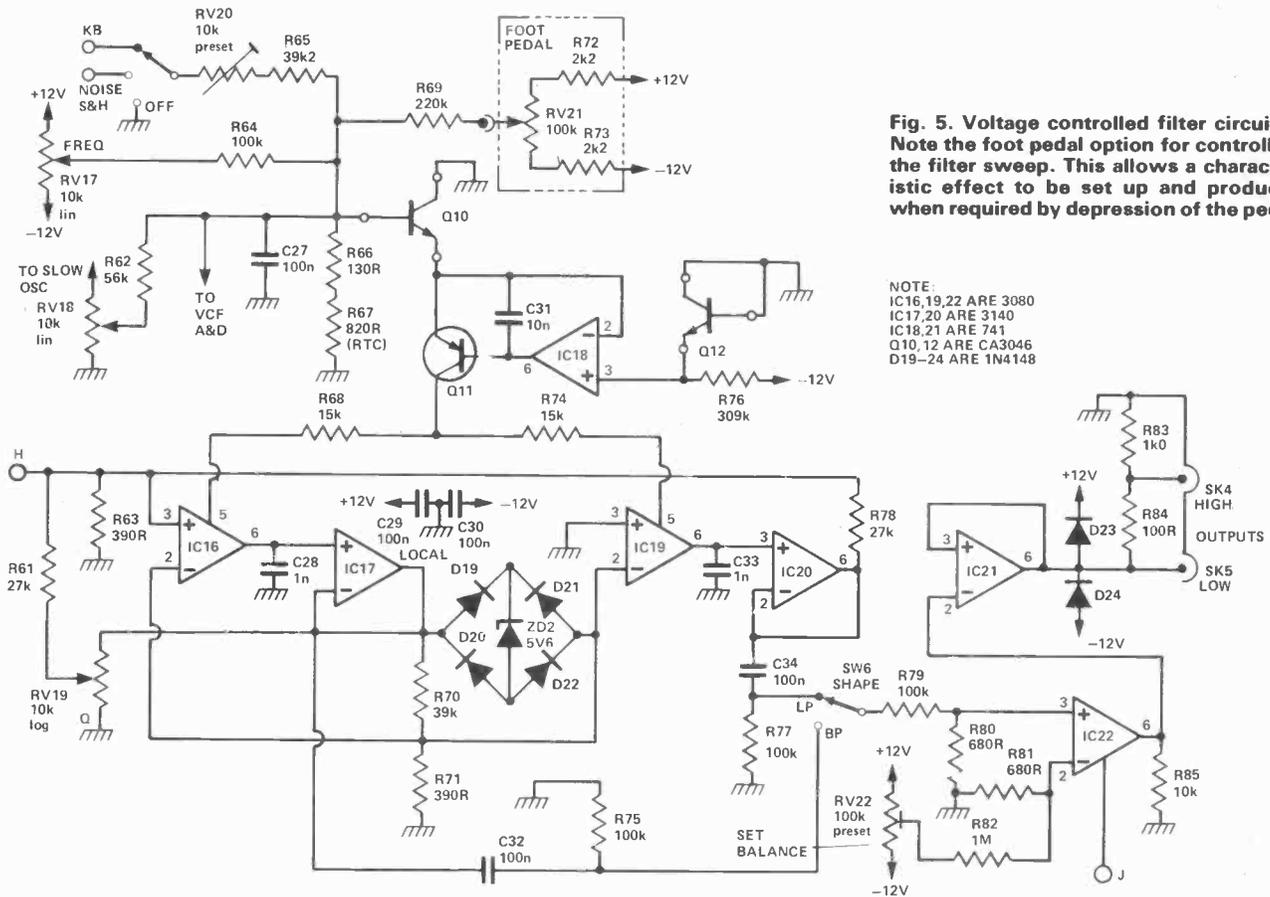


Fig. 5. Voltage controlled filter circuitry. Note the foot pedal option for controlling the filter sweep. This allows a characteristic effect to be set up and produced when required by depression of the pedal.

NOTE:
 IC16,19,22 ARE 3080
 IC17,20 ARE 3140
 IC18,21 ARE 741
 Q10,12 ARE CA3046
 D19-24 ARE 1N4148

HOW IT WORKS

Voltage Controlled Filter

The VCF is a voltage controlled state variable filter. This particular design generates both low pass and bandpass outputs. It has the same voltage response as the VCO, i.e. it is logarithmic, as opposed to linear. A CA3046 transistor array converts the control voltage into a log current using very similar circuitry to that which was employed in the VCO to minimise temperature effects.

The control current needs to be sourced to the VCF, in fact to pin 5 of IC16 and IC19 which are both at about $-11V_4$. This is accomplished with Q11 and IC18. The current that comes out of the logging transistor flows into the emitter of Q11 and about 99% of it comes out of the collector, the other 1% flows out of base. As long as the h_{fe} doesn't vary too drastically as a function of the collector current, then this source of error will not be greatly significant.

The tracking accuracy of the VCF is much less of a problem than for the VCO. VCF tracking errors will only result in a slight change in tone, not pitch.

IC18 maintains Q12 at a fixed bias vol-

tage of approximately $-0V_62$. The control current that comes out if Q11 collector splits equally down R68, 74 and into IC16, 19 respectively. These devices are CA3080's, a two quadrant multiplier which is used as a variable gain cell to tune the filter resonance.

In fact they are gain controlled integrators, where C28, 33 are the timing capacitors. The outputs are current outputs and are therefore high impedance. IC17, 20 are very high input impedance voltage followers and they unload the outputs of the integrators. IC16, 17, 19, 20, 23 is in fact an analogue model of a second order differential equation, (i.e. a tuned circuit or a mechanical resonator).

The loop gain, which is controlled by IC16, 19, is linearly proportional to the resonant frequency, therefore by varying the current into IC16, IC19 the resonant frequency of the model is controlled. Note that there is both negative and positive feedback around IC16, IC19. The negative feedback is fixed but the positive feedback is variable via the resonance pot RV19.

As more positive feedback is applied the model becomes more resonant, the Q factor increases. Too much feedback and the

circuit will oscillate. In fact stable, low distortion sinewave oscillations can be produced by turning the resonance pot fully clockwise. The diode bridge amplitude limits the signal excursions and will thus stabilise the signal level when the VCF is in its oscillator mode.

The VCF can therefore be used as a low distortion oscillator or as a filter. However, the signal level in the oscillator mode is much louder, (about 10 dB) than in the filter mode.

VCA

The CA3080 is used as a two quadrant multiplier. That is the gain of the device is controlled by the current flowing into pin 5. As this current has the same contour as that of the ADSR, then any signal flowing through the VCA will have its amplitude modulated with the ADSR contour. The output is buffered by a voltage follower providing a high level output (typically 0dBm) and a low level output (typically $-20dBm$). By putting a fixed DC current in, a constant output level is produced (BY-PASS ON), unaffected by the ADSR.

WHAT DOES WHAT AND WHERE

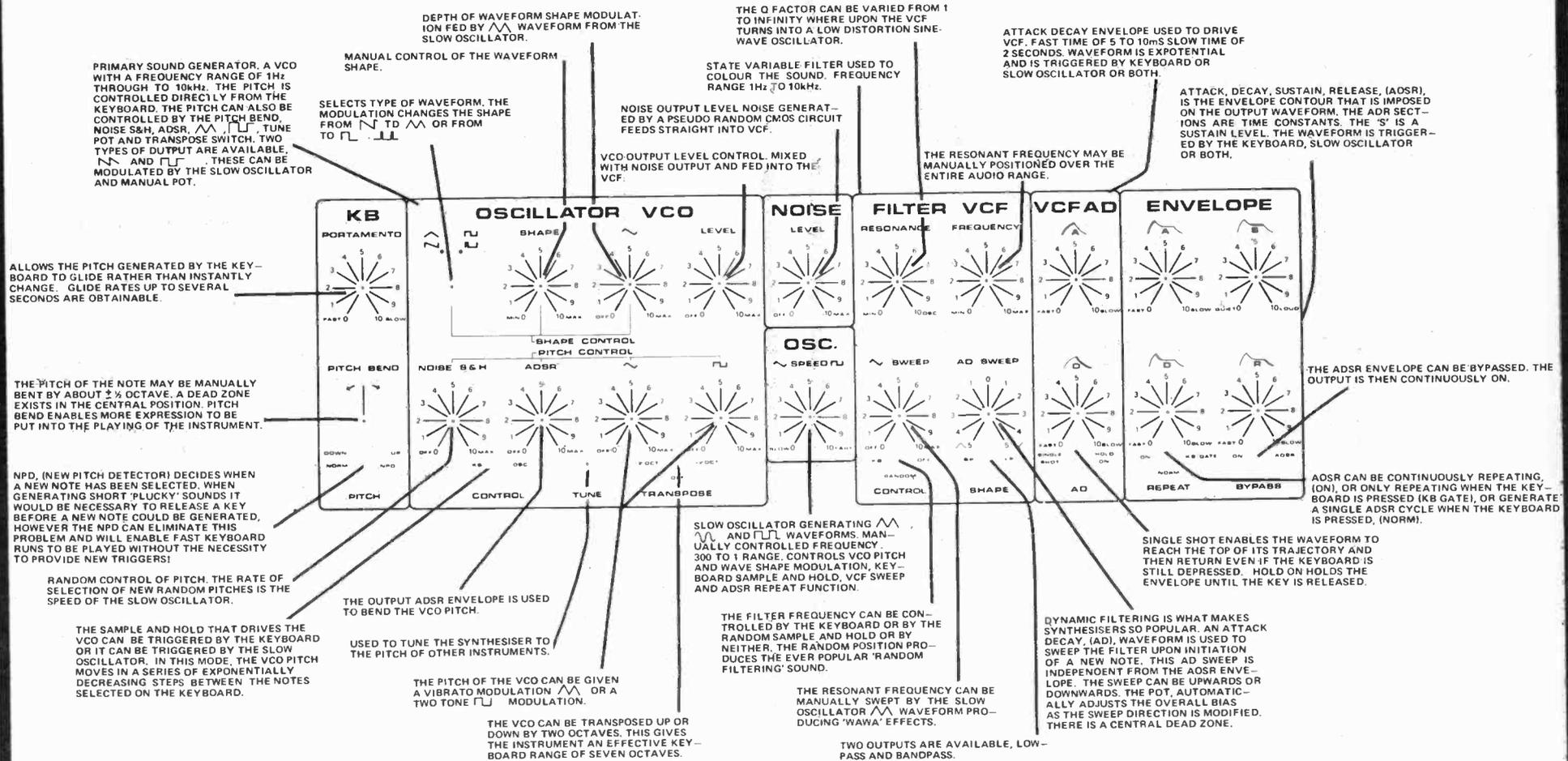


Fig. 6. The front panel layout and what to do with it. This drawing should show the newcomer to sound synthesis what to expect from the various circuit blocks, and give the expert an

idea of the versatility of the Transcendent 2000 design. The keyboard, a 37 note unit, is not shown, but reference is made to its control effects where appropriate.

NOISE GENERATOR

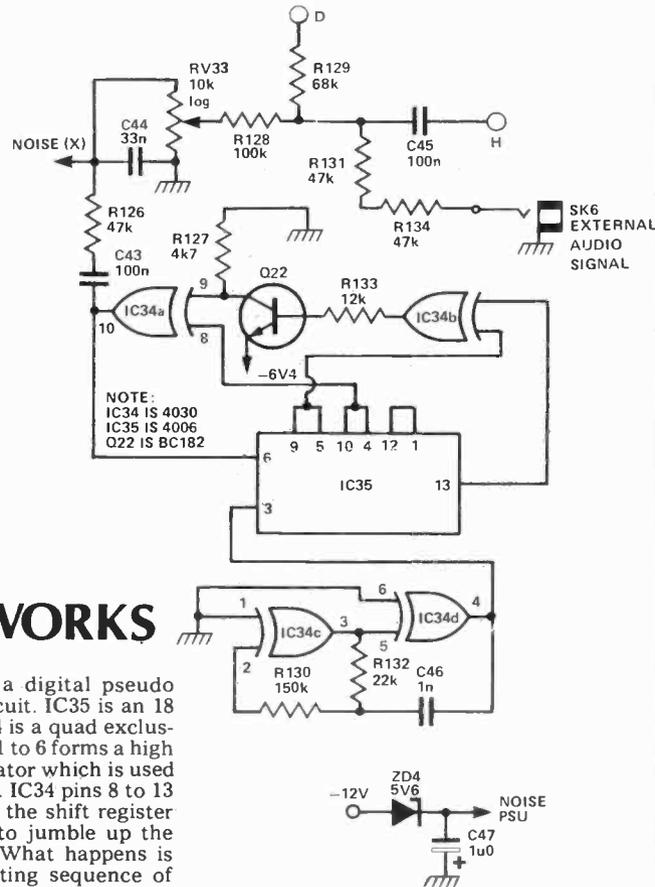


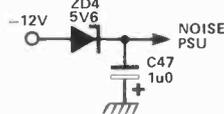
Fig. 7. The digital noise circuit is locally decoupled by C47, and the supply rail stabilised by ZD4 as shown right. The external audio signal level should be about 1V for best results.

HOW IT WORKS

The noise generator is a digital pseudo random shift register circuit. IC35 is an 18 bit shift register and IC34 is a quad exclusive OR device. IC34, pins 1 to 6 forms a high frequency (30 kHz) oscillator which is used to clock the shift register. IC34 pins 8 to 13 provide feedback around the shift register and are so arranged as to jumble up the data that is circulating. What happens is that a continuous repeating sequence of '0's and 1's flows around the register but the sequence is so very long that it only repeats about once every second. This repetition is inaudible. However the output has the characteristics of a noise source with a fairly flat spectrum.

The noise output is mixed into the audio input of the filter (RV33) and is also taken to the Random sample and hold. The noise is the signal that is sampled and the gate is

generated by the slow oscillator. The output is a sampled DC signal of random voltage, the sampling rate being that of the slow oscillator. This random voltage can be used to control the frequency of the VCO and VCF.



SLOW OSCILLATOR

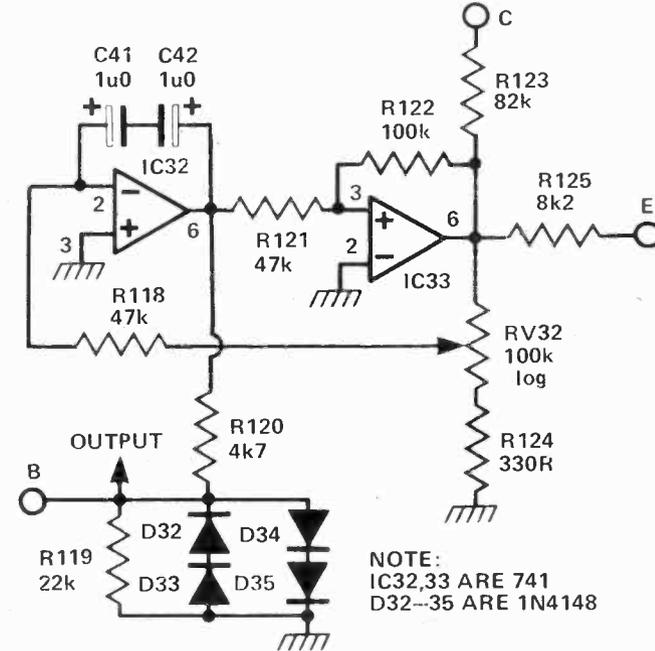


Fig. 8. Full circuit diagram for the slow oscillator block. Although very simple on paper, this circuit has a great deal of influence on the performance of the machine as a whole. The range is about 300 to 1, and the oscillator exercises control over the voltage controlled oscillator pitch, the VCO waveform modulation, the keyboard sample and hold function, the voltage controlled filter sweep rate and the ADSR repeat facility.

HOW IT WORKS

IC32 and IC33 form a triangle square wave oscillator. IC32 is an integrator the output of which ramps up and down between the hysteresis thresholds set by the schmitt trigger IC33. The square wave output of IC33 is fed back to the integrator via RV32 which determines the oscillator frequency, providing a range of 0.06 Hz to 20 Hz (300 to

1). The triangle is bent by D32-35 to form a sine wave which is used as a frequency shape modulator for the VCO. The square wave output is used to perform a repeat function with the AD and ADSR circuits. Also it is used to frequency modulate the VCO and to provide sampling pulses, for the two sample and hold circuits.

HOW IT WORKS

The keyboard generates two outputs. A pitch output and a gate voltage. This is then fed via R14, C12 (reduces contact bounce), to a schmitt trigger IC4. When a key is pressed the output of IC4 goes high, when it is released it goes low. This gate voltage is used to operate the keyboard sample and hold and the AD and ADSR units.

The keyboard voltage is generated by passing a constant current through a precision resistor chain. Thus a series of precise voltages is set up along the chain which can be picked off by the keyboard contacts. The constant current is generated by IC3, R9. R9 puts 2.526 mA into the node at IC3 pin 2. This then adjusts its output so that almost exactly 2.526 mA flows down the resistor chain.

When a key is pressed, a voltage appears which tells the synthesiser which key has been pressed. If more than one key is pressed, then the voltage is $(2.526 \times 27.4 \times N)$ mV where N is the number of resistors between the top note pressed and IC3 pin 2.

Thus the keyboard always generates the voltage of the highest note selected, and this is fed via R13, RV2, Q4 to C13 where it is stored. Q4 is a FET switch which has an on resistance of a few hundred ohms and a pinch off resistance of a few hundred megohms.

It is turned on and off by the keyboard gate voltage. The sequence of operation is as follows.

The keyboard is pressed. A pitch voltage is selected. A gate voltage is produced. Q4 is turned on and C13 is charged up to that

voltage via R13 RV2. The keyboard is released, the gate voltage dies, Q4 is turned off, and the voltage on C13 remains where it is. IC6 is a very high input impedance (1000 M), voltage follower, and so buffers the voltage on C13 to the rest of the electronics.

A PCB guard ring surrounds C13 so that surface leakage droop rate was about 0.1 mV/S which means that it would take 6922 seconds to drift one semitone or 8305 seconds for an octave.

The measured droop rate was about 0.1 mV/S which means that it would take 692 seconds to drift one semitone or 8305 seconds for an octave.

Portamento effects are obtained by varying RV2, anticlockwise the charging time of C13 is about 0.2 mS, when clockwise this becomes 330 mS, and the effect is to produce a slewing between notes.

If the keyboard contacts are badly out of alignment, a pitch change at the start of notes can be produced. If the first contact to close is the gate pair then this might cause a problem. The sequence of events is as follows:

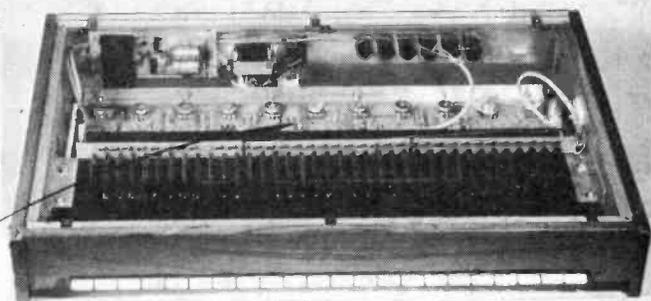
The gate contacts close. An envelope with the VCO at the previous pitch is produced. Then 10 or 20 mS. later the pitch contact is made and the sample and hold, and hence the VCO jumps to the correct pitch. The result is a pitch 'hiccup' at the start of some notes. If this is noticeable on any notes then the gate contact should be carefully bent so that it doesn't make contact before the pitch contact.

New Pitch Detector Circuit

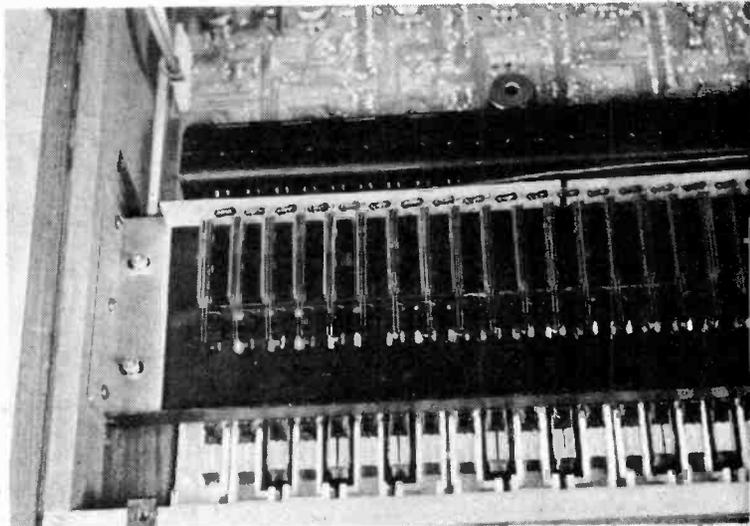
This circuit decides whether or not a new higher note has been played, even though the gate output signal (IC4 pin 6), has remained high all the time. IC5 is a high gain amplifier which looks at the voltage on the pitch contacts. If the pitch changes, the AC component of this change will be amplified by IC5.

If the output goes positive, a pulse is produced which passes through C14, D7 and ends up across R23. If the output of IC5 goes negative, the pulse goes through C14, D6, is inverted by IC7 and passes through D9 into R23, again as a positive pulse. This pulse then drives IC8 which is a schmitt trigger. Its output is normally low, and the arrival of the pulse makes it go high for a short while and then returns to its low state. Thus an ascending or descending scale of notes will cause a series of short pulses (at IC8, pin 6) to be generated, one per new note. When the last note held down is removed there is no pulse produced. When the same note is repressed, the pitch not actually being any different, a pulse is generated (this is what is wanted) via C11 from IC4 pin 6. This route only generates pulses on +ve edges, that is the start of a new gate voltage. The pulse output from IC8 is used to turn Q6 on and off. This in turn is used to momentarily turn off the AD and ADSR circuits. Thus the NPD can be used to provide a retrigger of the AD and ADSR circuits.

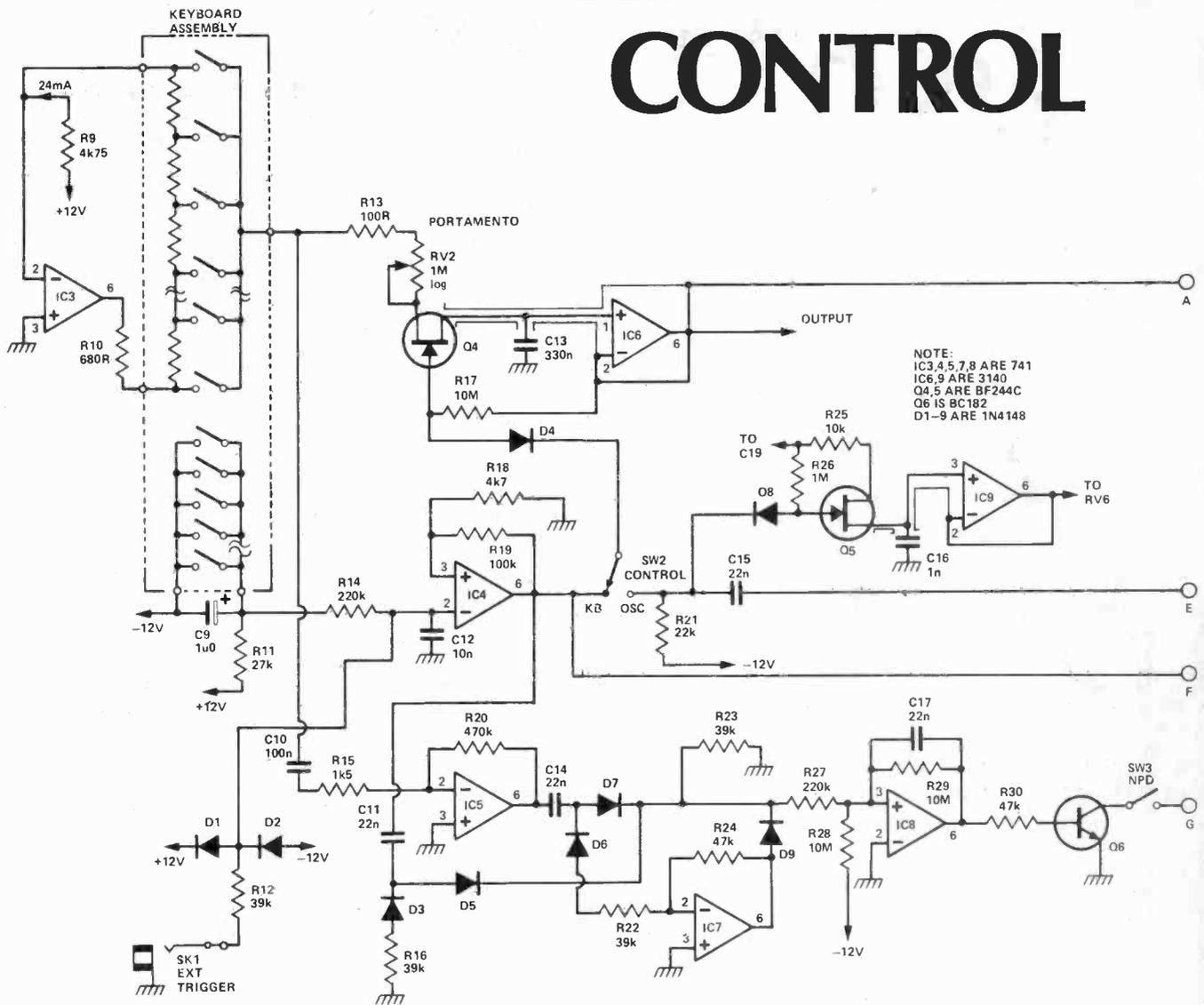
Fig. 9. On the right is shown the circuitry associated with the keyboard functions. Note the resistor chain for the keyboard is mounted remotely to the main PCB and fits into the contact block mounting board. The Ext Trigger input allows a sequencer to be wired to the synthesiser.



Above and right: a denuded synthesiser. Next month we go on to give full construction details of the design, but as you can see from the photos, it really couldn't be easier. The photo on the right shows the keyboard contact block mountings in close-up. This is perhaps the trickiest part of any synthesiser to build yourself, but as you can see ours is very straightforward.



KEYBOARD CONTROL

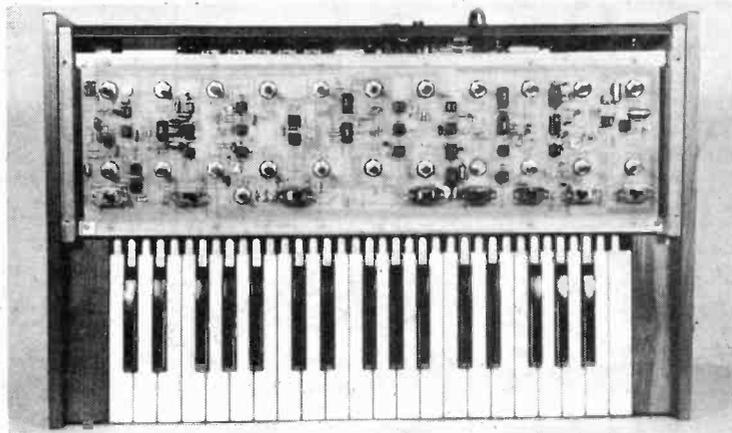


BUYLINES

A complete set of parts for this project, including all woodwork, metalwork, nuts and bolts, PCBs and components will be available from Powertran Electronics.

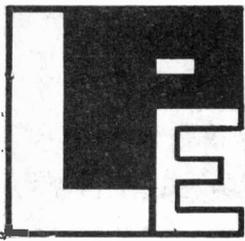
The machine used to illustrate this article was assembled using this kit, and constructional details will be based upon it. Kits will **only** be available from Powertran, as will the PCB. Because the design is based upon a single board construction, we cannot offer advice to people wishing to modify the synthesiser to a 'modular' form.

The price of the complete kit, including keyboard will be £186.50 + VAT. However if you're quick and put in your order before July 30th you can take advantage of an introductory offer at an even lower price of £172 + VAT. Powertran Electronics, Portway Industrial Estate, Andover, Hants.



Above: the lid removed to show the main PCB. It is worth noticing that all the controls and switches mount directly onto this, drastically reducing the interwiring necessary

Next month we conclude the article with all the constructional details of the Transcendent 2000 synthesiser, including keyboard fixing and alignment procedures.



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'ETI-Wet'



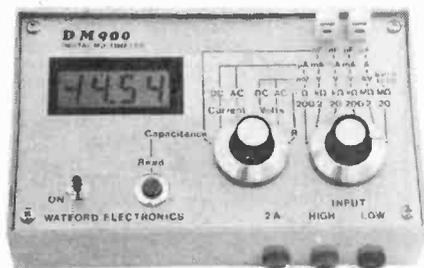
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EXPERIMENTER'S PSU



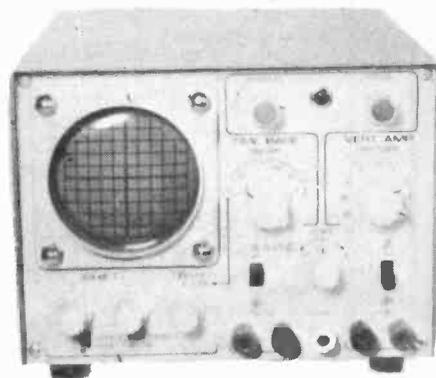
A rugged, totally dependable device which will stand even the worst insults (electrically speaking, that is) and still give a rock-steady performance (load regulation: 0.3%, line regulation: 0.1%). Not satisfied with being a mere power supply, this unit will also provide a constant-current source.

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DATA SHEET SPECIAL

THE ELECTRONICS PRESS is full of articles high-lighting the latest advances in memory technology, and we must plead guilty to this ourselves; it's quite fascinating. But we discovered that a lot of hobbyists who are using memories don't have access to good information on the devices available, and are consequently running into

problems while trying to get their systems up and running.

Here we attempt to give some real nitty-gritty down-to-earth useful information on memories. The data sheets are not complete by any means, but we hope they contain the most important information.

Bear in mind that distributors

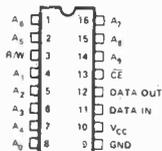
deal (in the main) with commercial organisations, and cannot possibly afford to supply hobbyists with heaps of expensive books, brochures and data sheets. If you request information from a manufacturer or distributor, please make life easy for them by enclosing a large stamped addressed envelope and payment, if any is required.

2102 STATIC RAM

NATIONAL

The 2102 is, without doubt, the commonest RAM in use today. It is a static 1024-bit (1K x 1) memory and is exceptionally easy to use, as many hobbyists will testify.

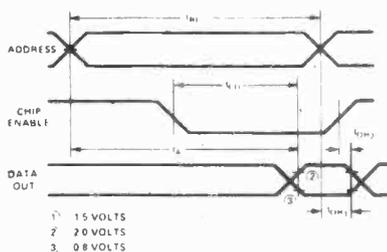
PIN CONFIGURATION



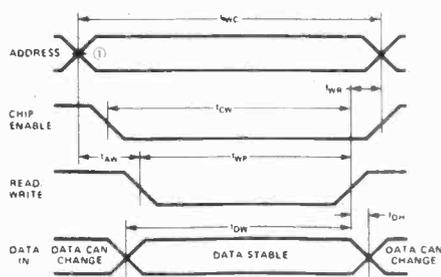
PIN NAMES

D_{in}	DATA INPUT
A_0 - A_9	ADDRESS INPUTS
R/W	READ/WRITE INPUT
\overline{CE}	CHIP ENABLE
D_{out}	DATA OUTPUT
V_{CC}	POWER (1.5V)

READ CYCLE



WRITE CYCLE



A. C. Characteristics $T_A = 0^\circ\text{C}$ to 70°C , $V_{CC} = 5\text{V} \pm 5\%$ unless otherwise specified

READ CYCLE

Symbol	Parameter	2102A-2, 2102AL-2 Limits (ns)		2102A, 2102AL Limits (ns)		2102A-4, 2102AL-4 Limits (ns)	
		Min.	Max.	Min.	Max.	Min.	Max.
t_{RC}	Read Cycle	250		350		450	
t_A	Access Time		250		350		450
t_{CO}	Chip Enable to Output Time		130		180		230
t_{OH1}	Previous Read Data Valid with Respect to Address	40		40		40	
t_{OH2}	Previous Read Data Valid with Respect to Chip Enable	0		0		0	

WRITE CYCLE

t_{WC}	Write Cycle	250		350		450	
t_{AW}	Address to Write Setup Time	20		20		20	
t_{WP}	Write Pulse Width	180		250		300	
t_{WR}	Write Recovery Time	0		0		0	
t_{DW}	Data Setup Time	180		250		300	
t_{DH}	Data Hold Time	0		0		0	
t_{CW}	Chip Enable to Write Setup Time	180		250		300	

D. C. and Operating Characteristics

$T_A = 0^\circ\text{C}$ to 70°C , $V_{CC} = 5\text{V} \pm 5\%$ unless otherwise specified.

Symbol	Parameter	2102A, 2102A-4 2102AL, 2102AL-4 Limits		2102A-2, 2102AL-2 Limits			
		Min.	Typ. (1)	Max.	Min.	Typ. (1)	Max.
I_{LI}	Input Load Current		1	10		1	10
I_{LOH}	Output Leakage Current		1	5		1	5
I_{LOL}	Output Leakage Current		-1	-10		-1	-10
I_{CC}	Power Supply Current		33	Note 2		45	65
V_{IL}	Input Low Voltage	-0.5		0.8		-0.5	0.8
V_{IH}	Input High Voltage	2.0		V_{CC}		2.0	V_{CC}
V_{OL}	Output Low Voltage			0.4			0.4
V_{OH}	Output High Voltage			2.4			2.4

Notes: 1. Typical values are for $T_A = 25^\circ\text{C}$ and nominal supply voltage.
2. The maximum I_{CC} value is 55mA for the 2102A and 2102A-4, and 33mA for the 2102AL and 2102AL-4.

POPULAR MEMORIES

The 2112 is a 256 x 4 bit TTL-compatible static RAM which is very popular in small systems where two 2112s will provide 256 bytes of memory. Memory expansion in 256 byte increments is easy until you reach 1 K, where 8 2102s could have done the job slightly more easily. The 2112 is made by Intel, National Semiconductor and many other semiconductor manufacturers.

ABSOLUTE MAXIMUM RATINGS

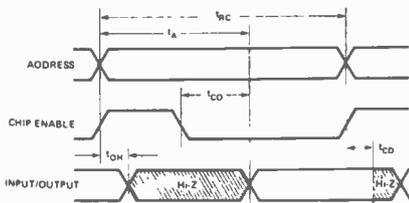
- Ambient Temperature Under Bias -10°C to 80°C
- Storage Temperature -65°C to +150°C
- Voltage On Any Pin
With Respect to Ground -0.5V to +7V
- Power Dissipation 1 Watt

CAPACITANCE ^[2] $T_A = 25^\circ\text{C}$, $f = 1\text{ MHz}$

Symbol	Test	Limits (pF)	
		Typ. ^[1]	Max.
C _{IN}	Input Capacitance (All Input Pins) V _{IN} = 0V	4	8
C _{I/O}	I/O Capacitance V _{I/O} = 0V	10	15

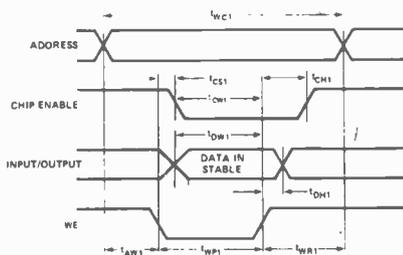
NOTES:
1. Typical values are for T_A = 25°C and nominal supply voltage.

READ CYCLE WAVEFORMS



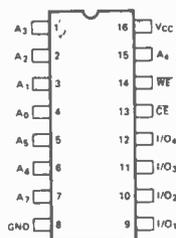
WRITE CYCLE WAVEFORMS

WRITE CYCLE #1

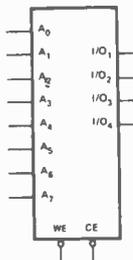


NOTE: 1. Typical values are for T_A = 25°C and nominal supply voltage

PIN CONFIGURATION



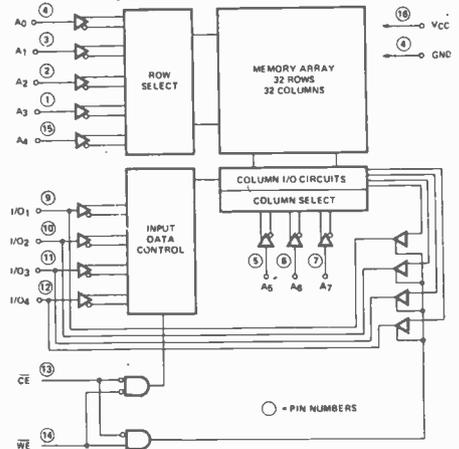
LOGIC SYMBOL



PIN NAMES

A ₀ -A ₇	ADDRESS INPUTS
WE	WRITE ENABLE
CE	CHIP ENABLE INPUT
I/O ₁ -I/O ₄	DATA INPUT/OUTPUT
V _{CC}	POWER (+5V)

BLOCK DIAGRAM



D.C. AND OPERATING CHARACTERISTICS

T_A = 0°C to 70°C, V_{CC} = 5V ±5% unless otherwise specified.

Symbol	Parameter	Min.	Typ. ^[1]	Max.	Unit	Test Conditions
I _{LI}	Input Current		1	10	μA	V _{IN} = 0 to 5.25V
I _{LOH}	I/O Leakage Current		1	10	μA	Output Disabled, V _{I/O} = 4.0V
I _{LOL}	I/O Leakage Current		-1	-10	μA	Output Disabled, V _{I/O} = 0.45V
I _{CC1}	Power Supply Current		35	55	mA	V _{IN} = 5.25V, I _{I/O} = 0mA T _A = 25°C
I _{CC2}	Power Supply Current		60	70	mA	V _{IN} = 5.25V, I _{I/O} = 0mA T _A = 0°C
V _{IL}	Input "Low" Voltage	-0.5		0.8	V	
V _{IH}	Input "High" Voltage	2.0		V _{CC}	V	
V _{OL}	Output "Low" Voltage			+0.45	V	I _{OL} = 2.0 mA
V _{OH}	Output "High" Voltage	2.4			V	I _{OH} = -200μA
		2.4			V	I _{OH} = -150μA

A.C. CHARACTERISTICS FOR 2112A

READ CYCLE T_A = 0°C to 70°C, V_{CC} = 5V ±5% unless otherwise specified.

Symbol	Parameter	Min.	Typ. ^[1]	Max.	Unit	Test Conditions
t _{RC}	Read Cycle	350			ns	t _r , t _f = 20ns
t _A	Access Time			350	ns	Input Levels = 0.8V or 2.0V
t _{CO}	Chip Enable To Output Time			240	ns	Timing Reference = 1.5V
t _{CD}	Chip Enable To Output Disable Time	0		200	ns	Load = 1 TTL Gate
t _{OH}	Previous Read Data Valid After Change of Address	40			ns	and C _L = 100pF.

WRITE CYCLE #1 T_A = 0°C to 70°C, V_{CC} = 5V ±5%

Symbol	Parameter	Min.	Typ. ^[1]	Max.	Unit	Test Conditions
t _{WC1}	Write Cycle	270			ns	t _r , t _f = 20ns
t _{AW1}	Address To Write Setup Time	20			ns	Input Levels = 0.8V or 2.0V
t _{DW1}	Write Setup Time	250			ns	Timing Reference = 1.5V
t _{WP1}	Write Pulse Width	250			ns	Load = 1 TTL Gate
t _{CS1}	Chip Enable Setup Time	0			ns	and C _L = 100pF.
t _{CH1}	Chip Enable Hold Time	0			ns	
t _{WR1}	Write Recovery Time	0			ns	
t _{DH1}	Data Hold Time	0			ns	
t _{CW1}	Chip Enable to Write Setup Time	250			ns	

2107 DYNAMIC RAM

WHEREAS STATIC RAMS basically consist of flip-flops and will retain data for as long as power is applied, with dynamic RAMs, life wasn't meant to be easy. The basic storage element in a dynamic RAM is a capacitor which is subject to leakage and requires data to be read from a cell, amplified and written back again in order to avoid total decay of the data.

Because the memory cell in a dynamic RAM is one transistor and a capacitor as against the six transistors of the static type, the density of dynamic RAMs is around four times higher. Thus, we now have 16 K dynamics, and 64 K types are rumoured to exist in research labs around the world!

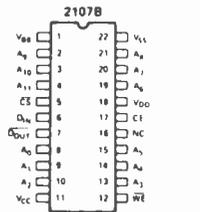
The innards of dynamic RAMs, like statics, are organised into rows and columns, 64 rows x 64 columns for a 4 K RAM, to be precise. All the cells in a single row are refreshed at the same time, and so to fully refresh a 4 K RAM, one need only cycle through all combinations of the low-order six address bits within 2 ms.

The first problem with these chips is that they are not fully TTL-compatible as is the 2102, for example. The chip enable input of the 2107B requires a high-level signal of at least 11 V to operate, but this can easily be got from a special driver chip, the Intel 3245, which also provides some selection logic.

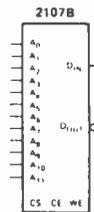
Given a 3245 and a handful of external logic, it looks as though the 2107B would be a good choice for hobbyists using the Z-80. The 2107 does not require address strobing, and consequently could run directly off the data bus, with the Z-80 supplying the refresh logic (the Z-80 has an internal refresh counter which is output while the processor decodes instructions).

If you are designing your own memory system, and your processor is not a Z-80, you will have to decide on one of three refresh schemes: Asynchronous, which insists on refresh occurring, even if this interrupts the processor; Synchronous, which runs 'in phase' with the processor, supplying refresh at times when the processor is not accessing memory; and Semi-synchronous, which is a combination of these schemes. Your decision will be dependent upon the circuit complexity, processor speed and overhead, and a number of other considerations.

PIN CONFIGURATION



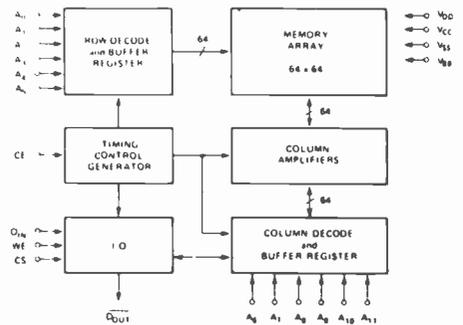
LOGIC SYMBOL



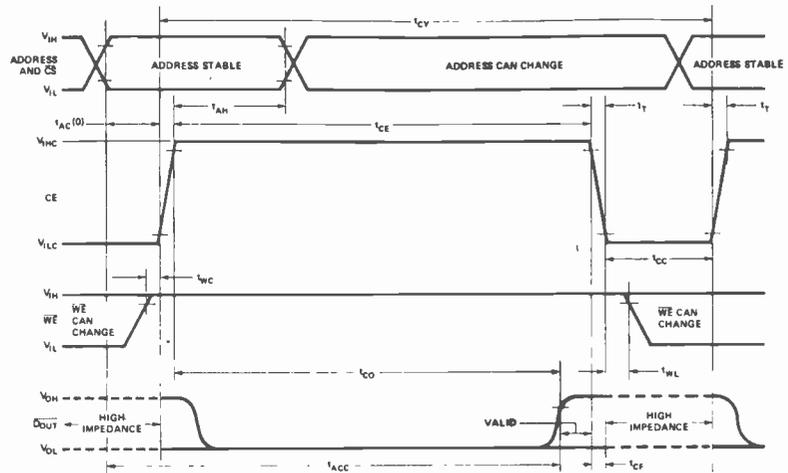
PIN NAMES			
A ₀ -A ₁₁	ADDRESS INPUTS*	V _{BB}	POWER (-5V)
CE	CHIP ENABLE	V _{CC}	POWER (+5V)
CS	CHIP SELECT	V _{DD}	POWER (+12V)
D _{IN}	DATA INPUT	V _{SS}	GROUND
D _{OUT}	DATA OUTPUT	WE	WRITE ENABLE
NC	NOT CONNECTED		

*Refresh Address A₀-A₅.

BLOCK DIAGRAM



Read and Refresh Cycle ⁽¹⁾



D.C. and Operating Characteristics

T_A = 0°C to 70°C, V_{DD} = +12V ±5%, V_{CC} = +5V ±10%, V_{BB} ⁽¹⁾ = -5V ±5%, V_{SS} = 0V, unless otherwise noted.

Symbol	Parameter	Limits			Unit	Conditions
		Min.	Typ. ⁽²⁾	Max.		
V _{IL}	Input Low Voltage	-1.0		0.6	V	t _T = 20ns, V _{ILC} = -1.0V
V _{IH}	Input High Voltage	2.4		V _{CC} +1	V	t _T = 20ns
V _{ILC}	CE Input Low Voltage	-1.0		+1.0	V	
V _{IHC}	CE Input High Voltage	V _{DD} -1		V _{DD} +1	V	
V _{OL}	Output Low Voltage	0.0		0.45	V	I _{OL} = 2.0mA
V _{OH}	Output High Voltage	2.4		V _{CC}	V	I _{OH} = -2.0mA

Absolute Maximum Ratings*

Temperature Under Bias	0°C to 70°C
Storage Temperature	-65°C to +150°C
All Input or Output Voltages with Respect to the most Negative Supply Voltage, V _{BB}	+25V to -0.3V
Supply Voltages V _{DD} , V _{CC} , and V _{SS} with Respect to V _{BB}	+20V to -0.3V
Power Dissipation	1.25W

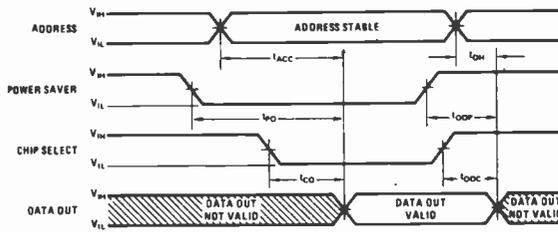
The second problem you will face in using dynamic RAMs is getting your memory system to work. It is a good idea to have some static RAM in the system so that the processor can be checked out without having to worry

too much about the memory. Once this is done, attention can be turned to the dynamic memories. In general, dynamic memory is a good choice for expanding your memory size, but not for starting a system.

absolute maximum ratings

All Input or Output Voltages with Respect to V_{BB} Except During Programming	+0.3V to -20V
Power Dissipation	750 mW
Operating Temperature Range	0°C to +70°C

The MM5204 is a 4096-bit static Read Only Memory which is electrically programmable and uses silicon gate technology to achieve bipolar compatibility. The device is a non-volatile memory organized as 512 words by 8 bits per word. Programming of the memory is accomplished by storing a charge in a cell location by applying a -50 V pulse. A logic input, "Power Saver," is provided which gives a 5:1 decrease in power when the memory is not being accessed.



Note: All times measured with respect to 1.5V level with t_h and t_f = 20 ns

FIGURE 1. Read Operation

Erasing

The MM5204Q (The Q suffix indicates the chip has a quartz window and is UV erasable. The other 5204s are not erasable.) may be erased by exposure to short-wave ultraviolet light of 254 nm wavelength. The recommended dosage of ultraviolet light exposure is 6 W sec/cm², but there is no absolute rule for erasing time or distance from the source. When erasing a worst case time required should be found and any chips then erased for three times this period.

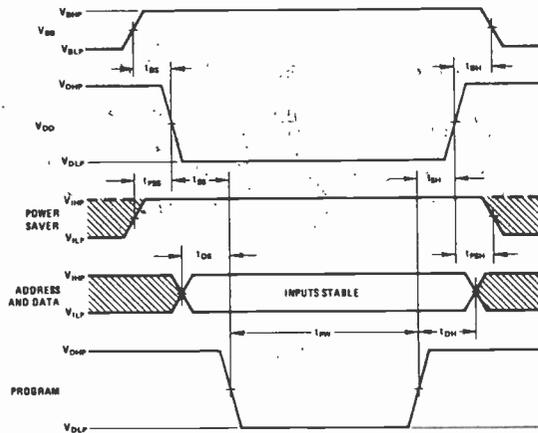
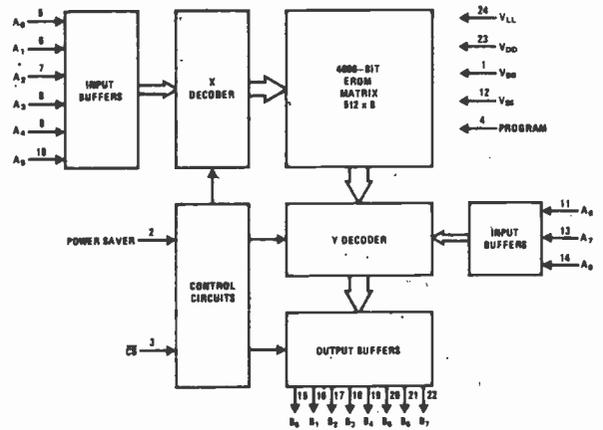


FIGURE 2. Write Operation

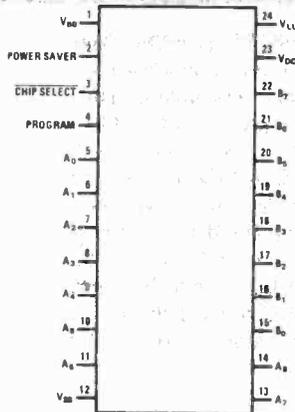
block and connection diagrams



electrical characteristics T_A within operating temperature range, V_{LL} = 0V, V_{BB} = PROGRAM = V_{SS}.

MM4204: V_{SS} = 5.0V ±10%, V_{DD} = -12V ±10%, MM5204: V_{SS} = 5.0V ±5%, V_{DD} = -12V ±5%, unless otherwise noted.

PARAMETER	CONDITIONS	MIN	MAX	UNITS
V _{IL} Input Low Voltage		V _{SS} -14	V _{SS} -4.2	V
V _{IH} Input High Voltage		V _{SS} -1.5	V _{SS} +0.3	V
I _{LI} Input Current	V _{IN} = 0V		1.0	μA
V _{OL} Output Low Voltage	I _{OL} = 1.6 mA	V _{LL}	0.4	V
V _{OH} Output High Voltage	I _{OH} = -0.8 mA	2.4-	V _{SS}	V
I _{LO} Output Leakage Current	V _{OUT} = 0V, \overline{CS} = V _{IH}		1.0	μA
Access Time	MM5204 T _A = 0°C, \overline{CS} = V _{IH} , Power Saver = V _{IL}	0.75	1.0	μs



Programming.

The MM5204 is normally supplied in the unprogrammed state. All 4096-bits at logic "0" state. In the program mode the device effectively becomes a RAM with the 512 word locations selected by address inputs A0-A8. Data inputs are B0-B7 and the write operation is controlled by pulsing the program input to -50 V. Since the EROM is initially supplied with all "0s" a V_{IHP} on any of the data input lines will leave the stored "0s" undisturbed and a V_{ILP} on any data input B0-B7 will write a logic "1" into that location. The program cycle should be repeated until the data reads true, then over programmed five times that number of cycles (denoted X + 5X programming)

programming electrical characteristics

PARAMETER	CONDITIONS	MIN	MAX	UNITS
I_{LD}	Data Input Load Current		-10	mA
I_{ALD}	Address Input Load Current		-10	mA
I_{LP}	Program Load Current		-10	mA
I_{LBB}	V_{BB} Load Current		50	mA
I_{LDD}	V_{DD} Load Current		-200	mA
V_{IHP}	Address Data and Power Saver Input High Voltage	-2.0	0.3	V
V_{ILP}	Address Input Low Voltage	-50	-11	V
	Data Input Low Voltage	-18	-11	V
V_{DHP}	V_{DD} and Program High Voltage	-2.0	0.5	V
V_{DLP}	V_{DD} and Program Low Voltage	-50	-48	V
V_{BLP}	V_{BB} Low Voltage	0	0.4	V
V_{BHP}	V_{BB} High Voltage	11.4	12.6	V
V_{DD}	Pulse Duty Cycle		25	%
t_{PW}	Program Pulse Width	0.5	5.0	ms
t_{DS}	Data and Address Set-Up Time	40		μ s
t_{DH}	Data and Address Hold Time	0		μ s
t_{SS}	Pulsed V_{DD} Set-Up Time	40	100	μ s
t_{SH}	Pulsed V_{DD} Hold Time	1.0		μ s
t_{BS}	Pulsed V_{BB} Set-Up Time	1.0		μ s
t_{BH}	Pulsed V_{BB} Hold Time	1.0		μ s
t_{PSS}	Power Saver Set-Up Time	1.0		μ s
t_{PSH}	Power Saver Hold Time	1.0		μ s
$t_{R, F}$	V_{DD} , Program, Address and Data Rise and Fall Time		1.0	μ s

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HONEYWELL Proximity Detector Integral Amplifier 8V DC £2.50 ea. 10 for £22.

SMITH INDUSTRIES AUDIBLE TRANSDUCED WARNING DEVICE 6-12 volts. Size 30mm x 10mm. Polarisred. 50p ea. 10 for £4. 100 for £35.

SUPPLY PANEL containing 6 high quality 0.1uF 10% 1KV poly capacitors. 102x19x75mm. 10 for £2.50.

ALMA pushbutton reed switches, push to make. High reliability. 18x27x18mm 35p. 25 for £7. 100 for £25. 1000 for £225.

BURROUGHS 9 digit Panaplex Calculator display. 7 segment. 0.15" digits, neon type, with red bezel, socket and instructions £3.50. 10 for £30. 100 for £250.

I.C. Audio Power by TOSHIBA 35 WATT module. 8 ohms o/p 200mV into 47K for full output. 0.3% distortion (max) 60V power supply required. £8.50. 10 for £75.

10.7MHz crystal filters. Size 35x25x20mm. 25KHz band width for NBFM £7. 10 for £60.

TEXAS 4 + 5 Digit C. Cathode Display with 16 pin DIL Base. 0.2" digits. Pair £1.50. 10 pairs £12.50. 100 pairs £100.

2 1/2" 40 ohm speaker 250 M.Watt - Ideal for that small space. 75p. 10 for £6. 100 for £50.

3 DIGIT 7 SEGMENT DISPLAYS. C cathode pack of 2 with data (segments are missing) 60p pack.

TBA 120A 75p. 10 for £7. 100 for £55. **TBA 120S. 75p.** 10 for £7. 100 for £55.

SOLDER at half price, 5 packs of 2 metres. 18 Gauge Servical £1.20. 20 packs £10.

AVO meter movements for a military version of the Av8 B. Precision 37.5 micro Amp (50uA with integral shunt) movement. Electronic voltmeter circuit available on request. £8.50.

28 pin calendar/clock chip type MK501 788 common cathode LED display (with circuit) £4.49.

JOYSTICK CONTROLS. (Ideal for TV Games, model control), sturdy constructed compact controls giving full 360° movement and control. Each unit fitted 4-off 100K linear controls. Pair £6.00.

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18-1 1/2 Watt Zeners 3.9-9.1 with mixed		85p	£7.50	£65
10-10 Watt Zeners mixed voltages		85p	£8.50	£75
10-400 M/W Zeners 3-3.33 volts		65p	£5.50	£45
50 Germanium & Silicon Diodes				

microfile.....

Gary Evans, fresh from a lesson in petting, reports on the world of micros and personal computers.

A HECTIC MONTH this, as the words you are now reading were penned in between the frantic, on my part anyway, preparations for our Petting for Beginners Seminar. A report on the event appears elsewhere in this issue but I think the two days can be summed up in a very few words — a good and informative time was had by all.

Informative not only in terms of the days lectures but because delegates talked to each other — very un-English — and found much in common. I was impressed with the high level of knowledge of most delegates and even those who knew very little of personal computing in the morning, could hold their own in discussions before the end of the day.

Petting For Softies

It was at the Saturday event that I talked to Julian Allason of William Hamilton and Allen. The company have in the past specialised in introducing advanced electronic consumer products into this country. They were one of the first to market car stereo systems and VCR equipment. They see Personal Computers as such as product but recognise that the potential is far greater than those products they have dealt with before.

The company have set up a new division which they have named PETSOF. This section of the group will concern itself with the market that is beginning to appear as more and more people want support for their home computers.

It is interesting to note that the current efforts of the firm are directed toward building a base of good, well tried software.

At present their range includes alien attack which is — guess what — a space war game and Dr. Sinister's Personality Test.

The latter package will ask the user some fifty questions and provide a readout of personality in terms of introvert/extrovert, stable/unstable, aggression, intelligence, attractiveness (micro, micro on the wall, who's the fairest of them all). This package sounds like fun and I'm not going to tell you what the machine said about me.

The range of programs will be extended to cover small business applications in the near future — VAT, stock control, etc.

If you have any programs which you feel would find a ready market, and/or ideas for programs PETSOF would like to hear from you — they would publish any suitable material on a royalty basis. As with their own programs, all submitted programs would be subjected to an extensive debugging operation.

At present all material is designed to run on the PET computer and will be sold in the form of cassettes recorded to the PET standard. Future plans include programs for the TRS-80 and, presumably, any other system that finds a mass market.

The cassettes will sell for between £2.50 (for small programs) to £10 (for the larger packages). This price reflects the high volume, low cost approach to software marketing that, I think, is the only effective way to circumvent software pirating.

Talking of pirating, the firm will have no objection to a few friends copying programs for each other but will pursue, in an alien attack mode, anybody selling their material.

A SAE to the firm at the address below will bring you a catalogue with details of all their programs.

PETSOF

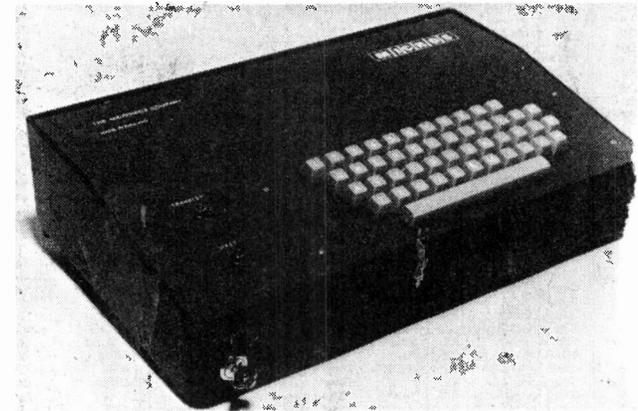
318 Fulham Road, SW10

Texas Soon

At present the number of personal computer systems on the mass market is not that large — all that will change.

General Instruments are to market a board with CPU, RAM, BASIC in ROM, etc. very soon. Texas are also to enter the market. Details are scarce but we hear of a US launch in June with the system being based on the 9940. This is a 40 pin package version of their (Texas) 16 bit MPU, with, we hear, a 7K (16 bit 7K remember) resident BASIC. The machine will be interesting to see. ITT are to market the Apple system under their own name. The machines will be built here and, while initially exactly as Apple, ITT may improve things.

News now of a price reduction in a system that I have mentioned in Microfile before. The MICROS machine from Micronics is now to sell for £399 assembled and £360 in kit form (it was £550 — quite a drop).



A quick recap of the system (pictured) might be in order. Z80 based, the machine provides a 1K monitor, 2K of RAM, a 47 key keyboard, serial I/O, two parallel output ports and an output — at UHF, to allow a domestic TV set to display the machines output.

If to you that sounds like a description of the NASCOM 1 you're right. The main outward difference between the systems seems to be that the MICROS is cased and includes a PSU. The only way to make a detailed comparison of the two machines is to get them side by side and take a close look at them. My editor, God, the companies involved (in that order) willing, I shall try to do just that.

Full details of the Micros and of an impact printer for about £150 that the company hope to launch can be obtained, SAE please from

The Micronics Company
1 Station Road
Twickenham
Middlesex

£ = £?

There have been quite a few comments over the past few weeks about the comparatively, high cost of many computer systems that are appearing on the British market. The general rule for American imports seems to be to take the American price and swap the dollar sign for a pound symbol, saves printing costs maybe.

It has been pointed out that on the higher priced of systems it would be possible to fly over to the states, nice one Fred, buy a system from one of the American computer stores and return to this country for the same price as purchasing the system here. You get a day or so in New York as a bonus. Sounds good doesn't it. But think again!

Many systems are not the most robust of creatures and after your, and their, travels may require attention. What happens when your machine breaks down—the UK organization is not likely to be too interested in servicing a machine brought over from the States. After all it costs a fair amount of money to set up a marketing organization together with service centres and it is this, in some part, that accounts for the higher UK price.

There is no doubt that many people are making a profit which may, politely, be called excessive: not offering much support or help to their customers and are in the personal computer business for a quick profit. Others, however are here to stay and have invested in setting up an organization that will not leave owners to fend for themselves when the going gets tough.

So, by all means compare US prices with the UK going rate but also look at the backup offered by the UK distributor/agent.

Let the buyer beware especially if he buys from the States.

CSF VDU

It probably will not be news to most of you that Thompson CSF have introduced a CRT controller chip into this country (details from Marshall's of Edgware Rd.). This chip will take care of a lot of the timing and control signals required by any VDU. Just hang a crystal, 2513, RAM and about five TTL chips around the device and you have a VDU.

I've been playing around with the thing for the past few weeks and found it to be very easy to use and capable of producing a very good display. I mention the device because you may be interested, not a lot maybe, but maybe a little, in my prototyping method.

Being brought up as I was on a diet of that product that refreshes the bits and veroboard, I find it difficult to come to terms with the new prototype methods, wire wrap—wiring pen etc. However with ICs of forty and even sixty-four legs things can get difficult. I've found a way that combines the old and new which has speeded up my design work. I use DIP veroboard to mount the components but to wire the devices together, which take most of the time (cutting wires to length, stripping etc) I use prestripped, standard length wire wrap wire.

Don't bother to cut wires to length—this is where the time is saved. The final result does not look too good, but you've cut the time taken to set up and running in half.

Kit Bits

I am interested in gathering information on the problems, or potential problems involved in building and testing the various kits that are on the market at the moment. If you have built up a kit please send me your reports, good or bad, so that I can put together a review of these various product groups.

TTLs by TEXAS		C-MOS ICs		OP. AMPS		MEMORY I.C.s		TRANSISTORS		DIODES		BRIDGE RECTIFIERS		
7400	14p	4000	21p	NE531V	140p	2102-2	85p	MJ2501	250p	2N2846	52p	BY127	12p	
7401	15p	4001	21p	NE543K	225p	2102-2	85p	MJ2955	108p	2N2904/A	22p	0A47	15p	
7402	15p	4002	21p	CA3130	108p	2107	100p	MJ2955/A	110p	2N2905/A	22p	0A81	15p	
7402	15p	4002	21p	CA3140	70p	2112-2	300p	MJ3001	250p	2N2906/A	22p	0A85	15p	
7402	15p	4006	127p	CA3160	120p	2114	RAM	MPE102/3	40p	2N2907/A	25p	0A90	9p	
7403	20p	4007	21p	LM301A	40p	2114	RAM	MPE102/3	40p	2N2928B	9p	0A90	9p	
7404	20p	4008	180p	LM318N	175p	2708	EPROM	MPF104/5	40p	2N2828G	11p	0A91	9p	
05	25p	4009	67p	LM324N	75p	2716	EPROM	MPSA06	37p	2N3053	22p	0A95	9p	
06	43p	4010	67p	LM348N	130p	8080A	CPU	MPSA12	62p	2N3054	65p	0A200	9p	
07	43p	4011	21p	MC1458P	80p	AY-5-1013	UART	MPSA56	40p	2N3055	48p	0A202	10p	
08	22p	4012	23p	LINEAR I.C.s	NE5528	450p	AY-5-2176	KB Fnc	MPSU05	72p	1N914	4p	4A 100V	90p
09	22p	4013	58p	AY-10212	NE555	180p	MC6800	CPU	MPSU06	72p	1N914	4p	4A 400V	90p
10	22p	4014	90p	CA3019	NE566	180p	MC6810	RAM	MPSU55	90p	1N4001/2	6p	6A 50V	90p
11	22p	4015	90p	CA3028A	NE567	180p	MC6820	RAM	MPSU56	90p	1N4003/4	7p	6A 100V	108p
2	25p	4016	54p	CA3046	RC4151D	53p	MC6850	RAM	OC28	90p	1N4005/7	8p	6A 400V	120p
3	25p	4017	100p	CA3048	SN72710N	42p	RO-3-2513	ROM	OC35	90p	1N4006/7	8p	10A 400V	270p
4	85p	4018	110p	CA3053	SN76003N	275p			OC71	35p	1N5401/3	15p	25A 400V	432p
10	85p	4019	87p	CA3080E	SN76013ND	160p			R2008B	225p	1N5404/7	20p	VM18	48p
11	85p	4020	140p	CA3089E	SN76023ND	160p			R2010B	225p				
18	142	4021	120p	CA3090AQ	SN76023ND	175p			TIP29A	50p				
43	85p	4022	140p	FX209	SP8515	310p			TIP29C	62p				
28	74	4023	23p	ICL7106	1N75	175p			TIP30A	50p				
74	74	4024	110p	LM339N	1N75	175p			TIP30C	72p				
39	22p	4025	23p	LM337N	TBA611A	90p			TIP31A	52p				
10	22p	4026	140p	LM339N	TBA611B	90p			TIP31C	68p				
11	22p	4027	64p	LM380N	TBA612	90p			TIP32A	83p				
2	25p	4028	110p	LM381N	TBA651	225p			TIP32C	85p				
3	25p	4029	120p	LM389N	TBA800	112p			TIP33A	97p				
4	85p	4030	87p	LM3911N	TBA810	125p			TIP33C	120p				
10	85p	4031	87p	LM3911N	TBA820	100p			TIP34A	124p				
11	85p	4032	100p	MC1495L	TD41022	67p			TIP34B	160p				
43	85p	4033	100p	MC1496L	TD42020	380p			TIP35A	243p				
74	85p	4034	100p	MC3340P	XR2206C	362p			TIP35B	290p				
74	85p	4035	100p	MC3360P	XR2216C	756p			TIP36A	297p				
74	85p	4036	64p	NE540L	ZN414	110p			TIP36C	360p				
74	85p	4037	64p	NE555	ZN424E	145p			TIP41A	70p				
74	85p	4038	120p	NE556	ZN425E	432p			TIP41C	64p				
74	85p	4039	120p	NE561B	ZN1034E	216p			TIP42A	78p				
74	85p	4040	145p						TIP42C	98p				
74	85p	4041	145p						TIP2955	76p				
74	85p	4042	145p						TIP3055	60p				
74	85p	4043	145p						TIS43	40p				
74	85p	4044	145p						TN697	25p				
74	85p	4045	145p						TN698	37p				
74	85p	4046	145p						TN706/8	22p				
74	85p	4047	145p						TN818	43p				
74	85p	4048	145p						TN819	43p				
74	85p	4049	145p						TN820	43p				
74	85p	4050	145p						TN821	43p				
74	85p	4051	145p						TN822	43p				
74	85p	4052	145p						TN823	43p				
74	85p	4053	145p						TN824	43p				
74	85p	4054	145p						TN825	43p				
74	85p	4055	145p						TN826	43p				
74	85p	4056	145p						TN827	43p				
74	85p	4057	145p						TN828	43p				
74	85p	4058	145p						TN829	43p				
74	85p	4059	145p						TN830	43p				
74	85p	4060	145p						TN831	43p				
74	85p	4061	145p						TN832	43p				
74	85p	4062	145p						TN833	43p				
74	85p	4063	145p						TN834	43p				
74	85p	4064	145p						TN835	43p				
74	85p	4065	145p						TN836	43p				
74	85p	4066	145p						TN837	43p				
74	85p	4067	145p						TN838	43p				
74	85p	4068	145p						TN839	43p				
74	85p	4069	145p						TN840	43p				
74	85p	4070	145p						TN841	43p				
74	85p	4071	145p						TN842	43p				
74	85p	4072	145p						TN843	43p				
74	85p	4073	145p						TN844	43p				
74	85p	4074	145p						TN845	43p				
74	85p	4075	145p						TN846	43p				
74	85p	4076	145p						TN847	43p				
74	85p	4077	145p						TN848	43p				
74	85p	4078	145p						TN849	43p				
74	85p	4079	145p						TN850	43p				
74	85p	4080	145p						TN851	43p				
74	85p	4081	145p						TN852	43p				
74	85p	4082	145p						TN853	43p				
74	85p	4083	145p						TN854	43p				
74	85p	4084	145p						TN855	43p				
74	85p	4085	145p						TN856	43p				
74	85p	4086	145p						TN857	43p				
74	85p	4087	145p						TN858	43p				
74	85p	4088	145p						TN859	43p				
74	85p	4089	145p						TN860	43p				
74	85p	4090	145p						TN861	43p				
74	85p	4091	145p						TN862	43p				
74	85p	4092	145p						TN863	43p				
74	85p	4093	145p						TN864	43p				
74	85p	4094	145p						TN865	43p				
74	85p	4095	145p						TN866	43p				
74	85p	4096	145p						TN867	43p				
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TV Typewriter Cookbook £7.40
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This book is intended for undergraduate courses on microprocessors.

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A completely up-to-date report on the state of the art of microprocessors and microcomputers, written by one of the leading experts. It thoroughly analyzes currently available equipment, including associated large scale integration hardware and firmware.

The 8080A Bugbook: Microcomputer Interfacing and Programming £7.60
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The principles, concepts and applications of an 8-bit microcomputer based on the 8080 microprocessor IC chip. The emphasis is on the computer as a controller.

6800 Software Gourmet Guide and Cookbook £7.80
by SCELBI

8080 Software Gourmet Guide and Cookbook £7.80
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by SCELBI

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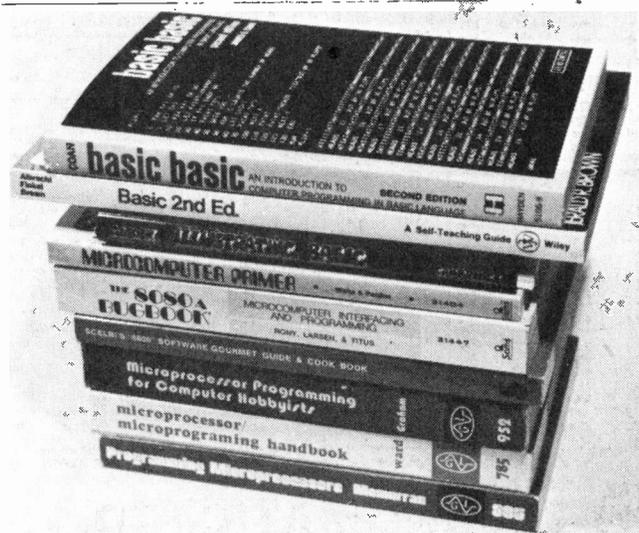
Microcomputer Primer £6.05
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Introduces the beginner to the basic principles of the microcomputers. Discusses the five main parts of a computer — central processing unit, memory, input/output interfaces, and programs. The important characteristics of several well-known microprocessors are given and a chapter is included on programming your own microcomputer.

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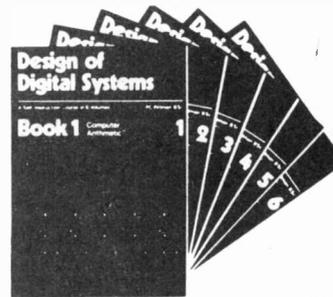
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ET17

UFO DETECTOR

Making no claims as to the efficacy of the device, we present a circuit that will provide an indication of the magnetic disturbances which much UFO literature associates with UFO activity.

EVERY YEAR MANY thousands of people see objects in the sky which they cannot explain in terms of their previous experience. In this sense the existence of unidentified flying objects (UFOs) is not a matter for debate — people see flying things they cannot identify, thus, by definition, these things are unidentified flying objects.

The vast majority of sightings are caused by various objects or phenomena perceived in an unusual manner — cloud formations, meteors, satellites, planets, an unusually bright star, temperature inversions, etc. There are also a substantial number of hoax devices. Most people are satisfied if presented with a rational explanation for what they have seen, but a minority are not — they are 'conspiracy theorists' who deny totally the principle of Occam's razor. Faced with 99 probable explanations for an unusual happening — and just one explanation which complies with a previously accepted set of concepts — they will inevitably choose the odd one out.

Klass Encounters

No explanation or proof will convince the dedicated conspiracy theorist to think otherwise — a classic example of this is the often repeated story that the results of the USA Department of Air Force UFO investigation 'project blue book' have been suppressed. This is not really true. The blue book project files were declassified in 1970, and the USA Department of Air Force Office of Information state that the files are available to all bona-fide researchers and media representatives.

The conspiracy theory was well summed up by Salvador Freixedo at the UFO conference in Acapulco (April 1977). "The basic appeal of Ufology (for the masses) is that it is a belief system rather than a field of scientific investigation". A further large number of classic cases quoted by Ufologists has been well and truly debunked by Philip Klass (a technical journalist working with Aviation Week and Space Technology magazine).

Of The Financial Kind

Klass's book (UFOs explained) thoroughly demolishes the most classic cases and provides evidence which casts major doubt on those few remaining. Consider for example the often quoted 'UFO landing' in Socorro, New Mexico in 1964. It now turns out that the 'landing' was set up as a publicity stunt by the local mayor, who just happened to own that bit of land where the UFO 'landed'.

It is perhaps significant that no serious challenger has ever taken up the USA's National Enquirer's offer to pay one million US dollars for proof that UFOs are unnatural phenomena emanating from outer space.

A small minority of ufologists should however be taken more seriously. These are dedicated people who investigate reported sightings as thoroughly as they are able. Unfortunately most of their investigations tend to be 'unscientific' in the sense that they lack the rigorous discipline which truly scientific investigation demands. Nevertheless, it is to the movement's great credit that they realise their investigational

limitations and are currently doing their best to check out as thoroughly as they can a number of previously accepted classic sightings. In fact magazines such as the authoritative US official publication 'UFO' currently feature exposes of previously 'proven' situations. In the light of this recent background, ETI was extremely interested to learn of a UFO magnetic anomaly detector recently developed by one of our contributors.

The basis of this device is that many UFO sightings are claimed to have coincided with major magnetic disturbances. In many reported situations, electrical equipment is claimed to have ceased to operate whilst the UFO was in the vicinity.

Thus, claim some ufologists, it may well be possible to sense the approach of a UFO by detecting abnormal perturbations of the earth's magnetic field. The unit described here has been designed by Mr F C Gillespie who has considerable expertise in this field.

Flux Be With You

UFO literature indicates that magnetic disturbances associated with some UFO activity are of such a magnitude that they should be detectable by relatively simple equipment. Naturally the more sensitive the equipment the further away a disturbance could be detected — however, an upper practical limit for sensitivity is set in most areas by the generally high level of background noise associated with civilisation — and which, ironically, is often postulated as attracting UFOs to this planet.

It is not at all difficult to detect the magnetic disturbance caused by a

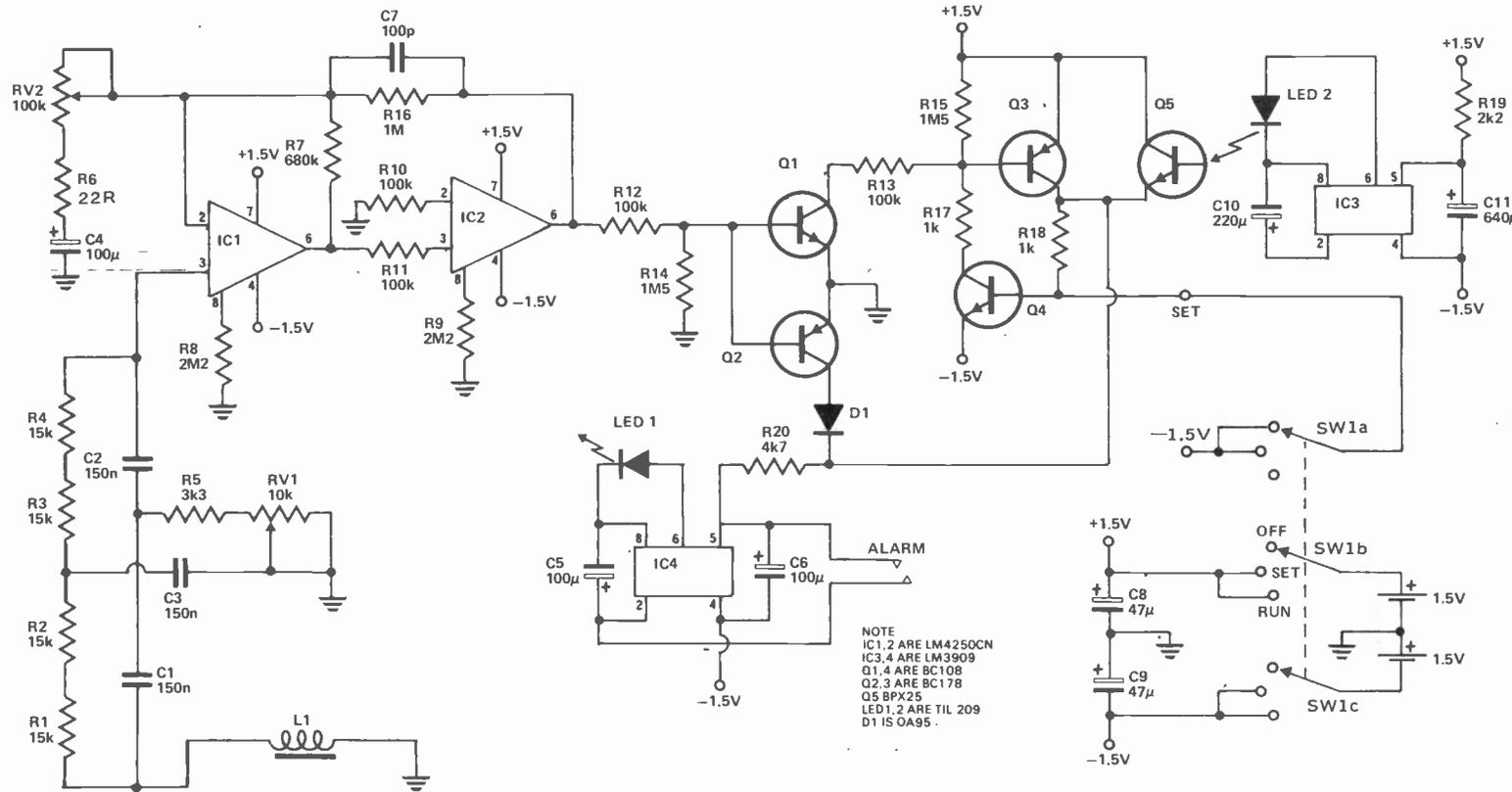


Fig. 1. Full circuit diagram of the UFO detector. Two detecting systems are provided, one based on a compass system and the other on coil L1.

HOW IT WORKS

There is anecdotal evidence that the magnetic disturbances associated with UFOs may be transient in nature or may build up and decay over a period of time or may also be of an oscillatory nature. For this reason the magnetic anomaly detector has two detecting systems capable of responding to all three types of disturbance.

The simpler of the two systems responds to minor movements of a very sensitive compass. The compass needle is set up so that when undisturbed it blocks the passage of

light from a flashing LED, the light output from which would otherwise fall on a sensitive phototransistor. The phototransistor output is then amplified, latched and passed to a second flasher circuit which in turn can trigger alarms.

A second and more complex circuit monitors a solenoid (L1) across which a voltage would be generated if it were subjected to a changing magnetic field. A twin-T notch filter is incorporated in this circuit to null out ambient 50 Hz.

Any voltage output resulting from a changing magnetic field around L1 is passed to the two-stage amplifier formed by IC1 and IC2. 50 Hz background noise is greatly attenuated by the twin-T notch filter formed by the components between L1 and the amplifier. The frequency of the notch is adjustable by RV1.

The gain of the amplifier IC1/IC2 is varied by RV2. Output signals from the amplifier are passed to Q1/Q2/Q3/Q4 which form two latching circuits (each functioning depend-

ing on the polarity of the output signal).

The output of the latching circuitry is then passed to IC4. This is a National LM3909 LED flasher. This causes the alarm LED to flash at about 3 Hz. An external alarm output is also provided.

The compass circuitry is quite straightforward. IC3 is used to extend battery life. Any output from the phototransistor Q5 triggers the latching mechanism thus initiating the alarm sequence.

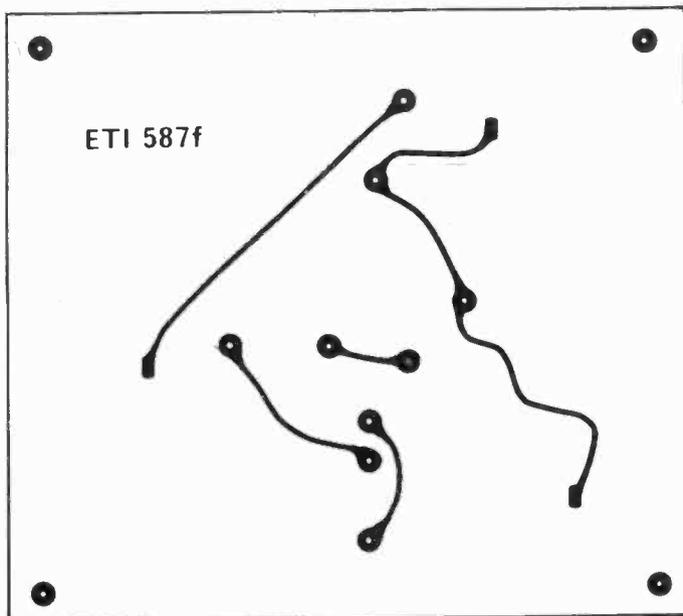


Fig. 2. Foil pattern for topside of UFO PCB.

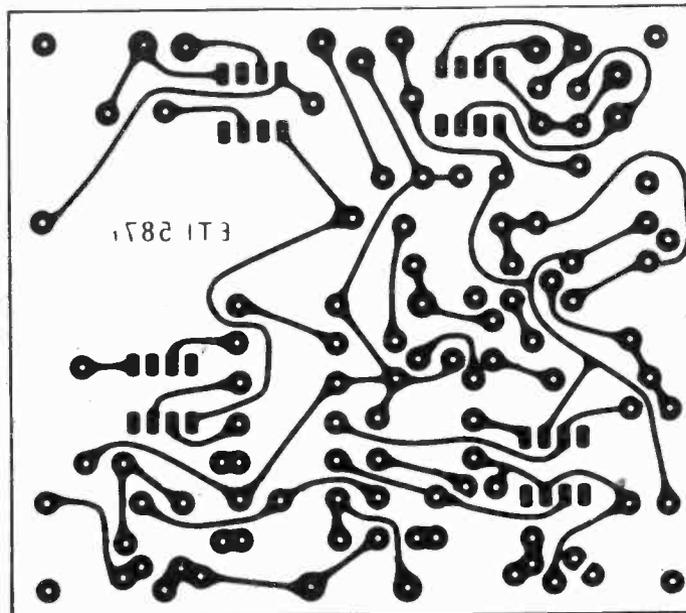


Fig. 3. Underside foil pattern.

light switched on 20m away — or a car 100 or more metres distant, but one can rarely find a sufficiently magnetic-noise-free environment in which to set up an instrument of such sensitivity. The detector described here has adjustable sensitivity and in all but the very 'quietest' of areas the sensitivity can be set so that the noise just fails to trigger it. It is only in very rare and remote locations that the detector itself is the limiting factor.

Construction

The unit has been designed in such a way that either or both detecting circuits may be used, or indeed, duplicated if required. Circuit

construction is relatively straightforward, especially if the printed circuit board is used. The solenoid is the actuating coil from a Post Office type 3000 relay (5k). Many people will have such a device in their junk boxes — otherwise it can be obtained from shops handling post office surplus bits and pieces. The solenoid is located external to the unit and connected to it by a screened cable.

The block holding the LED and phototransistor associated with the compass mechanism is a little tricky to make. It may be built up from pieces of wood or plastic — or if you have the facilities it may be milled out of a block of brass or other non-magnetic material. The main requirements are that the LED and

phototransistor must be very rigidly located and that the compass needle should just — but only just — block the light from the LED. The simplest way to make this section is to rebuild an old compass. We suggest that you build the unit in sections checking out each section as it is completed.

No matter how you build the device it is absolutely essential to make sure that the compass assembly is mounted very rigidly — if there is any freedom of movement random mechanical disturbances will be registered as alarms.

Setting Up

The compass circuitry is quite straightforward. Provided it has been made correctly the phototransistor

PARTS LIST

RESISTORS (all ¼ W 5%)

R1-R4	15k
R5	3k3
R6	22R
R7	680k
R8, 9	2M2
R10-R13	100k
R14, R15	1M5
R16	1M
R17, 18	1k
R19	2k2
R20	4k7

POTENTIOMETERS

RV1 10k	Trimpot
RV2 100k	Trimpot

CAPACITORS

C1-C3	150n	polyester
C4-C6	100u	3V6 Tantalum
C7	100p	polyester
C8, 9	47u	6V3 Tantalum
C10	220u	10V Electrolytic
C11	640u	16V Electrolytic

SEMICONDUCTORS

IC1, 2	LM4250CN Op-Amp
IC3, 4	LM3909 Flasher
Q1, 4	BC108
Q2, 3	BC178
Q4, Q5	BPX25
D1	OA95, or similar germanium diode
LED 1, 2	Red LED with mounting clip

MISCELLANEOUS

L1	Solenoid (eg PO 3000 relay coil)
S1	3p 3w switch
Compass	(40mm max. needle length)
Connectors	
PCB	as pattern
Knob, Case, Batteries and holder, cable.	

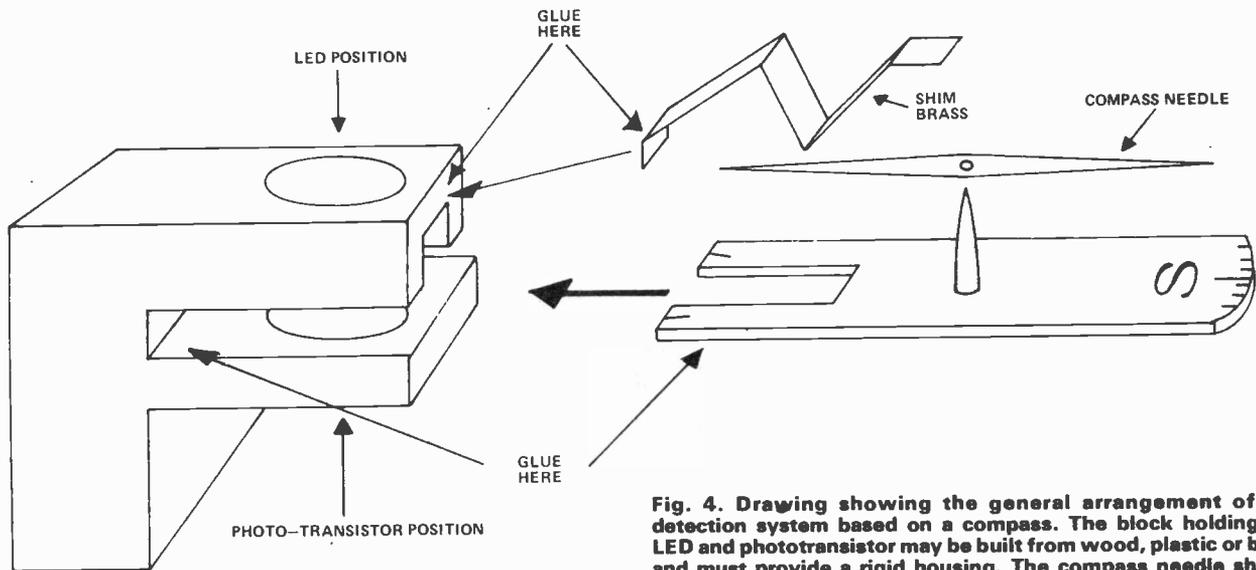


Fig. 4. Drawing showing the general arrangement of the detection system based on a compass. The block holding the LED and phototransistor may be built from wood, plastic or brass and must provide a rigid housing. The compass needle should just block the light from the LED in the quiescent state.

should be blocked by the compass needle when the complete detector assembly has been aligned precisely along the magnetic north/south line. Bringing a magnet or iron bar near the assembly should cause the needle to move slightly, thus allowing light to pass from the LED to the phototransistor, triggering Q3 and Q4, actuating the alarm.

The solenoid circuit is slightly more complex in that the twin-T rejection filter must be adjusted to optimise 50 Hz rejection. This may be done by observing the output from IC2 on a 'scope while adjusting RV1 for maximum rejection. If a 'scope is not available, then RV1 must be adjusted so that the circuit is not triggered by 50 Hz — increasing circuit gain via RV2 until the optimum setting is obtained. There is no need to inject 50 Hz into the circuit whilst setting up — in most

places there's more around than you'll need.

Once the initial adjustments are made there will be little need to change anything except the sensitivity (gain) control RV2. This should be adjusted so that the unit is just short of triggering under normal conditions. Local thunderstorms may occasionally trigger the unit but this

is inevitable unless you use the unit on low sensitivities. Well, there it is — the device will detect magnetic anomalies. Whether it will consistently detect UFO's is another matter — we were unable to obtain a DIN standard UFO for calibration purposes. Until we do, we refrain from making any claims as to the efficacy of this device.

ETI

BUYLINES

The electronic parts should not be too difficult to obtain, indeed a number of our advertisers now offer complete kits of parts for our projects.

If you incorporate the compass based detection system, the pieces for this may prove more illusive, but a raid through your junk box or a surplus component store should produce the goods.

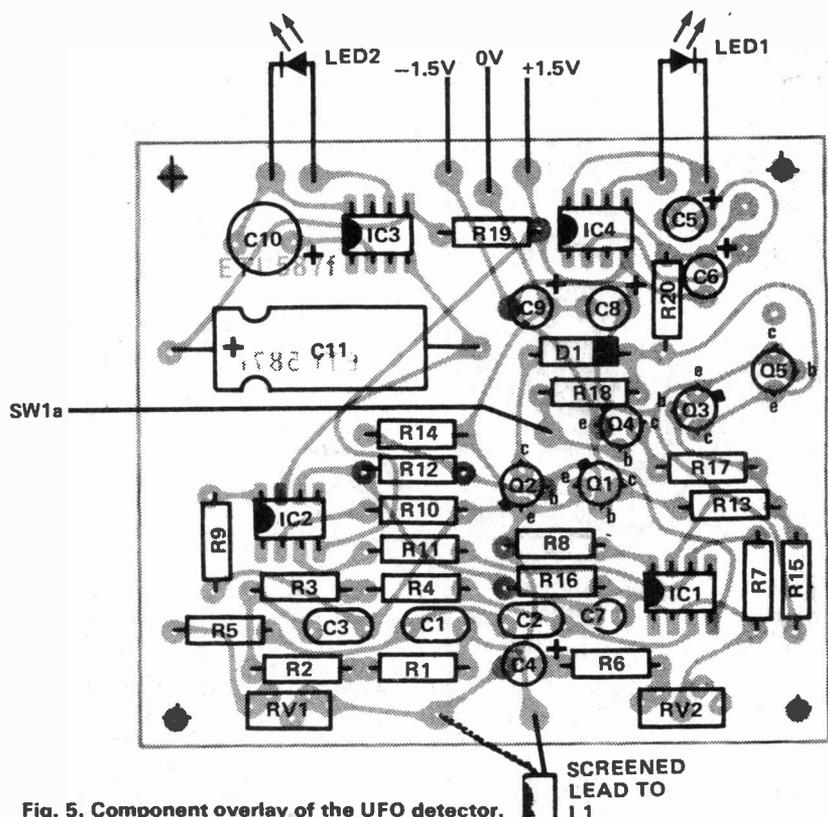


Fig. 5. Component overlay of the UFO detector.

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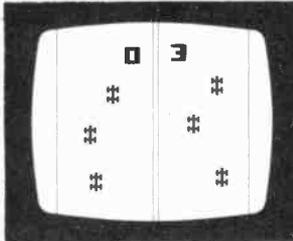
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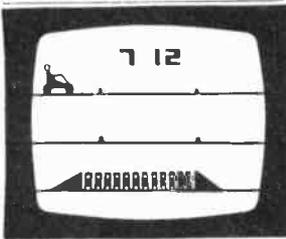


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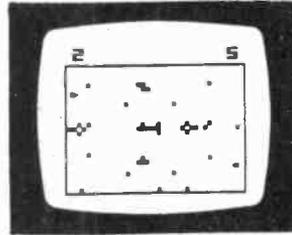


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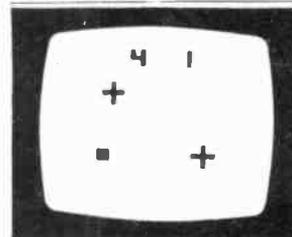


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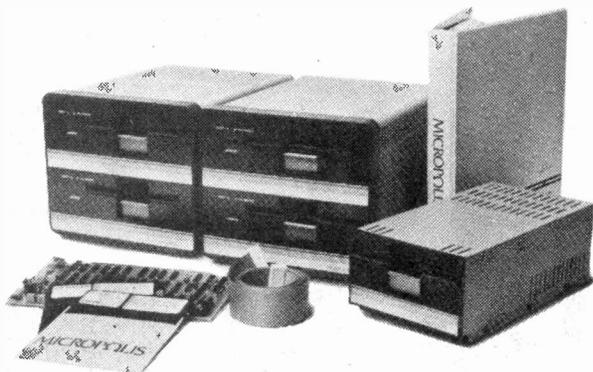
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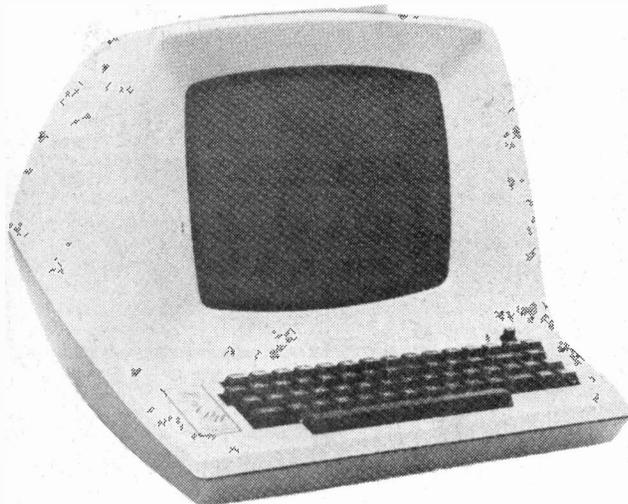
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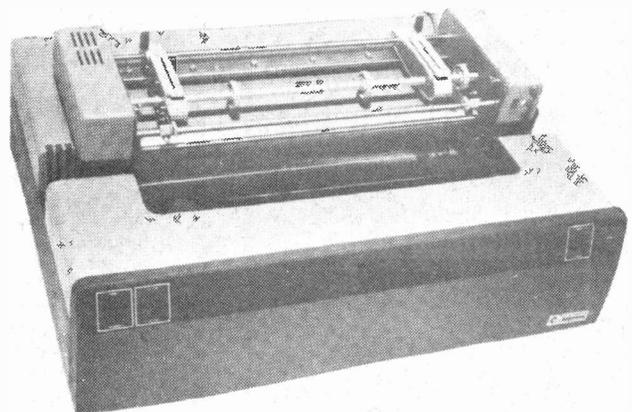
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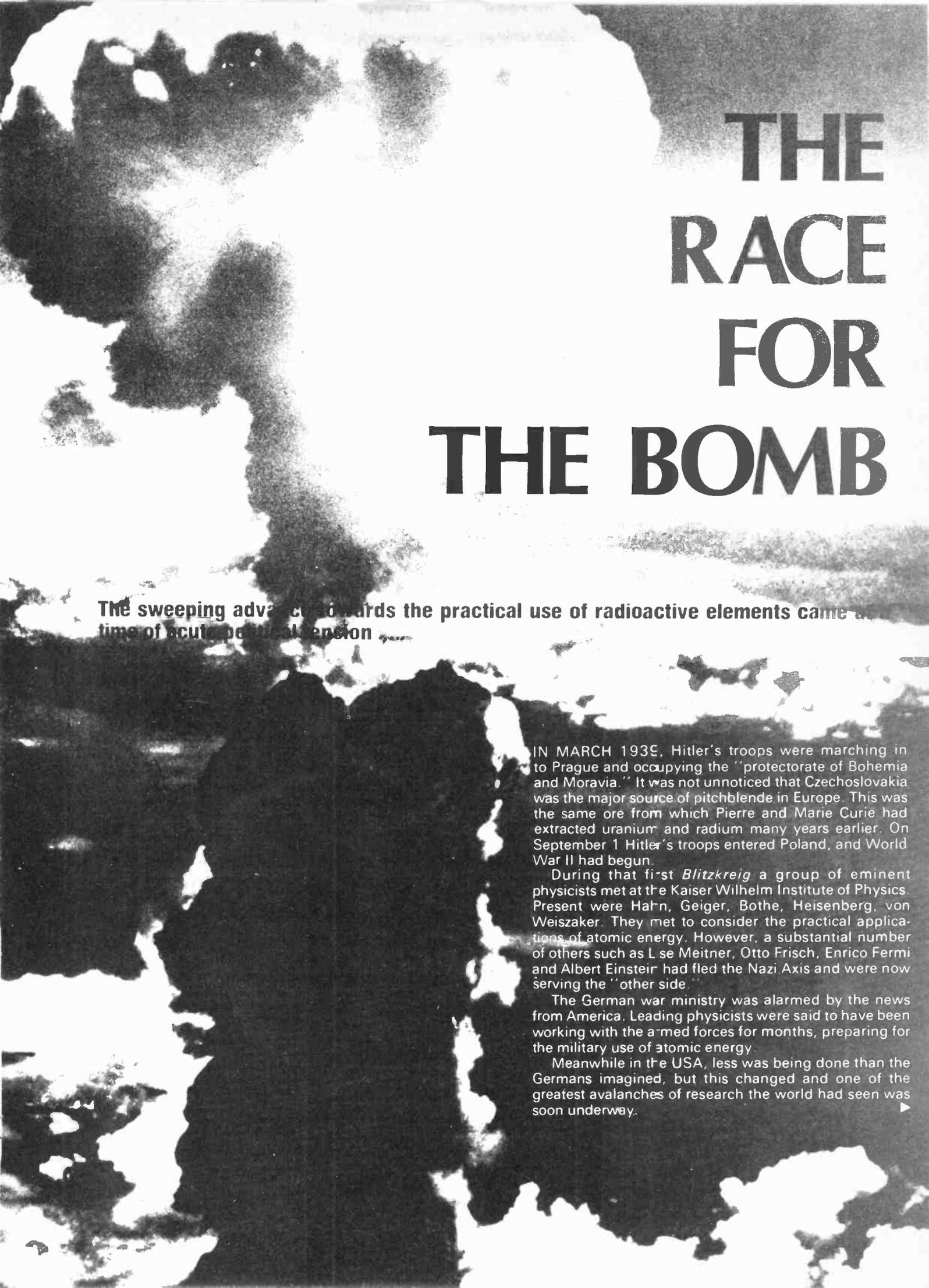
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THE RACE FOR THE BOMB

The sweeping advance towards the practical use of radioactive elements came at a time of acute political tension.

IN MARCH 1939, Hitler's troops were marching in to Prague and occupying the "protectorate of Bohemia and Moravia." It was not unnoticed that Czechoslovakia was the major source of pitchblende in Europe. This was the same ore from which Pierre and Marie Curie had extracted uranium and radium many years earlier. On September 1 Hitler's troops entered Poland, and World War II had begun.

During that first *Blitzkrieg* a group of eminent physicists met at the Kaiser Wilhelm Institute of Physics. Present were Hahn, Geiger, Bothe, Heisenberg, von Weizsacker. They met to consider the practical applications of atomic energy. However, a substantial number of others such as Lise Meitner, Otto Frisch, Enrico Fermi and Albert Einstein had fled the Nazi Axis and were now serving the "other side."

The German war ministry was alarmed by the news from America. Leading physicists were said to have been working with the armed forces for months, preparing for the military use of atomic energy.

Meanwhile in the USA, less was being done than the Germans imagined, but this changed and one of the greatest avalanches of research the world had seen was soon underway. ▶

When Niels Bohr had reported the news from Europe, Enrico Fermi, by then a professor of Columbia University, began lobbying for increased nuclear research, and an attack on the problems of developing the atomic bomb. His campaign against the fatal dangers of delay was unheeded till he gained the support of Albert Einstein.

Relatively supported

In July, Bohr and Einstein eventually reached the President, warning that war was imminent (the USA was still then a non-combatant) and that *"the Nazis will construct an atom bomb and will not hesitate to use it."* Bohr and Einstein thus became the driving forces in atomic research. President Roosevelt realised what was at stake, and he appointed an advisory commission of physicists and forces representatives. Their momentous decision was to make an atomic bomb. The first grant in 1940 was a mere \$6,000 but by November a further \$40,000 had been advanced, the sums increased like a landslide until by 1945 the sum of two billion dollars had been spent. Adjusted to present-day values this represents about ten billion dollars.

The problem facing both the Germans and the Americans was the same, natural uranium will not make a bomb. The isotope uranium-235 undergoes nuclear fission, while the major isotope, uranium-238, is a hindrance.

Uranium-235 is only 0.7% of natural uranium, and it must be separated out and concentrated. This is extremely difficult, and expensive, since it must be done, using physical means, as the two isotopes have identical chemical properties. However, it is a direct method of making a bomb. When sufficient pure uranium-235 has been separated out, a bomb can be made. Two sub-critical masses of uranium-235 are brought together extremely rapidly, and an uncontrolled chain-reaction results in explosion.

No detonator was required, as once a "critical mass" is reached, the material goes off spontaneously, to release the energy equivalent of 20,000 tonnes of TNT.

Meanwhile back at the fiord

Meanwhile the Germans had occupied Norway, thus ensuring themselves a supply of heavy water from the Norsk hydro-plant at Rjukan in the mountains, where hydro-electric power was plentiful and cheap. With the ready supply of pitchblende from Czechoslovakia and heavy water from Norway everything was in favour of German success in constructing a nuclear reactor.

While German scientists did have some success in building a reactor, which could have led to development of nuclear weapons, they appeared to *avoid* the acquisition of the technology to do this.

On June 6, 1942, a group of scientists met in the great hall of Harnack House in Berlin, also present were the men behind the German war machine, including their chief, Albert Speer.

They reported some progress towards harnessing nuclear energy in an atomic pile, but did not give a positive report on the possibilities of developing nuclear weapons as initial efforts to separate out uranium-235 had failed, and it would take an enormous expenditure to find a way to do it. In addition, they did not have any

expertise in particle accelerators, and were therefore not able to research many of the fundamental processes of nuclear physics.

Since the economy was already hard-pressed by the war, the decision was taken to scrap ideas of producing an atomic bomb.

United we explode

On the other side of the Atlantic, the American research project developed quickly. At the commencement of the war some twelve particle accelerators of varying power were either in operation or in various stages of construction. These were the experimental tools that enabled the scientists to understand the mechanisms of transmutations and nuclear reactions. Using such as the Berkeley cyclotron, American scientists MacMillan and Seaborg bombarded ordinary uranium with high energy deuterons and succeeded in producing new elements. Among these were minute quantities of neptunium and plutonium.

The discovery of plutonium-239 in 1941 added a new dimension. Like uranium-235 it is fissile. That is, it will undergo nuclear fission, can take part in a chain reaction, and if purified can be used in an atomic bomb instead of uranium.

Of particular importance is the fact that it is produced in significant amounts in a nuclear reactor, or atomic pile, using natural uranium (often enriched in uranium-235). The plutonium then can be separated from the uranium fuel using chemical methods, since plutonium has different chemical properties from uranium. (This separation is much easier than concentrating uranium-235 out of natural uranium.)

There were then three ways of releasing atomic energy. The direct way is to separate uranium-235 from natural uranium, and use it in a bomb. Second, natural uranium, possibly enriched in fissile materials, is used in an atomic pile in controlled energy release, and simultaneous production of plutonium. Third, the plutonium from the reactor fuel can be separated and used in a bomb. The Americans pushed ahead with all three aspects. They were co-ordinated under the name "Manhattan Project."

The direct method needed uranium-235. Ernest Lawrence, inventor of the cyclotron, had an idea. In a mass spectrograph, charged atoms (ions) were separated according to their mass. This was done by sending them through a magnetic field. The atoms were deflected variably according to their weight by the field.

Lawrence of Berkeley

Lawrence had at his disposal the then most powerful magnetic fields on earth, generated by the 940mm electromagnet of the Berkeley cyclotron.

His research group converted the cyclotron using the giant magnet as the basic component into a kind of gargantuan mass spectrograph. They called the new apparatus the "calutron" (California University Cyclotron).

By the end of 1941 this machine was capable of separating one microgram of U235 per hour. Whilst this was nowhere near the many kilograms that were required it was not a futile enterprise. It provided the basis

FEATURE: Race for the Bomb

of future technology for separating uranium-235 on a larger scale.

The indirect method, of manufacturing a bomb with plutonium produced in an atomic pile, also had enormous problems. There was then no operating pile, and a chemical plant had to be built to separate the fissile material from the uranium fuel by the time the atomic piles were ready to deliver it.

To make a chemical plant, the chemistry of plutonium would have to be known. At this time it had not yet been produced in observable quantities. A measurable quantity was needed urgently.

Accelerating matters

Every available accelerator was brought into service and hundreds of kilograms of uranium were bombarded with neutrons for months until about a milligram of plutonium was made and separated. On this tiny amount, chemists used ultra-micro techniques to study its chemistry and design a method for separating it from uranium. By the time the atomic reactors were able to deliver large quantities of uranium fuel containing plutonium, a huge chemical plant was ready to extract it.

Meanwhile, Fermi and Allison had continued their constructions of experimental piles in Chicago. On the ninth attempt a multiplication factor of 1.0007 was achieved, signifying a self-sustaining chain reaction.

Fermi now concentrated on manufacturing a pile in which a chain reaction could be sustained and control-

led. To prevent the system going out of control, a series of cadmium rods were inserted into the graphite/uranium pellet structure. The purpose of the rods was to absorb as many neutrons as possible, thus inhibiting their action when necessary. A sustained reaction was achieved in December 1942. Power was kept to a mere half watt whilst measurements were taken. This was increased to 200 watts ten days later. Outputs of one megawatt were being produced two years later.

The bomb could be made.

Development of the bomb was placed at Los Alamos some 50 km from Santa Fe, the state capital of New Mexico. To this place came physicists from all over the United States and other Allied countries, assembled by the eminent physicist Robert Oppenheimer.

Put to use

The first atomic bomb was exploded from a tower at Alamogordo in the New Mexican desert at 5.30am on July 16, 1945, at the height of a thunderstorm, and its successful result presented US President Truman with a very difficult decision, whether to defeat Japan by orthodox means — with estimated Allied casualties of 300,000 or whether to use the atomic bomb against Japan's civilian population and by such overwhelming evidence of power force Japan to surrender.

Three weeks after the first test, the city of Hiroshima was destroyed with a uranium-235 atomic bomb. **ETI**

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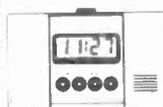
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HY5 Preamplifier

The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.), are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits, merely require connecting to external potentiometers (not included). The HY5 is compatible with all I.L.P. power amplifiers and power supplies. To ease construction and mounting a P.C. connector is supplied with each pre-amplifier.

FEATURES: Complete pre-amplifier in single pack — Multi-function equalization — Low noise — Low distortion — High overload — two simply combined for stereo.

APPLICATIONS: Hi-Fi — Mixers — Disco — Guitar and Organ — Public address.

SPECIFICATIONS:

INPUTS: Magnetic Pick-up 3mV, Ceramic Pick-up 30mV, Tuner: 100mV, Microphone: 10mV, Auxiliary 3-100mV, input impedance 47k Ω at 1kHz.

OUTPUTS: Tape 100mV, Main output 500mV R.M.S.

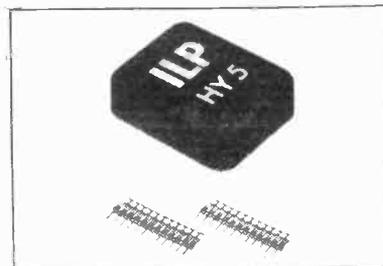
ACTIVE TONE CONTROLS: Treble \pm 12dB at 10kHz, Bass \pm at 100Hz.

DISTORTION: 0.1% at 1kHz, Signal/Noise Ratio 68dB.

OVERLOAD: 38dB on Magnetic Pick-up, SUPPLY VOLTAGE \pm 16.50V

Price **£5.22 + 65p VAT P&P free.**

HY5 mounting board B1 48p + 6p VAT P&P free.



HY30 15 Watts into 8 Ω

The HY30 is an exciting New kit from I.L.P., it features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier is ideally suited to the beginner in audio who wishes to use the most up-to-date technology available.

FEATURES: Complete kit — Low Distortion — Short, Open and Thermal Protection — Easy to Build

APPLICATIONS: Updating audio equipment — Guitar practice amplifier — Test amplifier — Audio oscillator.

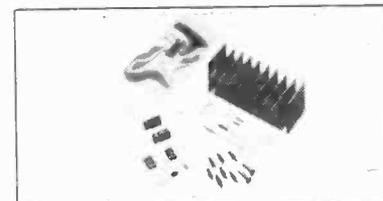
SPECIFICATIONS:

OUTPUT POWER 15W R.M.S. into 8 Ω DISTORTION 0.1% at 15W.

INPUT SENSITIVITY 500mV FREQUENCY RESPONSE 10Hz-16kHz — 3dB.

SUPPLY VOLTAGE \pm 18V.

Price **£5.22 + 65p VAT P&P free.**



HY50 25 Watts into 8 Ω

The HY50 leads I.L.P.'s total integration approach to power amplifier design. The amplifier features an integral heatsink together with the simplicity of no external components. During the past three years the amplifier has been refined to the extent that it must be one of the most reliable and robust High Fidelity modules in the World.

FEATURES: Low Distortion — Integral Heatsink — Only five connections — 7 Amp output transistors — No external components.

APPLICATIONS: Medium Power Hi-Fi systems — Low power disco — Guitar amplifier.

SPECIFICATIONS: INPUT SENSITIVITY 500mV

OUTPUT POWER 25W RMS in 8 Ω LOAD IMPEDANCE 4-16 Ω DISTORTION 0.04% at 25W at 1kHz.

SIGNAL/NOISE RATIO 75dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB

SUPPLY VOLTAGE \pm 25V. SIZE 105.50 x 25mm.

Price **£6.82 + 85p VAT P&P free.**



HY120 60 Watts into 8 Ω

The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection, this amplifier sets a new standard in modular design.

FEATURES: Very low distortion — Integral Heatsink — Load line protection — Thermal protection — Five connections — No external components.

APPLICATIONS: Hi-Fi — High quality disco — Public address — Monitor amplifier — Guitar and organ.

SPECIFICATIONS:

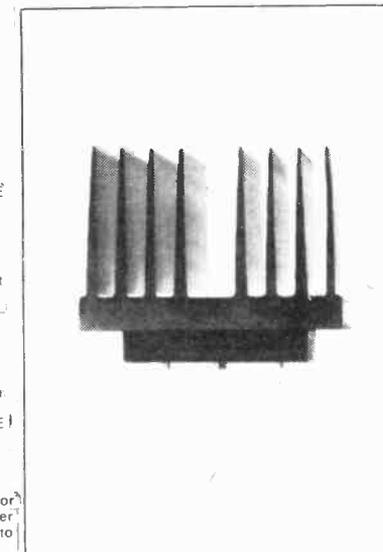
INPUT SENSITIVITY 500mV

OUTPUT POWER 60W RMS into 8 Ω LOAD IMPEDANCE 4-16 Ω DISTORTION 0.04% at 60W at 1kHz.

SIGNAL/NOISE RATIO 90dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB. SUPPLY VOLTAGE \pm 35V.

Size: 114 x 50 x 85mm.

Price **£15.84 + £1.27 VAT P&P free.**



HY200 120 Watts into 8 Ω

The HY200, now improved to give an output of 120 Watts, has been designed to stand the most rugged conditions, such as disco or group while still retaining true Hi-Fi performance.

FEATURES: Thermal shutdown — Very low distortion — Load line protection — Integral Heatsink — No external components.

APPLICATIONS: Hi-Fi — Disco — Monitor — Power Slave — Industrial — Public address.

SPECIFICATIONS:

INPUT SENSITIVITY 500mV

OUTPUT POWER 120W RMS into 8 Ω LOAD IMPEDANCE 4-16 Ω DISTORTION 0.05% at 100W at 1kHz.

SIGNAL/NOISE RATIO 96dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB. SUPPLY VOLTAGE \pm 45V.

SIZE 114 x 100 x 85mm.

Price **£23.34 + £1.07 VAT P&P free.**

HY400 240 Watts into 4 Ω

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4 Ω ! It has been designed for high power disco or public address applications. If the amplifier is to be used at continuous high power levels a cooling fan is recommended. The amplifier includes all the qualities of the rest of the family to lead the market as a true high power hi-fidelity power module.

FEATURES: Thermal shutdown — Very low distortion — Load line protection — No external components.

APPLICATIONS: Public address — Disco — Power slave — Industrial.

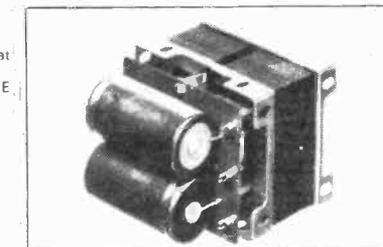
SPECIFICATIONS:

OUTPUT POWER 240W RMS into 4 Ω LOAD IMPEDANCE 4-16 Ω DISTORTION 0.1% at 240W at 1kHz.

SIGNAL/NOISE RATIO 94dB FREQUENCY RESPONSE 10Hz-45kHz — 3dB SUPPLY VOLTAGE \pm 45V.

INPUT SENSITIVITY 500mV SIZE 114 x 100 x 85mm.

Price **£32.17 + £2.57 VAT P&P free.**



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seminar report

Judging from the reactions of the 700 delegates an informative and enjoyable time was had by all, Jim Perry reports on 'Petting for Beginners' the ETI-Commodore seminar.

THE TWO SEMINARS took place at the Cafe Royal in London, the setting was in the plush splendour of the Empire Napoleon Suite — a veritable hall of mirrors and gilt fittings. Halvor Moorshead* introduced and chaired the proceedings each day, using his impressive wit and charm to link the speakers (how about that rise now Halvor?).

The first talk was given by ETIs answer to Vera Lynn, the one and only, Gary Evans. He entranced the audience with his background to Home Computing, outlining the development of MPUs from fledgling TTL to present LSI. Gary was followed by Chris Corbett from the University of Essex (Dept. of Electrical Engineering Science) who gave an introduction to the Kim 1 evaluation kit, with an explanation of its architecture and capabilities.

Derek Rowe from Commodore was the third speaker with 'PET — What it can do'. As Derek probably knows more about PET than anyone else in Europe, he was able to describe its structure and applications very well indeed. After question time and lunch Jim Perry gave some sample program runs in his talk on Computer Games, making use of the video projection equipment supplied by Canard Productions (UK) Ltd. John Miller-Kirkpatrick followed with his talk on peripherals, basing applications on the Bywood SCRUMPI system.

The draw for a KIM 1 and a PET was run on ETI's PET with a lady (yes folks some were present) winning the KIM 1 on the Friday. All through the day 5 PETs, 3 KIMs, 4 SCRUMPIs plus the ETI and Marshalls stands were available for delegates to practise with and get hands on experience.

* ETI — Editor

Thanks to Paul Edwards for taking the photos and all the rest who worked behind the scenes.



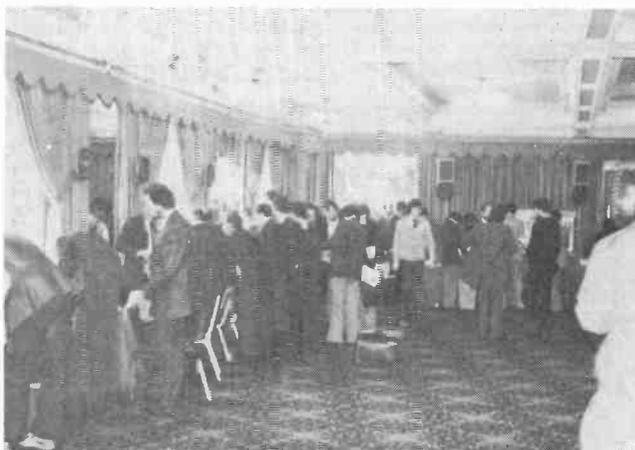
Above are Fridays winners being congratulated by Kit Spencer from Commodore and Halvor Moorshead from ETI. On the left with Kit is the lucky lady who won a KIM 1, Miss M. Odlin and on the right the PET winner Mr B. Hurrige with Halvor. Saturdays winners are below with Mr J. D. Smith on the left (smiling about his new PET) and the KIM 1 winner Mr S. Gardner on the right.



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John Miller-Kirkpatrick on the Bywood stand explaining the delights of SCRUMPI to a delegate (JMK's the one with the T-shirt).



No, people aren't trying to jump out the window, all the computers are on tables round the walls.



Bren, Margaret and William serving at the ETI stand. (William's the one with the tie on.)



Chris Corbitt (standing on left with his back to camera) answering questions during a coffee break.



From left to right: article-writer Mike Hughes, Nigel Stride from Marshalls and Gary Evans snatching a quick cuppa in an interval.



Jim Perry (front right) and Mark Strathern (left) trying to get their programs debugged at the last minute.



Derek Rowe snapped in mid-speech.

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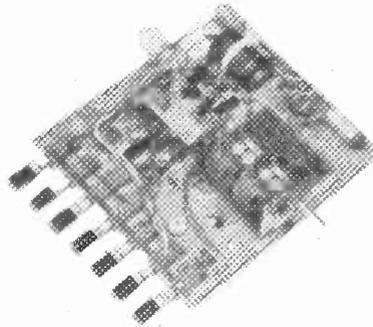
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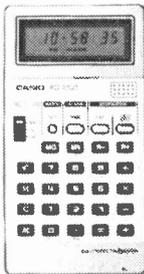
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electronics tomorrow.....

by John Miller-Kirkpatrick

I AM IN THE ENVIOUS position of knowing someone who knows someone who knows a director of a company which is going to have a viewdata terminal (notice the lower case v as the Post Office now want us to call their viewdata service 'PRESTEL'). As an example of the average electronic engineer who is interested in viewdata and Teletext I am somewhat overjoyed to be in this position as there is now a very slight chance that one day I might be able to talk to someone who has used viewdata and thus knows something about it. I avidly read every scrap of information which is published on viewdata and at present I think I could sum up this as follows. Viewdata has the following characteristics —

1. Output is to a 40 x 24 VDU based on a commercial television set using the Teletext display format, control characters and graphics capabilities.
2. User input is designed to operate from a simple keyboard and thus all user entries are to be in the form of a choice number to a set of options displayed on the screen.
3. Communication is to be via Post Office telephone links using a PO approved MODEM (rentable from the PO at ridiculous rates).
4. Communication is to a large computer installation which is hidden away in a remote part of the country on an exchange which is a local charge call to only a very small number of people — many of whom will have not yet heard of viewdata.
5. Use of the service is for information exchange in a format which is presumably similar in format to a magazine with articles, information and advertisers all available at the push (or a dozen or so pushes) of a button.

I think that accurately summarises my knowledge of viewdata and I would think that it is possibly more than a lot of electronic engineers know—let alone the majority of the public. Let us look at the potential of a system such as a good telephone network and a few microprocessors can provide.

MPUs Make Connection

Automatic dialling is very simple to achieve for even a complete beginner. Dialling a number is achieved by picking up the receiver and then using the dial to activate a circuit breaker a preset number of times by twisting the dial to a required position and then releasing it. These two actions are handled by simple contact switches

which in a simple example could be replaced by relays and could thus be driven by electronic counters or microprocessors. A simple SC/MP circuit such as SCRUMPI 2 or the MK14 could handle automatic dialling of about 200 subscriber numbers with only 768 bytes of RAM and could also be persuaded to decode the tones for ringing, engaged, unavailable or the more usual '?????' lack of tone altogether and thus redial or take other appropriate action. Total cost of building your own device would be about £80, in commercial quantities the device could cost under £10.

With an automatic dialler we could program our viewdata terminal to search several viewdata libraries on different telephone numbers to find the first available service. At this stage we will also let our microprocessor handle the required keyboard entries, for example, assume you know that the latest information on the price of bananas at the supermarket is available by dialling each of your local supermarket's viewdata systems and then answering 6 questions in the following form:

FREDS CORNER DELI

DO YOU REQUIRE?—

PRICES	1
AVAILABILITY	2
DELIVERY	3
PERSONAL SERVICE	9
REPLY? 1	

FRED'S CORNER DELI

PRICES OF?

GROCERIES	1
VEGETABLES	2
FRUITS	3
MEATS	4
BAKERIES	5
REPLY? 3	

FRED'S CORNER DELI

FRUIT PRICES?

PER KILO	1
PER BUNCH	2
PER BAG	3
PER BOX	4
PER JAR/BOTTLE	5
REPLY? 2	

FRED'S CORNER DELI

FRUITS

APPLES	1
APRICOTS	2
BANANAS	3
BREADFRUIT	4
MORE	5
REPLY? 3	

FRED'S CORNER DELI

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BUNCHES OF
BANANAS:

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THANK YOU FOR YOUR
ENQUIRY, WOULD YOU
LIKE TO ORDER?

YES 1
NO 2

Thus by dialling the local supermarket or delicatessen and then **always** entering the keyboard entries for 1, 3, 2, 3 and you will be presented with the required price on line 4 of the display (ie immediately after the third carriage return/line feed). So now we have a unit with a commercial price of about £25 which can order groceries on the basis of price/availability/delivery.

We have assumed that the unit can read the data on the screen which is no great technical feat but does not seem to be included as a viewdata feature. Can the output be other than a Teletext compatible unit (printer, RAM, Floppy) or is viewdata limited to the 40 x 24 VDU format?

We have also assumed that "Fred's Corner Deli" has its own viewdata computer which appears to be a feature of viewdata but also appears to require large and expensive equipment. Surely any MPU system capable of handling Fred's bought and sales, invoicing, stock control and ordering (about £5,000 worth) would also be capable of communicating with something as simple as a viewdata terminal. In fact, why can't your home computer system control viewdata enquiries in and out? Let your computer answer your phone after four or five rings and test for a viewdata or vocal caller (a viewdata caller would be recognisable with a tone). The computer can then either take a taped message for a vocal caller or start interrogating a viewdata caller and give out appropriate messages to friends (who know your password codes) or strangers. There is thus even the facility for Fred's Corner Deli to call your computer and leave a viewdata format message as your invoice, statement or this week's special offers.

All the above is a perfectly feasible proposition with today's technology, the amateur constructor could build a viewdata computer for under £500. Note that the word used is 'could', because you are in theory not allowed to—BY LAW. It is illegal to 'Permanently' connect unauthorised equipment to the Post Office Telephone or Telecommunications circuits, it is also illegal to 'steal' electricity by making unauthorised or unrecorded use of Post Office electricity. It would also be very difficult to build a viewdata computer because of the lack of specifications published. There are ways round the problem of interfacing 'Permanently' to the telephone line, one is the use of a PO MODEM at about £300 per year rental (plus installation), another is well the magazine would not be allowed to publish circuits but ask yourself whether the plug and socket system offered by the PO (Plan 4A?) means that the telephone unit is "Permanently" connected or not?

I don't like to get politics into a column such as this but how can our internal telecommunications industry and services grow to fruition if the cost and complexity of installation of a system such as viewdata is left in the hands of a monopoly protected by the law of the land?

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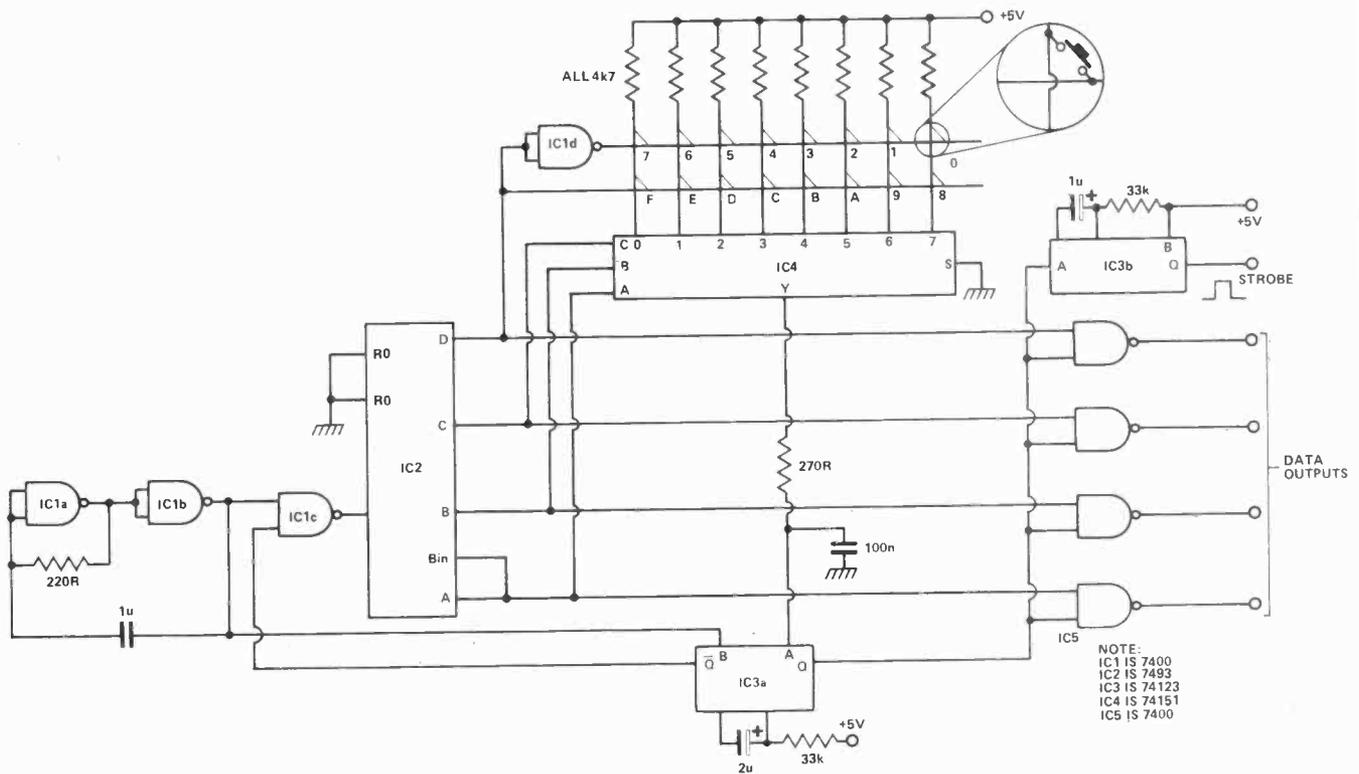
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tech tips



Hexadecimal Keyboard

C. N. Harrison

Programming a microprocessor can be a time consuming business if instructions are entered in binary using rows of toggle switches. A far more convenient method is to enter the code in hexadecimal notation using an appropriate keyboard. A suitable keyboard should be fully debounced, provide a strobe whenever a key is struck and use standard power supplies. The following circuit provides all these features.

The eight by two matrix of keys are scanned sequentially by the 74151 data selector, IC3 and the D output of the 7493 four bit counter, IC2. If no keys are pressed the Y output of IC3 is always logic 1 since all eight inputs are pulled high by the 4k7 resistors. When a key is pressed the Y output remains high until the counter reaches the inverse of the required 4 bit data. The appropriate input of IC3 is then pulled low and the Y output changes to logic 0. This triggers monostable IC4a which disables the

clock input to the counter, enables the data outputs via IC5 and triggers IC4b to provide a data strobe. While the key is closed IC4a is retriggered by the clock so that the data remains stable on the output lines until the key is released.

If latched data outputs are required IC5 can be replaced by a 7475 quad latch clocked from the output of IC4b. The data would be available at the Q outputs of the latch.

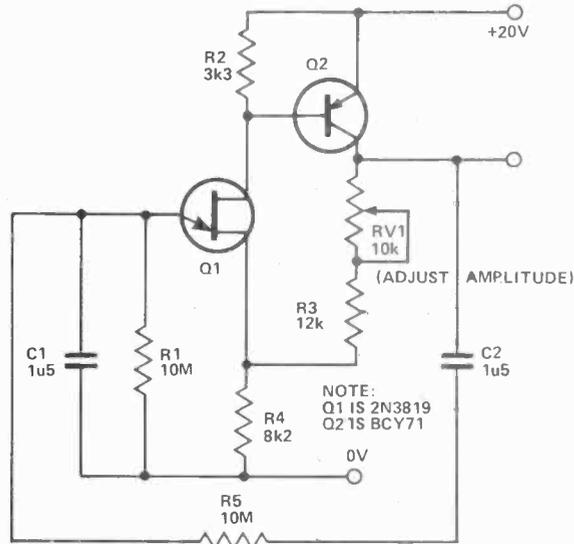
Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items.

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.

VLF Sine Generator

G. Loveday

Generating very low frequency sine waves (i.e. less than 0.1 Hz) presents several problems. Timing capacitors usually have to be large value electrolytics, any amplifier used must be D.C. coupled, and the amplifier's input impedance must be very high. One standard method is to first generate low frequency square waves, and then to shape these into an approximation of a sine wave by the use of several non linear devices, such as diodes. The circuit shown in Fig. 1 is a relatively simple approach based on the familiar Wien bridge. An n-channel FET and a pnp transistor are arranged in a DC coupled circuit and the voltage gain is determined by the negative feedback R3 and R4. The gain need only be about three, thus if the bias required by the FET is 3V the output level will be approximately half the supply voltage.



Since R1 can be a high value resistor the value of the capacitor is only 1u5 for sine wave outputs of 0.01 Hz. This capacitor is available in polycarbonate. The amplitude of the output can be adjusted by RV1 to give

low harmonic distortion and to be about 10V peak to peak. As expected, with this Wien bridge circuit, frequency stability is good with changes in both supply voltage and temperature.

Balance Circuit For ETI Metal Locator

C. Bray

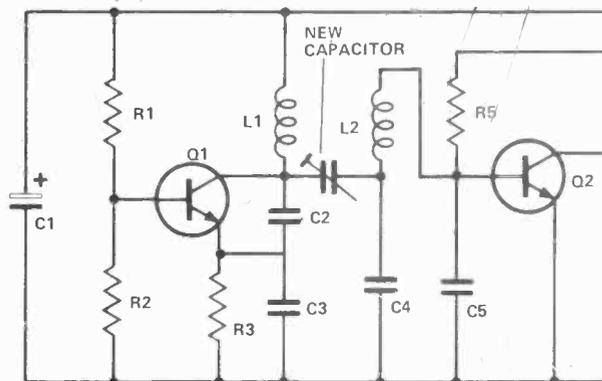
This modification is an improvement to the ETI IB metal locator Mark 2, as published in the February 1978 issue of ETI. The first two stages of the circuit showing have been redrawn showing the modifications, the additional trimmer capacitor is a Wingrove and Rogers type S60 multiturn tubular 2-25p, although any similar type giving smooth control between 1 and 8p will do. The function of the trimmer is to balance out coupling between the search head coils L1, L2.

In practice, the trimmer is set to approximately 3pf and the search head coils adjusted as in the original article.

Before a search is started, the trimmer should be adjusted for mini-

mum meter reading, with gain control RV1 set as high as possible. This should be done in free air, but if it is found that lowering the head to the ground produces a slight change, this effect can also be trimmed out.

Even if the coils are mounted very substantially, and should not move, the degree of imbalance that occurs over quite short periods of time is surprisingly high and makes the fitting of this device well worthwhile.



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T. POWELL

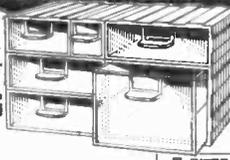
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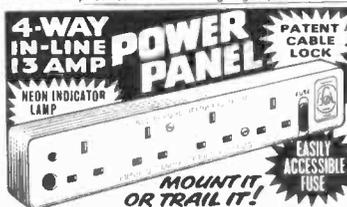
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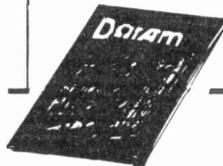
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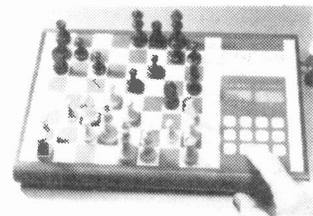
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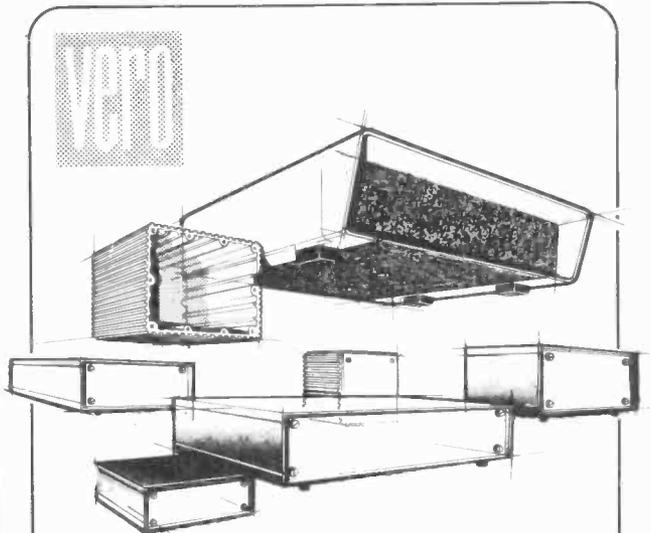
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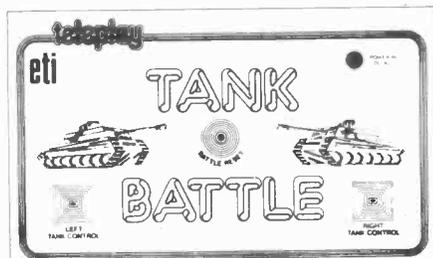
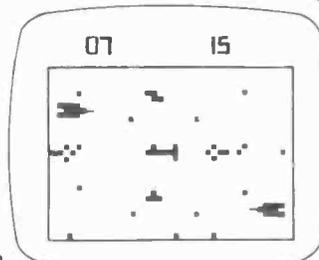
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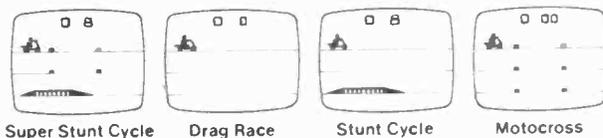
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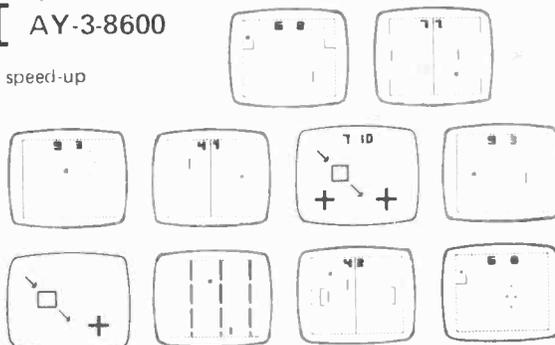
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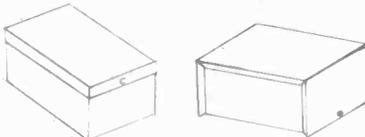
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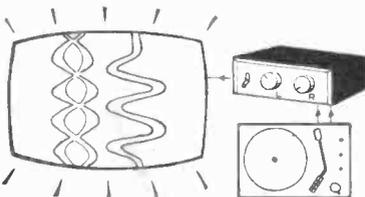
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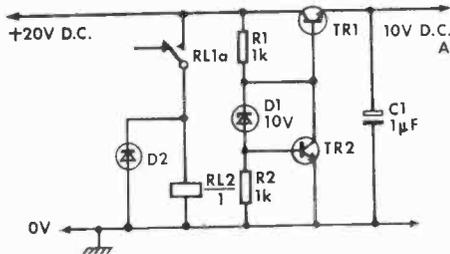
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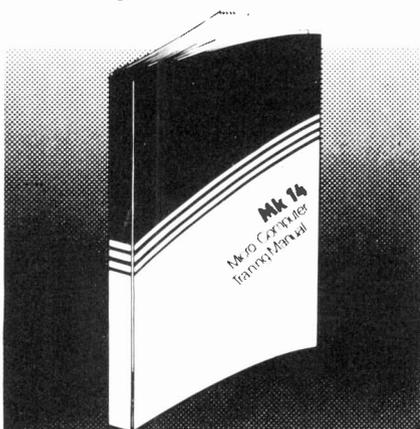
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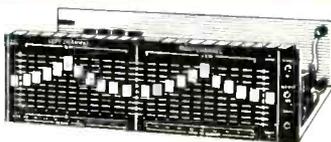
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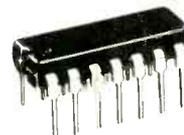
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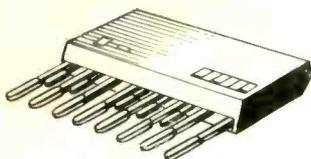
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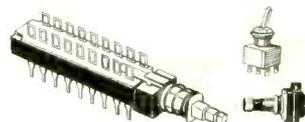
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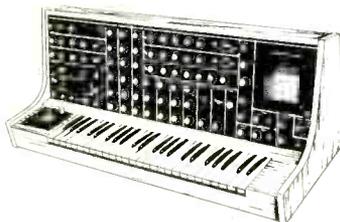
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