

# electronics today

JANUARY 1979

INTERNATIONAL

50p

Take out the scratches with our



**eti**

CLICK  
ELIMINATOR

INPUT

CLICK

CLICK

LEVEL

# CLICK ELIMINATOR

**Digital Tacho**  
**Boris in Check**  
**Power Supplies**  
**Loudspeaker Principles**

**Inside:**  
**computing**  
**today no3**

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

# TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

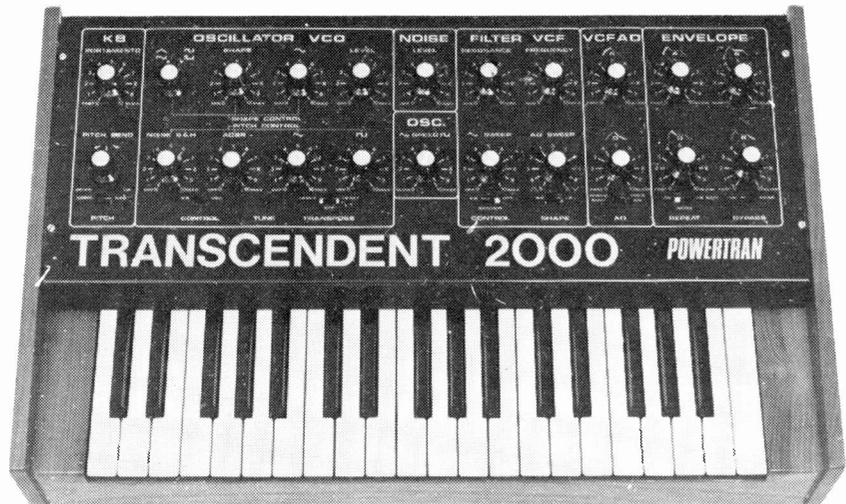
LIVE PERFORMANCE SYNTHESIZER DESIGNED BY CONSULTANT TIM ORR (FORMERLY SYNTHESIZER DESIGNER FOR EMS LIMITED) AND FEATURED AS A CONSTRUCTIONAL ARTICLE IN ELECTRONICS TODAY INTERNATIONAL.

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

The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or 1/2% metal film!) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibre glass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready built units selling for between £500 and £700!

**COMPLETE KIT  
ONLY  
£172.00 + VAT!**

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



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

## LAST MONTH'S FRONT COVER FEATURE!



**COMPLETE KIT  
ONLY  
£49.50 + VAT!**

PSI 4002 STUDIO MODEL



cabinet size 17.2" x 17.2" x 6.7"

**COMPLETE KIT ONLY £196.90 + VAT**

The kits shown on this page are also available as separate packs (e.g. P.C.B. component sets, hardware sets etc) Prices are given in our FREE CATALOGUE

## 200+ 200 watt AMPLIFIER

As featured in *Electronics Today International*

**400W rms continuous — 800W peak!**

**0.03% THD at FULL power!**

**PLUS all the following features too!**

- ★ Each channel totally independent with its own stabilised power supply driven by custom designed TOROIDAL transformers!
- ★ Inherent reliability — monster heat sinks for cool running at the hottest venues — electronic open and short circuit protection!
- ★ Ultra low feedback (an incredible low 14dB overall!), super high slewing rate (20V/μs), 200W rms continuous to 4 ohm from EACH channel, input sensitivity 0.775V (0dB).
- ★ Professional quality components, sturdy 19" rack mounting chassis complete with sleeve and feet for free standing work too.
- ★ Easy to build — plenty of working space with ready access to all components, minimal wiring, extensive instruction suitable for both experience constructors and newcomers to electronics.
- ★ Value for money — quality and performance comparable with ready-built amplifiers costing over £600!

**PRICE STABILITY:** Order with confidence irrespective of any price changes. We will honour all prices in this advertisement until February 28th, 1979, if ETI January, 1979 issue is mentioned with your order. Errors and VAT rate changes excluded.

**EXPORT ORDERS:** No VAT. Postage charged at actual cost plus 50p handling and documentation.

**U.K. ORDERS:** Subject to 12% surcharge for VAT\* (i.e. add 1/6 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

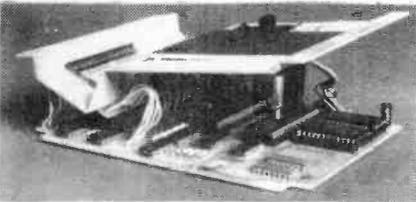
ANDOVER  
(STD 0264) 64455

# electronics today

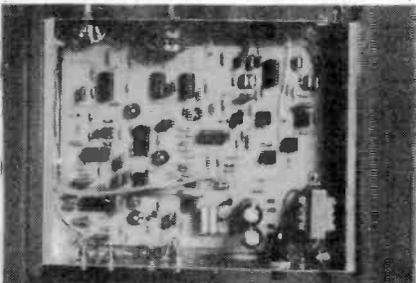
JANUARY 1979 VOL 8 NO 1 **INTERNATIONAL**



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Check it out p.81



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| DIGITAL MODULE   | <b>35</b> | Useful four digit design.           |
| DIGITAL DIAL     | <b>49</b> | Medium wave high quality.           |
| LOG CONVERTOR    | <b>62</b> | Turn your keyboard to use.          |
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## INFORMATION

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### INTERNATIONAL EDITIONS

|           |   |
|-----------|---|
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# High quality audio modules for Stereo and Mono

## \$450

**STEREO FM TUNER**  
Fitted with phase lock-loop

**£22.30**

+ 40p p&p  
+ 12½% VAT



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

|                                   |                      |
|-----------------------------------|----------------------|
| 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 |

## 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          | 18 to 30 V—re earth                |
| DIMENSIONS      | 110x50x25mm (inc DIN socket)       |

## Stereo 30

**COMPLETE AUDIO CHASSIS**

**£18.95**

+ 40p p&p  
+ 12½% VAT



7 + 7w R.M.S.

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.

|                                      |                              |
|--------------------------------------|------------------------------|
| 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         |

## PA12

**STEREO PRE-AMPLIFIER**



**£7.10**

30p p&p  
+ 12½% VAT

The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL 20/30 Audio Amplifier Modules, the PS12 power supply and the T538 Transformer. Features 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 Mz      |
| 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 OUTOUT IMPEDANCE | 25 K ohms             |
| DIMENSIONS            | 152mm x 84mm x 35mm   |

## AL60

**AUDIO AMPLIFIER MODULE**  
25 Watts RMS

**£4.55** + 25p p&p

+ 12½% VAT



25w R.M.S.

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%.

|                            |                               |
|----------------------------|-------------------------------|
| 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           |

## PS12 POWER SUPPLY MODULE

Power supply for AL20A-30A, PA12, S450 etc. Transformer T538. INPUT A.C. VOLTAGE 15-20V. OUTPUT D.C. VOLTAGE 22-30V approx. (dependent upon input). OUTPUT CURRENT 800mA maximum. DIMENSIONS 60x43x26 mm.



**£1.30**

+ 12½% VAT P&P 25p

## AL80

**AUDIO AMPLIFIER MODULE**

**£7.15\*** + 25p p&p

+ 8% VAT



35w R.M.S.

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%.

|                            |                               |
|----------------------------|-------------------------------|
| 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           |

## AL250

**POWER AMPLIFIER**

125w R.M.S.

**£17.25\*** + 40p p&p

+ 8% VAT



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

|  |                                      |
|--|--------------------------------------|
| 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%            |
| 50 WATTS into 8 ohms                   | 0.06%                                |

## AL30A

**AUDIO AMPLIFIER MODULES**

**£3.75**

+ 25p p&p

12½% VAT



10w R.M.S.

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

|                           |                       |
|---------------------------|-----------------------|
| 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    |

## SPM80

**STABILISED POWER SUPPLY**

**£4.25** + 25p p&p

+ 12½% VAT



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

|                     |                     |
|---------------------|---------------------|
| 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 |

## PA100

**STEREO PRE-AMPLIFIER**

**£15.80**

+ 40p p&p  
+ 12½% VAT



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

|                           |                                    |
|---------------------------|------------------------------------|
| FREQUENCY RESPONSE        | 20Hz to 20 kHz x 1 dB              |
| 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 |
| BASS CONTROL RANGE        | ± 15 dBs at 75 Hz                  |
| TREBLE CONTROL RANGE      | + 10—20 dBs at 15 kHz              |
| SIGNAL/NOISE RATIO        | Better than 65 dBs (All inputs)    |
| INPUT OVERLOAD            | Better than 26 dBs (All inputs)    |
| SUPPLY                    | 20 to 40 V                         |
| DIMENSIONS                | 300x90x33mm (less controls)        |

## 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 SPMB0 stabilised power supply 1x BMTB0 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 beautiful 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        | Price £3.25 + 55p p&p + 12½% VAT   |
| Order No. 2050                      |                                    |
| BMTB0 For use with AL60 SPM80       | Price £5.40 + 86p p&p + 12½% VAT   |
| Order No. 2034                      |                                    |
| BMT250 For use with AL250           | Price £6.35 + £1 10 p&p + 12½% VAT |
| Order No. 2035                      |                                    |

# BI-PAK

DEPT. ET16, P.O. Box 6, Ware, Herts

# High quality audio accessories

## AL120

**50W**  
R.M.S.

**AUDIO AMPLIFIER**  
(With integral heat sink and short-circuit protection)

**£11.95**  
+8% VAT P&P 25p



**OUTPUT POWER SUPPLY**  
LOAD IMPEDANCE  
TOTAL HARMONIC DISTORTION  
FREQUENCY RESPONSE  $\pm 1$ dB  
SENSITIVITY  
MAX HEAT SINK TEMP.  
DIMENSIONS

50 Watts R.M.S.  
70 Watts  
8-16 Ohms  
05% Max. (typically 02%)  
25Hz-20kHz  
500mV  
45 deg. C  
192x89x49mm

Introduced to fulfill the demand for a fully protected power amp. capable of driving high quality speaker systems at up to 50W, with distortion levels below 05%. Ideal for domestic use, discos, p.a. systems, electronic organs, etc. The generously rated components ensure continuous operation at high output levels.

## SPM120

STABILISED POWER SUPPLIES

SPM120/45  
SPM120/55  
SPM120/65

**£5.50**  
+12½% VAT P&P 25p

**NEW**



### A.C. INPUTS

SPM120/45  
SPM120/55  
SPM120/65

OUTPUT CURRENT  
RIPPLE

40-48V  
50-55V  
60-65V  
2.5A  
1A 100mV  
2A 150mV

SPM120 is a fixed voltage stabiliser available with an output voltage of either 45V, 55V or 65V. Designed primarily for use in audio applications, the stabiliser which provides output currents up to 2.5A, operates direct from a mains transformer requiring only the addition of 2 Electrolytic capacitors to complete the s/c protection.

## GE100 Mk. 2

10 Channel monographic equaliser

**£20**  
+12½% VAT P&P 35p

**NEW**



CONTROL RANGE  
DYNAMIC RANGE  
MAXIMUM OUTPUT  
FREQUENCY RESPONSE  
POWER SUPPLY  
VOLTAGE HANDLING INPUT  
T.H.D.

$\pm 12$ dB  
110dB  
+15dB  
30Hz-20kHz ( $\pm 1$ dB)  
15-0-15V  
3V R.M.S.  
005%

Only 155mmx65mmx50mm including the 10x10K lin slider potentiometers and knobs which are mounted on a board positioned above the circuitry. In the frequency range of 31Hz to 20kHz you can cut and boost  $\pm 12$ dB with the 10 sliders, each of which has its frequency marked on the circuit board. The GE100 has numerous uses including mixers, p.a. systems and discos. It will also greatly improve the sound reproduction of your existing audio equipment. Power supply for GE100, o/d SG30 £3.80.

## VPS30

Regulated variable stabilised power supply

**£7.60**  
+8% VAT P&P 35p



A.C. INPUT MAXIMUM  
VOLTAGE REGULATION  
REGULATED CURRENT  
Incorporating short circuit protection

25V  
2-30V  
0-2A

This NEW versatile Regulated Variable Stabilised Power Supply with short circuit protection and current limiting, is a must for all electronics enthusiasts. It incorporates adjustable voltage from 2V-30V, with a current limiting range of 0-2A. With this module there is no need to build a separate power supply for each of your projects, with the simple addition of a transformer (o/d 2033), 0-1mA (o/d 1310 or 1305), plus a suitable shunt, a voltmeter (o/d 1311 or 1306), a 470ohm pot (o/d 1896), a 4K7 pot (o/d 1899), it can be used again and again as a self-contained bench, power supply, eliminating the use of batteries and thus saving ££'s!

## PA200

STEREO PRE-AMPLIFIER

**£16.55**  
+12½% VAT P&P 40p



FREQUENCY RESPONSE  
TOTAL HARMONIC DISTORTION  
SENSITIVITY 1 TAPE  
INPUTS 2 RADIO TUNER  
3 MAGNETIC

20 Hz to 20 kHz x 1dB  
Less than 1% (typically .07%)  
100mV/100K ohms For an  
100mV/100K ohms output  
P U 3-5mV/50K

BASS CONTROL RANGE  
TREBLE CONTROL RANGE  
SIGNAL/NOISE RATIO  
INPUT OVERLOAD  
SUPPLY  
DIMENSIONS

Within  $\pm 1$ dB from 20Hz to 20kHz  
 $\pm 15$ dBs at 75kHz  
 $\pm 10-20$ dBs at 15kHz  
Better than 65dBs (all inputs)  
Better than 26dBs (all inputs)  
35 to 75V  
300x90x33mm (less controls)

The PA200 is basically our popular PA100. Modifications have been made to make it compatible with the higher output AL120 and AL250 amplifiers.

## HEADPHONES

A top quality headphone with cushioned earpads and headband. Separate balance/volume controls. Stereo or mono switch. Impedance 8ohms. Frequency 30-18,000Hz o/n 884 **£8.70** +12½% VAT P&P 70p. A brilliant compromise between price and performance. Superb stereo reproduction for the newcomer to Hi-Fi. Impedance 8ohms. Frequency 30-15,000Hz o/n 885 **£4.40** +12½% VAT P&P 50p.

## BIB

HI-FI ACCESSORIES

**Parallel Tracking GROOV KLEEN**  
The very latest in automatic record cleaning. Designed to suit all modern single play decks. Simple to fit, it is extremely efficient. Complete with two types of base and three height extensions o/n 8101 **£3.68** +8% VAT P&P 35p.

**Cassette Tape Editing Kit**  
Enables cassette tapes to be edited and joined easily, quickly and accurately. Kit comprises: Tape Splicer (3.2mm) 2 Precision Tape Cutters, Tape Piercer, 9 Self adhesive Labels, Reel of Splicing Tape, 3 Winders and removers and instructions, all in a handy wallet o/n 811 **£2.40** +8% VAT P&P 35p.

**GRDOV-STAT**  
The BIB Groov-Stat static reducer neutralises the static charge on records and other plastic surfaces o/n 8103 **£5.45** +8% VAT P&P 35p.

**Cassette Head Cleaner**  
Essential for cleaning of tape heads, capstans and rollers. Pack contains Tape Head Applicator and tape head polisher tools. Plus bottle of special formula cleaning fluid and full instructions o/n 832 **£0.56** +12½% VAT P&P 35p.

## ADAPTORS

**AC-DC** enables a large range of battery powered radios, recorders, calculators to be run off the mains (220-240V A.C.). Switchable for 6, 7.5 or 9 volts. Current rating 2,500mA. Polarity reversing switch. Universal plug incorporated. o/n 137 **£3.95** +12½% VAT P&P 35p.

**DC-DC** for use in all cars, boats, etc., with pos. or neg. earth for a regulated output of 6, 2.5 or 9 volts D.C. at 1A max. For radios, recorders, etc. o/n 138 **£2.80** +12½% VAT P&P 32p.

## CROSSOVER NETWORKS

**2-WAY** channels for high and low frequencies to correct speakers — high to tweeters, low to woofers. Complete with instructions. Frequency 3,000Hz o/d 1904 **£1.10** +12½% VAT P&P 35p.

**2-WAY** for Bohm speakers up to 30 watts. Frequency 3kHz o/n 1905 **£1.65** +12½% VAT P&P 35p.

**3-WAY** for Bohm speakers up to 3D watts. Frequency 800Hz and 4.5kHz o/n 1906 **£2.95** +12½% VAT P&P 35p.

## CASES

**TEAK 30** designed mainly for use with our stereo 30 Audio System but has proved very helpful to home constructors. Fitted with solid uncut front and back o/n 139 **£6.45** +12½% VAT P&P 70p.

**TEAK 60** for use with AL60/MK60 Audio Kit. Useful for the home constructor requiring an amplifier sleeve — has no front or back panel o/n 140 **£7.00** +12½% VAT P&P 85p.

## METERS

**Miniature Balance & Tuning Meter**  
Miniature moving-coil meter for stereo balance indicator, tuning indicator for FM or similar application. Pointer at centre indicates zero or null position. Robust construction. Sensitivity 100-0-100mA. Dimensions: 23x22x26mm. o/n 1318. **£1.95** +8% VAT P&P 35p.



**Balance and Tuning Meter**  
Clear view edgewise meter. Centre zero application. Sensitivity 100-0-100mA. Dimensions: 45x22x34mm. o/n 1319. **£2.00** +8% VAT P&P 35p.



**Miniature Level Meter**  
Moving coil, for accurate level indication for tape recorders, amplifiers, etc. Neat design, rugged construction — will withstand five times rated value. Sensitivity: FSD: 200uA, 0dB; 130uA. Dimensions: 23x22x26mm. o/n 1320. **£2.80** +8% VAT P&P 35p.



**VU Meter**  
Calibrated — 20 to +3 and 0-100%: making it suitable for use as a recording level meter or as a power output indicator. Sensitivity: 130uA. Dimensions: 40x40x29mm. o/n 1321. **£2.00** +8% VAT P&P 35p.



## MICROPHONES

### DYNAMIC CASSETTE

For equipment requiring a high quality microphone. Sturdy, solid moulded body in black with neat chrome surround. Pick-up pattern is omnidirectional. On/off switch. 1 metre of tough lead with floating 2.5 and 3.5mm plugs. Matching moulded strut. Impedance: 200ohms. Sensitivity: 90dB. Frequency: 90-10,000Hz. Size: 20mm dia. x 120mm. o/n 1326. **£1.50** +12½% VAT P&P 35p.

### DYNAMIC MICROPHONE

Superior quality portable cassette recorder mike with built-in remote control switch and lead fitted with 5-pin 240° DIN plug (remote switch) and 3-pin DIN plug (microphone). Provides a direct replacement for those supplied with recorders. With detachable stand. Omnidirectional. Impedance: 200ohms. Freq. response: 100 to 10,000Hz. Sensitivity: 79dB at 1,000Hz. o/n 1327. **£2.65** +12½% VAT P&P 35p.

### RE-317: DYNAMIC MICROPHONE

Highly sensitive, high-grade desk or hand mike suitable for use with many popular cassette decks. Incorporates on/off switch and 1 metre lead with moulded standard jack plug. Complete with desk stand. Omnidirectional. Impedance: 5,000ohms. Freq. response: 100 to 12,000Hz. Sensitivity: (-7dB at 1,000Hz) o/n 1336. **£4.10** +12½% VAT P&P 35p.

### OMNIDIRECTIONAL CARDIOID

Powered by a 1½ volt battery located within the aluminium body. Satin silver finish with front disk protection to the diaphragm housing. On/off switch. Also with 'Buxby' type windshield, 'U' bracket and stem and extremely supple cable. Consumption: 0.2mA from 1½V battery providing approx. 8-10,000 hours continuous life. Impedance: 600ohms. Sensitivity: 70dB. Frequency: 30-16,000Hz. Size: 23mm dia. x 267mm. o/n 1329. **£12.80** +12½% VAT P&P 35p.

### UNIDIRECTIONAL CARDIOID

Dual imp. 600 and 50,000ohms. Response 50 to 14,000Hz. Sensitivity: 54dB at 50K/ohms. Size: 1½" dia. x 6½" long. Weight approx. 190gm. o/n 1328. **£10.95** +12½% VAT P&P 35p.

## STANDS

### GOOSENECK CHROME FLEXIBLE HOLDERS

Length 320mm. o/n 1333. **£2.40** +12½% VAT P&P 30p.  
Length 515mm. o/n 1334. **£3.40** +12½% VAT P&P 30p.  
**FLOOR STAND**, Heavy chrome. Slow-away feet with rubber ends for maximum stability. Draws to a height of 5' maximum. o/n 1335. **£9.00** +12½% VAT P&P 85p.  
**BOOM ARM** for use with the above stand. Heavy chromed metal, it gives 30" reach from the stand. o/n 1337. **£8.00** +12½% VAT P&P 70p.

### WINDSHIELD COVERS

O/n 1531. Medium per pair **£1.20** +12½% VAT P&P 35p. o/n 1332. Large per pair **£1.80** +12½% VAT P&P 35p.

## 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 & socket **£1.10\***
- 117 AC mains connecting lead for cassette recorders & radios. 2 metres **£0.68\***
- 118 5 pin DIN phono plug to stereo headphone jack socket **£1.05\***
- 119 2 + 2 pin DIN plugs 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, 8 track cartridge & combination units. Supplied with in-line fused power lead and instructions **£0.60\***
- 123 6.8m 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 in-line socket. Length 5m **£0.68\***
- 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\***

# BI-PAK

DEPT. ET11, P.O. Box 6, Ware, Herts.

# AUDIO KITS OF DISTINCTION FROM **POWERTRAN**



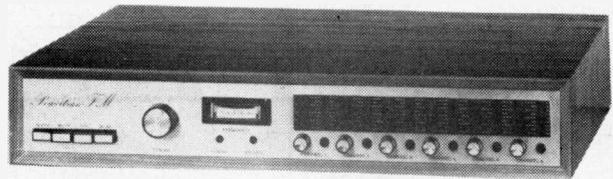
cabinet size 18.3" x 12.7" x 3.1".

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

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

## WIRELESS WORLD FM TUNER £70.20 + VAT

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



cabinet size 18.3" x 12.7" x 3.1".



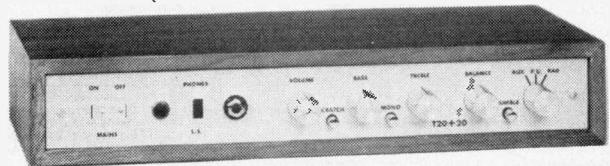
cabinet size 18.3" x 12.7" x 3.1".

## LINSLEY-HOOD CASSETTE DECK £79.60 + VAT

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

## T20 + 20 AMPLIFIER £33.10 + VAT

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



cabinet size 15.5" x 6.7" x 2.8".



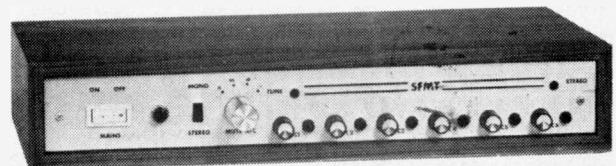
cabinet size 15.5" x 6.7" x 2.8".

## WWII TUNER £47.70 + VAT

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

## POWERTRAN SFMT TUNER £35.90 + VAT

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



cabinet size 15.5" x 6.7" x 2.8".

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

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

**PRICE STABILITY:** Order with confidence! Irrespective of any price changes. We will honour all prices in this advertisement until February 28th, 1979. If ETI January, 1979 issue is mentioned with your order. Errors and VAT rate changes excluded.

**EXPORT ORDERS:** No VAT. Postage charged at actual cost plus 50p handling and documentation.

**U.K. ORDERS:** Subject to 12½% surcharge for VAT\* (i.e. add ½ to the price). No charge is made for carrier, \*or at current rate if changed.

**SECURICOR DELIVERY:** For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.

**SALES COUNTER:** If you prefer to collect your kit from the factory. Call at Sales Counter (at rear of factory). Open 9 a.m. - 4.30 p.m. Monday-Thursday

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

# POWERTRAN ELECTRONICS

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# news digest.....

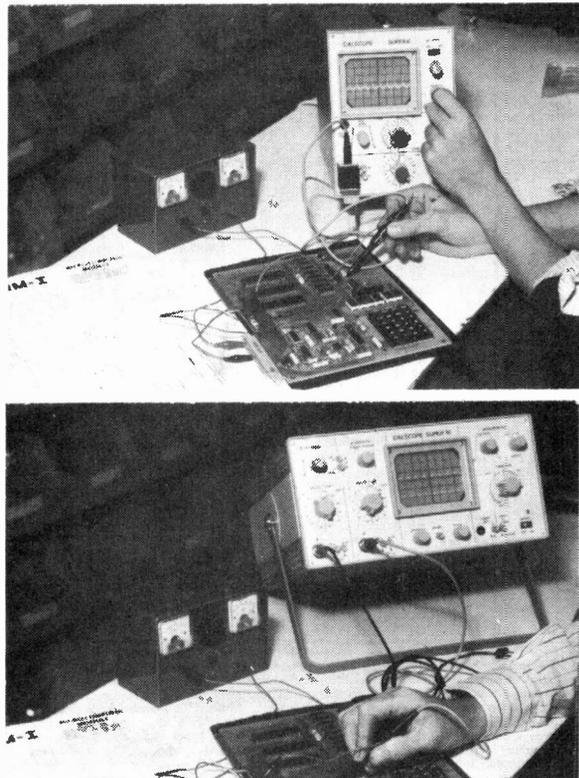
## FLEET OF FOOT?



For all us kiddies (anyone who isn't — please leave now) this is a good idea. Those nasty sneaky MPUs have invaded our nice little game of Battleships. Based on a TMS 1000 the unit contains enough

RAM to hold the board as seen by both players, and make appropriate noises at time of defeat or victory or whatever. Nice explosion sound effects etc too. And what's more it's British designed — which

is a distinct recommendation and selling well in America — which isn't. Price £29 or thereabouts. AID, 10 RATHBONE PLACE, LONDON W1P 2DN.



## NOT A TRACE OF GREED

Two new oscilloscopes for the home constructor, from the Scopex stable. Called the Calscope 6 and Calscope 10 they are probably indicative of the fact the home market is of growing importance to manufacturers. Specs. below.

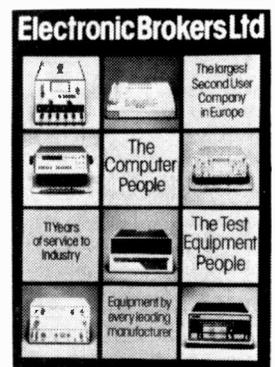
**Calscope 6:** — single trace: sensitivity range 50mV to 50V per cm/in 12 ranges: Bandwidth 6MHz: time base range 1 and to 100 ms per cm. Time base triggering is claimed to be particularly good. Price £162.

**Calscope 10:** — dual trace: 10mV sensitivity: bandwidth 10MHz (displayable across full screen size): time base range 200ns to 100 ms: accuracy 3% all ranges. Price £219.

Both available from Maplin and Marshall both of whom you should know already.

## PEDIGREE CATS

**Electronic Brokers** — superb range of second hand hardware that should interest most small firms and not a few individuals. Much new equipment is also included, and although the cost is high at £1 to private individuals companies can get it free!



Not fair this world is it? ELECTRONIC BROKERS, 4a PANCRAS ROAD, LONDON NW1 2GB.

**Ace Electronics** — good range of components. Poorly produced catalogue but it is free, and adequate, and contains some nice little kits amongst other things worth sending for. ACE MAILTRONIX, TOOTAL STREET, WAKEFIELD, W. YORKS.

## PUT THESE TO GOOD USE

Some new PUTs (at last), and in different packages too. The MEU21 and 2N6028 are intended for use in long internal timers and such and have low leakage (100nA max).

The MEU22 (and 2N6027) are general purpose types. All have specs of: 150nA peak point current (2N6028), low forward voltage (1V5 for 50mA  $I_{FWD}$ ) and high pulse output voltage (6V minimum) MICRO ELECTRONICS LTD, YORK HOUSE, EMPIRE WAY, WEMBLEY, MIDDX.

# ambit international <sup>®</sup>

Production of the new catalogue has been held up for a few weeks - since we have just been appointed as distributors for two of the most exciting ranges of radio-components products yet: The Micrometals range of iron dust torroids cores and formers, and the OKI range of VLSI for digital frequency displays for receivers. We apologize for any inconvenience, but these two ranges are really worth the wait, and include some products you will find hard to believe, like the MSM5523 IC, an IC with less than ten external components that gives AM frequency readout to 1kHz from LW to 39.999MHz, FM frequency readout in 100kHz steps - (all usual IF offsets programmable by diodes), a 24 hour format clock with 12 hour display, independent on and off timers, time signals on the hours, stopwatch facility and a sleep timer. This costs £14 with its timebase crystal, and makes all that has gone before an expensive and time wasting exercise. Rather like the way the Intersil ICM7216 has revolutionized the instrument counter market. (See the OSTs ad.) And those of you familiar with Amidon and IG dust torroids, favoured in many new RF designs, will be pleased to know Ambit will be stocking a broad range of the Micrometals types for applications from EMI filters to RF PA stages.

DKI frequency counter ICs: details in cat2  
MSM5523 for CA LEDs with RHPD such as FND507 £14 inc xtal  
MSM5525 for 3 1/2 digit LCD AM/FM with direct segment drive, no clock or timers £11 inc xtal  
Other types for fluorescent displays etc OA

Other new semiconductor additions:  
KB4437 pilot cancel mpw decoder 4.35  
KB4438 muting stereo preamp 2.22  
HA1370 supercedes TDA2020 2.99  
TDA1090 HiFi AM/FM 3.35  
TDA1220 low cost AM/FM 1.45

PRICES DOWN ON VMOS: as expected, this new technology in power transistor is getting cheaper. 120V comp pair /100W for £10.00  
Price reduction on CA3189E .....now £2.20  
New varicaps: to add to the biggest range.....  
KV1211 2.9v bias to tune MW, like the KV1210, but a double diode £1.75

New pilot tone filters from TOKO.....  
2068LR series, individual per channel with a 2673kHz version for pilot cancel decoder applications. Flat to 15kHz £0.90  
New crystal filter for amateur NB-FM.....  
TOYD 10M4B1 with over 90dB adjacent ch. rejection for 2m NB-FM, 10.7MHz £14

New ceramic IF filters for 455kHz.....  
CFM455H 6kHz/6dB, 15kHz max /60dB - ideal for MC3357 etc. £10.

A brief summary of some of our range of ICs:  
TDA1062/1.95; TDA1083/1.95; HA1197/£1.40  
CA3123E/£1.40; TB6651/£1.81; CA3089/1.94  
HA1137/£2.20; MC1310/£2.20; HA1196/£3.95  
KB4424/£2.75; KB4423/£2.53; SD6000/£3.75  
KB4412/£2.55; KB4413/£2.75; KB4417/£2.55  
MC1495L/£6.86\*; MC1496P/£1.25  
LM381N/£1.81; LM1303/£0.99; ULN2283B/£1.00; LM380N/£1; TB810AS/£1.09  
TCA940E/£1.80; TDA2002/£1.95;  
ICL2038C/£4.50\*; NE568/£2.50\*; NE567/£2.50\*; NE560B/£3.50; NE561B/£3.50;  
NE562B/£3.50\*; NE565A/£2.50\*

SEE THE OSTs ADVERT FOR CMOS/TTL REGULATORS, OPTO DISPLAYS, and other types of linear devices.

Some transistors for RF specifically:  
BF256LB/0.34; 40822/0.43\*; 40823/0.51\*  
40673/0.55\*; BF900/961/0.80\*; BF960A/60\*  
BF24/0.22; BF274/0.18; BF195/0.18;  
BF240/0.22; BF241/0.22; BF362/0.70;  
BF479/0.86; BF679S/0.70; BF790/0.90\*

Pin and other Varicap diodes:  
BA102/0.30; BA121/0.30; ITT210/0.30  
BB104B/0.40; MVAM2/£1.48; MVAM115/£1.05; MVAM125/1.05; KV1210/£2.75  
BA479/0.35; TDA1061/0.95; BA182/0.21  
METER MADE low cost panel meters:  
3 x 930 series with blanks and dry transfer sheet of scales and legends for £12.5

## At last, DIY HiFi which looks as if it isn't.

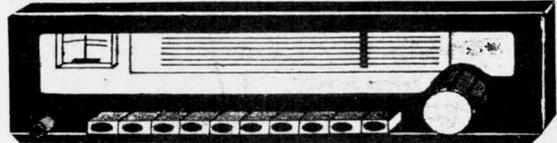
That's not to say it doesn't look like HiFi - just that it doesn't look like the usual sort of thing you have come to associate with DIY HiFi. The Mk3 outstrips and outperforms all British made HiFi tuners, and most imported ones too. Certainly at the price, there isn't one near it. But more than that, it looks superb. A small pic here would be an insult, so send an SAE for details on the kit that looks as if it isn't. It's something else.....

- \* Exceptionally high performance - exceptionally straightforward assembly
- \* Baseboard and plug-in construction. Future circuit developments will readily plug in, to keep the MkIII at the forefront of technical achievement
- \* Various options and module line-ups possible to enable an installment approach to the system

and now previewing the matching 60W/channel VMOS amplifier:

- \* Matching both the style and design concepts of the MkIII HiFi FM tuner
- \* Hitachi VMOS power fets - characterized especially for HiFi applications
- \* Power output readily multiplied by the addition of further MOSFETs
- \* VU meters on the preamp - not simply dancing according to vol level
- \* Backed with the usual Ambit expertise and technical capacity in audio

## The PW Dorchester-LW, MW, SW, & FM stereo tuner



In much the same way as we have swept away the 'old technology' in frequency/timer counters - with the OKI and Intersil single IC counters, we now offer a single IC 'All Band' radio tuner. Don't confuse this one chip radio with things like the ZN414 - for this is a genuine superhet receiver with a mechanical AM IF filter, and ceramic IF filters for FM. The AM section employs a balanced input mixer section, covering all broadcast bands - plus a BFO and MOSFET product detector for SSB/CW - though at this price, the tuner is not intended as a "communications receiver" - although we know of many lesser designs that make that claim. The AM sensitivity is nevertheless better than 5uV, and FM sensitivity is 1.2uV for 30dB S/N. As a multiband broadcast superhet receiver, it is a unique constructor project that fulfills the requests we very frequently get for a general coverage circuit that isn't over complicated. The set has CA3089E FM performance, with mute etc., and a PLL stereo decoder with full pilot tone filtering. The tuner board - with "on board" PCB mounted switching, all components etc : £33.00  
The case/cabinet with PSU, meter and mechanics etc £25.00  
An SAE for full details please. See the feature article in Practical Wireless (Dec/Jan)

TERMS etc: CWO please, VAT on Ambit items is generally 12%, except where marked (\*).  
Catalogue part 1:45p, part 2:50p all inclusive. Postage 25p per order, carriage on tuner kits £3.  
Phone Brentwood (0277) 216029/227050 9am-7pm. Callers welcome inc. Saturdays.

2 Gresham Road, Brentwood, Essex.

## OSTS

Since AMBIT introduced the "One Stop Technology Shop" to our service, we have been pleased to see just how many users of electronic components appreciate our guarantee to supply goods only from BS9000 approved sources. More than ever, professional and amateur electronics engineers cannot afford to waste time on anything less than perfect pedigree products.

## CD4000 CMOS

|      |      |      |      |      |      |
|------|------|------|------|------|------|
| 4000 | 17p  | 4059 | 563p | 4522 | 149p |
| 4001 | 17p  | 4060 | 115p | 4527 | 157p |
| 4002 | 17p  | 4063 | 109p | 4528 | 102p |
| 4006 | 109p | 4056 | 53p  | 4529 | 141p |
| 4007 | 18p  | 4057 | 40p  | 4530 | 90p  |
| 4008 | 80p  | 4068 | 25p  | 4531 | 141p |
| 4009 | 58p  | 4069 | 20p  | 4532 | 125p |
| 4010 | 58p  | 4070 | 20p  | 4534 | 614p |
| 4011 | 17p  | 4071 | 20p  | 4536 | 380p |
| 4012 | 17p  | 4072 | 20p  | 4538 | 150p |
| 4013 | 56p  | 4073 | 20p  | 4539 | 110p |
| 4016 | 52p  | 4075 | 20p  | 4541 | 141p |
| 4017 | 80p  | 4076 | 90p  | 4543 | 174p |
| 4018 | 80p  | 4077 | 20p  | 4549 | 399p |
| 4019 | 80p  | 4078 | 20p  | 4553 | 440p |
| 4020 | 93p  | 4081 | 20p  | 4554 | 153p |
| 4021 | 82p  | 4082 | 20p  | 4556 | 77p  |
| 4022 | 90p  | 4085 | 82p  | 4557 | 386p |
| 4023 | 17p  | 4086 | 82p  | 4558 | 117p |
| 4024 | 76p  | 4089 | 150p | 4559 | 388p |
| 4025 | 17p  | 4093 | 50p  | 4560 | 218p |
| 4026 | 180p | 4094 | 190p | 4561 | 65p  |
| 4027 | 55p  | 4096 | 105p | 4562 | 530p |
| 4028 | 72p  | 4097 | 372p | 4566 | 159p |
| 4029 | 100p | 4098 | 110p | 4568 | 281p |
| 4030 | 58p  | 4099 | 122p | 4569 | 303p |
| 4031 | 250p | 4160 | 90p  | 4572 | 25p  |
| 4032 | 100p | 4161 | 90p  | 4580 | 600p |
| 4033 | 145p | 4162 | 90p  | 4581 | 319p |
| 4034 | 200p | 4163 | 90p  | 4582 | 164p |
| 4035 | 120p | 4174 | 104p | 4583 | 84p  |
| 4036 | 250p | 4175 | 95p  | 4584 | 63p  |
| 4037 | 100p | 4194 | 95p  | 4585 | 100p |
| 4038 | 105p | 4501 | 23p  |      |      |
| 4039 | 250p | 4502 | 91p  |      |      |
| 4040 | 83p  | 4503 | 69p  |      |      |
| 4041 | 90p  | 4506 | 51p  |      |      |
| 4042 | 85p  | 4507 | 55p  |      |      |
| 4043 | 85p  | 4508 | 248p |      |      |
| 4044 | 80p  | 4510 | 99p  |      |      |
| 4045 | 150p | 4511 | 149p |      |      |
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| 4049 | 55p  | 4515 | 300p |      |      |
| 4050 | 55p  | 4516 | 125p |      |      |
| 4051 | 65p  | 4517 | 382p |      |      |
| 4052 | 65p  | 4518 | 103p |      |      |
| 4053 | 65p  | 4519 | 57p  |      |      |
| 4054 | 120p | 4520 | 108p |      |      |
| 4055 | 135p | 4521 | 236p |      |      |

## Micromarket

|             |      |      |        |
|-------------|------|------|--------|
| 8216        | 1.95 | 2114 | £10    |
| 8224        | 3.50 | 2708 | £10.55 |
| 6800P       | 6.50 |      |        |
| 6820P       | £6   |      |        |
| 6850P       | 2.75 |      |        |
| 6810P       | £4   |      |        |
| 6852        | 3.65 |      |        |
| 8080 series |      |      |        |
| 8080        | 6.30 |      |        |
| 8212        | 2.30 |      |        |

## Voltage Regs

NEW LOW PRICES  
7800 series UC TO220 package 1A all 95p  
7900 series UC TO220 package 1A all 91p  
78MUC series TO220 package 1/2A all 90p  
78LCP series TO92 100mA all 35p  
L200 up to 3A/adjustable V&A 195p  
78MGT2C 1/2amp adjustable volts 175p  
79MGT2C 1/2amp adjustable volts 175p  
723C precision controller 65p  
MAINS FILTERS FOR NOISE/RFI etc.  
1 amp in IEC connector £4.83  
5 amp in 'wire in' case £3.87  
NE550A 73p

## LINEARS non-consumer OPTO 7 seg displays

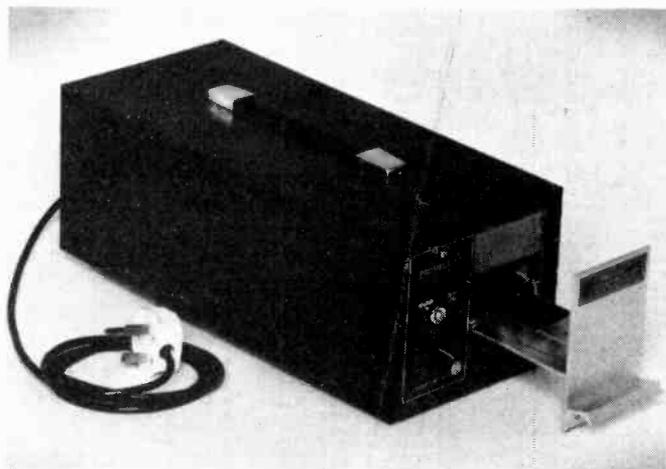
|         |      |         |         |                           |
|---------|------|---------|---------|---------------------------|
| CA3130E | 84p  | LM339N  | 66p     | 0.43" High Efficiency HP: |
| CA3130T | 90p  | LM348N  | 186p    | 5082: 7650 red CA         |
| CA3140E | 35p  | LM3900N | 60p     | 5082: 7653 red CC         |
| CA3140T | 72p  | 709HC   | 105 64p | 5082: 7650 yellow CA      |
| CA3160E | 90p  | 709PC   | 105 36p | 5082: 7663 yellow CC      |
| CA3160T | 99p  | 710HC   | 105 65p | 5082: 7670 green CA       |
|         |      | 710PC   | 105 59p | 5082: 7673 green CC       |
| Op amps |      | 723CN   | 65p     | 0.3" Standard HP          |
| LM301AH | 67p  | 741CH   | 105 66p | 5082: 7730 red CA         |
| LM301AN | 30p  | 741CN   | 84d 27p | 5082: 7740 red CC         |
| LM308H  | 121p | 747CN   | 70p     |                           |
| LM308N  | 97p  | 748CN   | 36p     |                           |
| LM318H  | 279p | NE531T  | 120p    | 0.5" Fairchild            |
| LM318N  | 224p | NE531N  | 105p    | FND500 red CC 150p        |
|         |      |         |         | FND507 red CA 150p        |

## TTL: Standard AND LP Schottky

| N'   | LSN' | N'    | LSN'  | N'  | LSN'  | N'    | LSN' | LSN   |       |     |               |                  |         |
|------|------|-------|-------|-----|-------|-------|------|-------|-------|-----|---------------|------------------|---------|
| 7400 | 13   | 20    | 7455  | 35  | 24    | 74126 | 57   | 44    | 74185 | 134 | 74377         | 124              |         |
| 7401 | 13   | 20    | 7460  | 17  |       | 74128 | 74   |       | 74188 | 275 | 74378         | 93               |         |
| 7402 | 14   | 20    | 7463  |     |       | 74132 | 73   | 78    | 74190 | 115 | 92            | 74379            | 130     |
| 7403 | 14   | 20    | 7470  | 28  |       | 74133 |      | 29    | 74191 |     |               | 74386            | 37      |
| 7404 | 14   | 24    | 7472  | 28  |       | 74136 |      | 40    | 74192 | 105 | 180           | 74390            | 140     |
| 7405 | 18   | 26    | 7473  | 32  |       | 74138 |      | 60    | 74193 | 105 | 180           | 74395            | 139     |
| 7406 | 38   |       | 7474  | 27  | 38    | 74139 |      | 60    | 74194 | 105 | 187           | 74396            | 133     |
| 7407 | 38   |       | 7475  | 38  | 40    | 74141 | 56   |       | 74195 | 95  | 137           | 74398            | 180     |
| 7408 | 17   | 24    | 7476  | 37  |       | 74142 | 265  |       | 74196 | 99  | 110           | 74399            | 150     |
| 7409 | 17   | 24    | 7478  |     |       | 74143 | 312  |       | 74197 | 85  | 110           | 74445            | 92      |
| 7410 | 15   | 24    | 7480  | 48  |       | 74144 | 312  |       | 74198 | 150 |               | 74447            | 90      |
| 7411 | 20   | 24    | 7481  | 86  |       | 74145 | 65   |       | 74199 | 160 |               | 74490            | 140     |
| 7412 | 17   | 24    | 7482  | 69  |       | 74147 | 175  |       | 74248 |     | 90            | 74668            | 110     |
| 7413 | 30   | 52    | 7483A |     |       | 74148 | 109  |       | 74249 |     | 93            | 74670            | 249     |
| 7414 | 51   | 130   | 7484  | 97  |       | 74150 | 99   |       | 74251 | 90  |               | MISCELLANY       |         |
| 7415 | 30   | 24    | 7485  | 104 | 99    | 74151 | 64   | 84    | 74253 | 105 |               | NE555            | 30p     |
| 7416 | 30   | 7486  | 64    | 40  | 74153 | 64    | 54   | 74257 | 108   |     | NE556         | 78p              |         |
| 7417 | 30   | 7489  | 205   |     | 74154 | 96    |      | 74258 | 420   |     | NE558         | 180p             |         |
| 7420 | 16   | 24    | 7490  | 33  | 90    | 74155 | 54   | 110   | 74259 | 420 |               | ICM7217          | 950p    |
| 7421 | 29   | 24    | 7491  | 76  | 110   | 74156 | 80   | 110   | 74260 | 153 |               | ICM7208          | 1495p   |
| 7422 | 24   | 24    | 7492  | 38  | 78    | 74157 | 67   | 55    | 74261 | 353 |               | ICL7106CP        | 140p    |
| 7423 | 27   | 24    | 7493  | 32  | 99    | 74158 | 67   | 60    | 74266 | 40  |               | LCD DVM IC       |         |
| 7425 | 27   | 24    | 7494  | 78  |       | 74159 | 210  |       | 74273 | 124 |               | LCD              | 955p    |
| 7426 | 36   | 27    | 7495A | 65  | 99    | 74160 | 82   | 130   | 74275 | 312 |               | LCD DVM KIT      |         |
| 7427 | 27   | 29    | 7496  | 58  | 120   | 74161 | 92   | 78    | 74279 | 52  |               | 2480p            |         |
| 7428 | 35   | 32    | 7497  | 195 |       | 74162 | 92   | 130   | 74283 | 120 |               | 3 1/2 digit LCD  |         |
| 7430 | 17   | 24    | 74100 | 119 |       | 74163 | 92   | 78    | 74290 | 90  |               | display          | 1150p   |
| 7432 | 25   | 24    | 74104 | 63  |       | 74164 | 104  |       | 74293 | 95  |               | ICL7107 LCD      |         |
| 7433 | 40   | 32    | 74105 | 62  |       | 74165 | 105  |       | 74295 | 120 |               | DVM kit          | 2065p   |
| 7437 | 40   | 24    | 74107 | 32  | 38    | 74166 |      |       | 74298 | 100 |               | ICM7218          | 8 digit |
| 7438 | 33   | 24    | 74109 | 63  | 38    | 74167 | 20   |       | 74324 | 157 |               | 10MHz DFM/       |         |
| 7440 | 17   | 24    | 74110 | 54  |       | 74168 |      |       | 74325 | 242 |               | timer            | £19.82  |
| 7441 | 74   | 24    | 74111 | 68  |       | 74169 |      | 200   | 74326 | 247 |               | (for LED C.Cath) |         |
| 7442 | 70   | 99    | 74112 | 88  |       | 74170 | 230  | 200   | 74327 | 237 |               | SCALAR ICs       |         |
| 7443 | 115  | 74113 |       |     | 74172 | 625   |      | 74332 | 100   |     | 8629 150MHz   |                  |         |
| 7444 | 112  | 74114 |       |     | 74173 | 170   |      | 74335 | 100   |     | divide by 100 |                  |         |
| 7445 | 94   | 74116 | 198   |     | 74174 | 87    | 120  | 74362 | 715   |     | 420p          |                  |         |
| 7446 | 94   | 74118 | 83    |     | 74175 | 87    | 110  | 74365 | 49    |     | 95H90DC       | 750p             |         |
| 7447 | 82   | 74119 | 119   |     | 74176 | 75    |      | 74366 | 49    |     | 11C90DC       | 440p             |         |
| 7448 | 56   | 99    | 74120 | 115 |       | 74177 | 78   |       | 74367 | 43  |               | new-divide       |         |
| 7449 | 97   | 99    | 74121 | 25  |       | 74180 | 85   |       | 74368 | 49  |               | by 100 or 10     |         |
| 7450 | 17   | 24    | 74122 | 46  |       | 74181 | 165  | 350   | 74373 | 77  |               | for 120/60MHz    |         |
| 7451 |      |       |       |     |       |       |      |       |       |     |               |                  |         |

# ..... news digest.....

## PROM-IN-AID TIME



Micro-men take note. The Prombix 12 can wipe out twelve PROMs at once with variable erase time with safety interlock. Priced at £59.00 all inc. Should be of interest to

small firms and rich enthusiasts. GP INDUSTRIAL ELECTRONICS, SKARDON WORKS, SKARDON PLACE, NORTH HILL, PLYMOUTH PL4 8EZ.

## GETTING INTO PRINT



A low cost printer is announced by Kimberley Business Records giving a low cost printer is announced by Kimberley Business Records giving good quality output. This will allow the expansion of many home systems into the extensive field of word processing, and God help you then! A standard lever operated typewriter mechanism has been used, driven by 240V solenoids.

Designed for parallel data input with handshake control, ASCII coding is

accepted for the 88 characters available operating at a speed of 8 CAPS from a standard peripheral interface. It is supplied fully built and cased at £200 (including carriage and VAT). Alternatively as a print mechanism only, requiring all power other than 240V, case, and TTL logic to be added, the cost is £160.

KIMBERLEY BUSINESS RECORDS, 2, HARTINGTON ROAD, GOSPORT, HANTS. PO12 3AG.

# Catronics for

## SOLID STATE R.T.T.Y.

We can supply Printed Circuit Boards and components for the RTTY Video Display published by G3PLX in "Radio Communication".

This video display unit is designed to be an all-electronic replacement for a Teleprinter, and therefore does not suffer its disadvantages — bulk, unreliability and noise. The basic function is to take Murray Code — either from a Terminal Unit (on receive) or from a Keyboard — and produce a complete TV signal. This signal may be fed into a monitor or modulated and fed into the aerial of an ordinary domestic TV set. The resulting display is a page of 24 lines of up to 40 characters. It may also be used (with its keyboard) to send fully encoded Murray Code signals for transmit purposes.

Hundreds of these units have been built, with very little trouble, and the pleasures and fascination of RTTY operation are now being experienced by more and more amateurs. Listeners, too, find it very interesting to be able to read international news and other transmissions without the inconvenience of the mechanical teleprinter.

Kit price from £83.55 — send SAE for details.

Introducing the most comprehensive R.T.T.Y. TERMINAL UNIT you can, or indeed, need ever buy —

## THE CATRONICS CT100 R.T.T.Y. TERMINAL UNIT

### INPUTS for:

Audio FSK signal in  
Data in from V.D.U. (e.g. G3PLX)  
TTY Keyboard or Tape Reader

### OUTPUTS for:

V.D.U. or other TTL compatible equipment  
TTY Magnet — single or double current  
AFSK to drive Transmitter

Featuring a unique digitally controlled "Autoprint" circuit which is a superior replacement for the "Antispace" and "Autostart" facilities found on some other terminal units. The terminal will ignore most CW and phone signals but will respond to a correct RTTY signal. Tuning correctly into an RTTY signal is made simple with a single "correctly tuned" LED plus an additional "Mark frequency" indicator.

The FSK demodulator circuit utilises a special "state-of-the-art" system to give excellent performance and stability at low cost.

The teleprinter interface unit incorporates electronic "de-bounce" circuitry to eliminate spurious switching from the Keyboard.

### UNITS ARE AS FOLLOWS:

|  |        |
|--|--------|
| CT100. Receive only RTTY Terminal Unit housed in attractively styled metal cabinet approx 9 by 7 by 2 1/2 in., with integral mains power supply. | £71.00 |
| CT101. Receive Unit + Hi-stability AFSK oscillator for transmission purposes.  | £79.00 |
| CT102. Receive Unit + Teleprinter interface unit.  | £80.00 |
| CT103. Complete terminal unit for reception and transmission with facilities for connection to Teleprinter.                                      | £88.00 |

ADD £3 for Securicor delivery

## Catronics NEW KEYBOARD KIT

Catronics Ltd. are proud to announce the introduction of the world's first modular Keyboard Kit available to the home constructor!

The printed circuit board is designed to take a maximum of 70 keys but may be assembled with a smaller number of keys for a simpler keyboard.

The board is not dedicated to any specific coding, allowing it to be used for any project whether it requires ASCII, Baudot or any other code. This makes it suitable for many projects including

E.T.I. — System 68 MPU (54 keys)

Auto morse sender, etc.

The Keyswitches themselves are single pole push-to-make type and require no extra mechanical mounting arrangements

A legend sheet is provided with each kit enabling the constructor to label the keys to suit individual requirements.

Catronics price: Kit for 70 station Keyboard: £29.00

Please add 50p for post and packing

All prices INCLUDE VAT at current rates

Send SAE for FREE PRICE LIST or 45p and large (A4) 18 1/2p SAE for copy of our Data Catalogue.

**CATRONICS LTD.**  
**COMMUNICATIONS HOUSE**  
**20 WALLINGTON SQUARE**  
**WALLINGTON, SURREY SM6 8RG**

(DEPT.  
951)

Tel. 01-669 6700. Open Mon.-Fri. Also Sat. a.m.





**Introducing DM900 — The DIGITAL MULTIMETER with "Hidden Capacity" — It measures Capacitance too!**

(as published in E.T.I. August 1978)  
 Away with analogue meters for with some of these you may often as not use a crystal ball to make circuit measurements instead gaze into our crystal — not a ball but the 3 1/2 0.5" LIQUID CRYSTAL DISPLAY — on our amazingly accurate DMM incorporating

- 5 AC & DC Voltage ranges; 6 resistance ranges
- 5 AC & DC Current ranges; 4 Capacitance ranges
- The prototype accuracy is better than 1%

This is a unique design using the latest MOS ICs and due to the minimal current drain, is powered by only one PP3 battery. There is also a battery check facility.

The DM900 is an attractive hand-held, light weight device, built into a high impact case with carrying handle and has been ingeniously designed to simplify assembly.

Never before have all these features been offered to the electronics enthusiast in a single unit.

Complete Kit Only **£54.50\*** (p&p Insured add 80p)

Optional Extras Probes **£1.50\*** Carrying Case **£1.50\***

Calibration service charge for working Units only **£5.75.**

Ready-built and tested units only **£78.50\*** incl. Case & probes p&p 80p

Demonstration on at our Shop

| JACK PLUGS            | SOCKETS      |                  |                             | SWITCHES*        | SLIDE 250V         |
|-----------------------|--------------|------------------|-----------------------------|------------------|--------------------|
| Screened chrome       | Plastic body | open metal       | moulded with break contacts | in line couplers | 1A DPDT 14p        |
| 2.5mm 12p             | 8p           | 8p               | 11p                         | 11p              | 1A DPDT c/over 15p |
| 3.5mm 15p             | 10p          | 8p               | 12p                         | 12p              | 1/2A DPDT 13p      |
| MONO 23p              | 15p          | 13p              | 18p                         | 18p              | 4 pole 2 way 24p   |
| STEREO 31p            | 18p          | 15p              | 22p                         | 22p              | <b>PUSH BUTTON</b> |
|                       |              |                  |                             |                  | Spring loaded      |
|                       |              |                  |                             |                  | SPST on/off 60p    |
|                       |              |                  |                             |                  | SPDT c/over 85p    |
|                       |              |                  |                             |                  | <b>MINIATURE</b>   |
|                       |              |                  |                             |                  | Non Locking 70p    |
|                       |              |                  |                             |                  | Push to Make 15p   |
|                       |              |                  |                             |                  | Push Break 25p     |
| <b>DIN</b>            | <b>PLUGS</b> | <b>SOCKETS</b>   | <b>In Line</b>              |                  |                    |
| 2 PIN Loudspeaker 11p | 7p           | 7p               | 18p                         |                  |                    |
| 3, 4, 5 Audio 13p     | 8p           | 8p               | 20p                         |                  |                    |
| <b>CO-AXIAL (TV)</b>  | <b>14p</b>   | <b>14p</b>       | <b>14p</b>                  |                  |                    |
| <b>PHONO</b>          | <b>9p</b>    | <b>5p single</b> | <b>15p</b>                  |                  |                    |
| assorted colours 12p  | 8p double    |                  |                             |                  |                    |
| Metal screened 10p    | 3-way        |                  |                             |                  |                    |
| <b>BANANA</b> 4mm 11p | 12p          |                  |                             |                  |                    |
| 2mm 10p               | 10p          |                  |                             |                  |                    |
| 1mm 7p                | 7p           |                  |                             |                  |                    |
| <b>WANDER</b> 3mm 8p  | 8p           |                  |                             |                  |                    |
| DC Type 15p           | 20p          |                  |                             |                  |                    |
| AC 2-pin American 15p | 15p          |                  |                             |                  |                    |

**VOLTAGE\* REGULATORS**

T03 Can Type p

1A +ve 5V 12V 15V 18V 145

MVR5 or 12 150

1A -ve 5V 12V 220

Plastic (T092)

+ve 0.1A 5V 6V 8V 12V 15V 30

+ve 1A (T0220) 5V 12V 15V 18V 24V 85

-ve 0.5A 5V 6V 8V 12V 15V 86

-ve 1A 5V 12V 110

-ve 0.1A (T092) 5V 12V 15V 85

**TRANSFORMERS\*** (Mains Prim. 220-240V)

6-0-6V 100mA 9-0-9V 75mA 12-0-12V 100mA 95p

8VA: 6V-5A 6V-5A 9V-4A 9V-4A 12V-3A 12V-3A 15V-2.5A 15V-2.5A 195p

12V: 4.5V-1.3A 4.5V-1.3A 6V-1.2A 6V-1.2A 12V-5A 12V-5A 15V-4A 15V-4A 20V-3A 20V-3A 220p (20p p&p)

24VA: 6V-1.5A 6V-1.5A 9V-1.3A 9V-1.3A 12V-1A 12V-1A 15V-8A 15V-8A 20V-6A 20V-6A 290p (45p p&p)

50VA: 6V-4A 6V-4A 9V-2.5A 9V-2.5A 12V-2A 12V-2A 15V-1.5A 15V-1.5A 20V-1.2A 20V-1.2A 25V-1A 25V-1A 30V-8A 30V-8A 350p (50p p&p)

100VA: 12V-4A 12V-4A 15V-3A 15V-3A 20V-2.5A 20V-2.5A 30V-1.5A 30V-1.5A 40V-1.25A 40V-1.25A 50V-1A 50V-1A 650p (60p p&p)

**ALUM. BOXES\* WITH LID\***

3x2x1 45

2 1/2 x 5 1/4 x 1 1/2 60

4x4 1/2 68

4x2 3/4 x 1 1/2 60

4x5 1/4 x 1 1/2 78

4x2 1/2 x 2 64

5x4 2 82

6x4 2 88

7x5 2 114

8x6 3 148

10x7 3 172

10x4 1/2 x 3 142

12x5 3 165

12x8 3 210

**PANEL METERS\***

FSD 60x46x 35mm 0.50uA 0.100uA 0.500uA 0.1mA 0.5mA 0.10mA 0.50mA 0.100mA 0.500mA 0.1A 0.2A 0.25V 0.50V AC 0.300V AC 5VU 475p each

4 1/2 x 3 1/4 x 1 1/2 0.50uA 0.100uA 0.500uA 595p each

**EARPHONES**

Magnetic 2.5mm 18p

3.5mm 18p

Crystal 33p

**ULTRASONIC TRANS-DUCERS** £3.95\* per pair

**COMPUTER HARDWARE\***

2101 99

2102 100

2111 175

2114 650

2516 TBA

2532 TBA

2708 650

27L08 995

27L16 1650

3064 TBA

4027 190

4047 750

74S188 165

74S262 875

74S297 325

74S470 325

74S475 825

81LS95 70

81LS96 70

9900 £35

9980 TBA

1MS6011 TBA

280 TBA

**COMPUTER HARDWARE\***

2101 99

2102 100

2111 175

2114 650

2516 TBA

2532 TBA

2708 650

27L08 995

27L16 1650

3064 TBA

4027 190

4047 750

74S188 165

74S262 875

74S297 325

74S470 325

74S475 825

81LS95 70

81LS96 70

9900 £35

9980 TBA

1MS6011 TBA

280 TBA

**CMOS\***

4001 15

4001 17

4002 17

4006 105

4007 18

4008 87

4009 50

4010 50

4011 18

4012 18

4013 42

4014 86

4015 89

4016 45

4017 89

**CMOS\***

4001 15

4001 17

4002 17

4006 105

4007 18

4008 87

4009 50

4010 50

4011 18

4012 18

4013 42

4014 86

4015 89

4016 45

4017 89

**VDU Chip and MODULE for TV**

Convert your TV into a VDU by using the new Thompson CSF TV-CRT controller chip SF F96364 16 line by 64 characters text refreshment. Cursor management. Cursor management on screen. Line erasing. Compatible with any computing system.

SF F96364E £11.75\*

AV-3 1015 £5.60\*

AV-5 1013UART £4.50\*

71301 ROM £8.20\*

SF580102 RAM £2.05\*

74LS163 £1.18\*

SN75450 £1.20\*

SN75451 70p\*

SN75452 70p\*

SN75454 £2.25\*

UHF Modulator £2.50\*

Complete Module £136.50\*

(Send 30p stamps for full technical data)

# .....news digest.....



**POCKET ADVANTAGE**

A wallet type machine with hold-on memory. The new TI 50 has two memories, some scientific features, some statistical features and will turn itself off after 15 minutes if you aren't using it. Up to 15 levels of parenthesis are allowed. There is even a 'battery low' indicator.

Available now, it will cost under £30 and be in most shops that sell this sort of thing.

**SCREEN TEST**

The UK is now Hong Kongs largest market for TV games. We absorbed 26% of their export in the field, some 523,506 items if you please, in the first eight months of this year. Germany finished second

on 22% and the USA came third with 13%.

Somewhat of a surprise, and a shame, that we take more than the States of these items. I always thought we had more taste.

**SHORTS**

● Every Ready — now called Berec — have released four rechargeable consumer batteries, in the HP2, HP11, HP7 and PP3 varieties. Chargers are also available. An undoubted reaction to the phenomenal loss of dry cell power these days.

● Fairchild are making a big fuss about having their F16K Dynamic 16K RAMs available at last. Access times vary from 150 ns to 300 ns.

● Direct drive turntables yes. But direct drive MPUs? Also yes — now. The S2000 is a new release from AMI which can drive fluorescent displays directly, with HT drive and 7-segment decoding on chip. Also on board 64 x 4 RAM and 1K ROM. Intended for low lost applications.



● Ingersoll — the tick tock people — are into electronics. They have released three TV games, three clock radios, two Door Chimes, and a portable micro cassette player. Photo shows one of their new TV games. It must be Christmas.

|   |  |  |  |  |  |  |  |  |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |  |  |  |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |   |  |  |  |  |  |   |  |
|---|--|--|--|--|--|--|--|--|--|---|--|---|--|---|--|---|--|---|--|---|--|---|--|--|--|--|--|---|--|---|--|---|--|---|--|---|--|---|--|---|--|---|--|---|--|---|--|--|--|--|--|---|--|
| <b>TTLs by TEXAS</b><br>74186 700p<br>7400 13p<br>7401 13p<br>7402 14p<br>7403 14p<br>7404 17p<br>7450A 90p<br>7405 18p<br>7406 32p<br>7407 32p<br>7408 19p<br>7409 19p<br>7410 15p<br>7411 24p<br>7412 20p<br>7413 30p<br>7414 60p<br>7416 27p<br>7417 27p<br>7420 17p<br>7421 40p<br>7422 22p<br>7423 34p<br>7425 30p<br>7426 30p<br>7427 34p<br>7428 39p<br>7430 17p<br>7432 30p<br>7433 40p<br>7437 35p<br>7438 35p<br>7440 17p<br>7441 70p<br>7442A 60p<br>7443 112p<br>7445 100p<br>7446A 93p<br>7447A 60p<br>7448 80p<br>7450 17p<br>7451 17p<br>7453 17p<br>7454 17p<br>7456 17p<br>7457 17p<br>7459 17p<br>7470 30p<br>7472 30p<br>7473 34p<br>7474 30p<br>7475 36p<br>7476 35p<br>7480 50p<br>7481 100p<br>7482 84p<br>7483A 90p<br>7484 100p<br>7485 110p<br>7486 34p<br>7489 210p<br>7490A 33p<br>7491 80p<br>7492A 48p<br>7493A 33p<br>7494 84p<br>7495A 70p<br>7496 85p<br>7497 180p<br>74100 130p<br>74104 65p<br>74105 65p<br>74107 34p<br>74109 55p<br>74110 55p<br>74111 70p<br>74116 200p<br>74118 130p<br>74119 210p<br>74120 110p<br>74121 28p<br>74122 48p<br>74123 55p<br>74125 55p<br>74126 60p<br>74128 75p<br>74132 75p<br>74136 75p<br>74141 70p<br>74142 200p<br>74145 90p<br>74147 190p<br>74148 150p<br>74510 100p<br>74151A 70p<br>74153 70p<br>74154 100p<br>74155 90p<br>74156 90p<br>74157 70p<br>74159 190p<br>74160 100p<br>74161 100p<br>74162 100p<br>74163 100p<br>74164 120p<br>74165 130p<br>74166 140p<br>74167 200p<br>74170 240p<br>74172 720p<br>74173 120p<br>74174 93p<br>74175 85p<br>74176 90p<br>74177 90p<br>74178 160p<br>74180 93p<br>74181 200p<br>74182 90p<br>74184A 150p<br>74185 150p |  | <b>4000 SERIES</b><br>4000 15p<br>4001 17p<br>4002 17p<br>4006 95p<br>4007 18p<br>4008 80p<br>4009 80p<br>4010 80p<br>4011 17p<br>4012 18p<br>4013 50p<br>4014 84p<br>4015 84p<br>4016 45p<br>4017 80p<br>4018 80p<br>4019 45p<br>4020 100p<br>4021 100p<br>4022 100p<br>4023 22p<br>4024 50p<br>4025 20p<br>4026 130p<br>4027 50p<br>4028 84p<br>4029 100p<br>4030 55p<br>4031 200p<br>4033 180p<br>4034 200p<br>4035 110p<br>4040 100p<br>4041 80p<br>4042 80p<br>4043 90p<br>4044 90p<br>4046 110p<br>4047 100p<br>4048 55p<br>4049 32p<br>4050 48p<br>4051 80p<br>4052 80p<br>4053 80p<br>4054 150p<br>4055 125p<br>4056 135p<br>4059 600p<br>4060 115p<br>4063 120p<br>4066 55p<br>4067 450p<br>4068 22p<br>4069 20p<br>4071 30p<br>4072 22p<br>4073 22p<br>4075 22p<br>4076 107p<br>4081 22p<br>4082 22p<br>4093 80p<br>4094 175p<br>4098 107p<br>4111 11p<br>4502 120p<br>4503 70p<br>4507 55p<br>4510 99p<br>4511 150p<br>4514 250p<br>4516 110p<br>4518 100p<br>4520 90p<br>4528 100p<br>4543 180p<br>4553 450p<br>4560 250p<br>4583 90p<br>4584 90p<br>4001A 90p<br>4008A 200p<br>4009 90p<br>14411 11p<br>14412V 11p<br>14433 11p |  | <b>93 SERIES</b><br>9301 180p<br>9302 175p<br>9308 316p<br>9310 275p<br>9311 275p<br>9312 180p<br>9314 185p<br>9316 225p<br>9321 225p<br>9322 150p<br>9334 225p<br>9368 200p<br>9370 200p<br>9374 200p |  | <b>VERO BOARD</b><br>0 1 0 15<br>(2x3x3)<br>41p 33p<br>49p 45p<br>3x3x3 49p 45p<br>3x3x5 56p 60p<br>3x3x7 152p 121p<br>3x3x17 195p 163p<br>4x4x17 252p<br>Pkt of 35 pins<br>Spot face cutter 85p<br>Pin insertion tool 99p |  | <b>VERO WIRING PEN</b><br>Plus Spool 325p<br>Spare spool (wire) 80p<br>Combs 7p each |  | <b>TRANSISTORS</b><br>AC126 25p<br>AC127/8 20p<br>AC176 25p<br>AC287/8 25p<br>AF116/7 30p<br>AD149 70p<br>AD161/2 45p<br>BC107/8 11p<br>BC109 11p<br>BC117 20p<br>BC147/8 9p<br>BC149 70p<br>BC157/8 9p<br>BC159 11p<br>BC169C 12p<br>BC172 12p<br>BC177/8 17p<br>BC179 18p<br>BC182/3 10p<br>BC184 11p<br>BC187 30p<br>BC212/3 11p<br>BC214 12p<br>BC461 30p<br>BC477 8 30p<br>BC516/7 50p<br>BC547B 16p<br>BC548C 16p<br>BC549C 16p<br>BC557B 16p<br>BC558B 16p<br>BC559C 16p<br>BCY70 18p<br>BCY71 2 22p<br>BD135/6 54p<br>BD138 56p<br>BD140 56p<br>BD242 70p<br>BF506 200p<br>BF200 32p<br>BF244B 35p<br>BF258 82p<br>BF259 36p<br>BF329 30p<br>BF340 34p<br>BF384/5 30p<br>BF386/7 30p<br>BF388 30p |  | <b>BFW10 90p</b><br>BFY50 22p<br>BFY51 2 22p<br>BFY56 33p<br>BFY90 90p<br>BYE83 700p<br>BRV39 45p<br>BSX19/20 20p<br>BU104 225p<br>BU105 190p<br>BU108 250p<br>BU109 225p<br>BU205 200p<br>BU208 200p<br>BU406 145p<br>BU481 175p<br>MU491 200p<br>MU2501 225p<br>MU2955 100p<br>MU3001 225p<br>MU340 65p<br>MUJ2955 100p<br>MC182/3 11p<br>MC214 12p<br>MC461 30p<br>MC477 8 30p<br>MC516/7 50p<br>MC547B 16p<br>MC548C 16p<br>MC549C 16p<br>MC557B 16p<br>MC558B 16p<br>MC559C 16p<br>OC2B 130p<br>OC35 130p<br>R2008B 200p<br>R2010B 200p<br>TIP29A 40p<br>TIP29C 55p<br>TIP30A 48p<br>TIP30C 60p<br>TIP31A 58p<br>TIP31C 62p<br>TIP32A 68p<br>TIP32C 82p<br>TIP33A 82p<br>TIP33C 114p<br>TIP34A 110p<br>TIP34C 165p<br>TIP35A 225p<br>TIP35C 280p<br>TIP36A 270p<br>TIP36C 340p<br>TIP41A 65p<br>TIP41C 78p<br>TIP42A 70p<br>TIP42C 82p |  | <b>TIP2955 78p</b><br>TIP3055 70p<br>TIS43 34p<br>TIS93 30p<br>ZTX108 12p<br>ZTX300 13p<br>ZTX500 15p<br>ZTX502 18p<br>ZTX504 30p<br>2N457A 250p<br>2N696 35p<br>2N697 25p<br>2N698 45p<br>2N706A 20p<br>2N708A 20p<br>2N918 45p<br>2N930 18p<br>2N1131/2 20p<br>2N1613 20p<br>2N1711 25p<br>2N2102 60p<br>2N2160 120p<br>2N2219A 20p<br>2N2222A 20p<br>2N2369A 16p<br>2N2484 30p<br>2N2646 50p<br>2N2904/5 25p<br>2N2906A 24p<br>2N2907A 30p<br>2N3052 20p<br>2N3053 20p<br>2N3054 65p<br>2N3055 48p<br>2N3442 140p<br>2N3553 240p<br>2N3565 30p<br>2N3643/4 48p<br>2N3702 3 21p<br>2N3704/5 12p<br>2N3706/7 12p<br>2N3708/9 12p<br>2N3773 300p<br>2N3819 25p<br>2N3820 108p<br>2N3823 70p<br>2N3866 90p<br>2N3903/4 18p |  | <b>2N3905/6 20p</b><br>2N4036 65p<br>2N4058/9 6p<br>2N4060 12p<br>2N4061/2 18p<br>2N4123/4 22p<br>2N4125/6 22p<br>2N4289 20p<br>2N4401 3 21p<br>2N4427 27p<br>2N4871 60p<br>2N5087 27p<br>2N5089 27p<br>2N5172 27p<br>2N5179 90p<br>2N5191 83p<br>2N5194 90p<br>2N5245 40p<br>2N5296 55p<br>2N5401 50p<br>2N5457 8<br>2N5459 40p<br>2N5460 40p<br>2N5485 44p<br>2N6027 48p<br>2N6247 190p<br>2N6254 130p<br>2N6290 65p<br>2N6322 65p<br>2N6298 120p<br>2N6553 240p<br>2N6565 30p<br>3N201 110p<br>3N290 100p<br>3N290 250p<br>40360 40p<br>40361/2 45p<br>40364 120p<br>40408 70p<br>40409 65p<br>40410 65p<br>40411 300p<br>40594 97p<br>40595 108p<br>40673 75p<br>40841 90p<br>40871/2 90p |  | <b>DIODES</b><br>BY127 12p<br>OAA7 9p<br>OAB1 15p<br>OAB5 15p<br>OAO9 9p<br>OAA91 9p<br>OAA85 9p<br>OAO200 9p<br>OAO20 10p<br>IN914 4p<br>IN916 7p<br>IN4148 4p<br>IN4001/2 5p<br>IN4003/4 6p<br>IN4005 6p<br>IN4006/7 7p<br>IN4007/3 14p<br>IN5404/7 19p<br>IS920 9p |  | <b>ZENERS</b><br>2.7V-33V 9p<br>400mW 15p<br>1W 15p |  | <b>TRIACS</b><br>PLASTIC 80p<br>3A 500V 85p<br>6A 400V 70p<br>6A 500V 88p<br>8A 400V 75p<br>8A 500V 85p<br>12A 400V 105p<br>16A 400V 110p<br>16A 500V 130p<br>T2800W 130p |  | <b>HEAT SINKS</b><br>For TO220 Volt-age Regs and Transistors For TO5 |  | <b>THYRISTORS</b><br>1A 50V 40p<br>1A 400V 65p<br>1A 600V 70p<br>3A 400V 90p<br>8A 600V 140p<br>12A 400V 180p<br>16A 400V 180p<br>16A 600V 220p<br>BT106 110p<br>C106D 45p<br>MCR101 36p<br>2N3525 130p<br>2N4444 140p<br>2N5001 34p<br>2N5064 40p |  | <b>BRIDGE RECTIFIERS</b><br>1A 50V 21p<br>1A 100V 22p<br>1A 400V 35p<br>1A 600V 35p<br>2A 100V 35p<br>2A 400V 45p<br>3A 200V 60p<br>3A 600V 75p<br>4A 400V 100p<br>6A 500V 108p<br>6A 100V 100p<br>2 1/2 BR 70p<br>2 BR 75p<br>1 1/2 BR 75p |  | <b>MEMORIES</b><br>2102 100p<br>2102-2 120p<br>2102L-4 140p<br>2107B 500p<br>2111 1 225p<br>2112-2 225p<br>2114 10p<br>5101 510p<br>6810 350p |  | <b>UART</b><br>AY-3-1015P 500p<br>AY-5-1013P 400p<br>TMS6011NC 400p |  | <b>CHARACTER GENERATOR</b><br>3257ADC 995p<br>MCM6576 750p<br>RO-3-2513U C 600p<br>SN74S262AN 1360p |  | <b>SUBMINIATURE SWITCHES</b><br>Toggle SPST 51p<br>SPDT 53p<br>DPDT 55p<br>DPDT (centre off) 75p<br>Push to make (Red Green Yel Blue) 15p<br>Push to break (Black only) 25p |  | <b>CRYSTALS</b><br>100KHz 300p<br>1MHz 370p<br>3.2768MHz 350p<br>10.7MHz 350p<br>18MHz 300p<br>27.135MHz 300p |  | <b>EDGEBOARD CONNECTORS</b><br>0.156" Solder Tail<br>2 x 10 way 85p<br>2 x 15 way 100p<br>2 x 18 way 120p<br>2 x 22 way 135p<br>2 x 25 way 160p |  | <b>OTHER</b><br>3245 400p<br>4201 350p<br>4289 970p<br>4801 500p<br>6820 600p<br>6850 700p<br>8205 320p<br>8212 225p<br>8216 225p<br>8224 400p<br>8228 525p<br>8251 700p<br>8253 12p<br>8255 12p<br>8257 11p<br>8259 11p<br>MC14411 11p<br>MC14412V 11p |  | <b>ROM/PROMS</b><br>74S185 225p<br>74S287 400p<br>74S387 400p<br>93427 400p<br>93436 650p<br>93446 650p |  | <b>CPU'S</b><br>4040A 670p<br>6502 1200p<br>6800 900p<br>6801 TBA<br>8080A 550p |  | <b>EPROMS</b><br>1702A 600p<br>2708 900p<br>2716 125p<br>4702 900p |  | <b>LOW PROFILE DIL SOCKETS BY TEXAS</b><br>8 pin 11p<br>14 pin 12p<br>16 pin 13p<br>18 pin 25p<br>20 pin 28p<br>24 pin 28p<br>28 pin 42p<br>30 pin 51p |  | <b>WIRE WRAP SOCKETS</b><br>8 pin 30p<br>14 pin 40p<br>16 pin 55p<br>24 pin 80p<br>28 pin 100p<br>40 pin 120p |  |
|---|--|--|--|--|--|--|--|--|--|---|--|---|--|---|--|---|--|---|--|---|--|---|--|--|--|--|--|---|--|---|--|---|--|---|--|---|--|---|--|---|--|---|--|---|--|---|--|--|--|--|--|---|--|

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# news digest.....

WHEN THE COMPUTING and Control department of Imperial College decided that they needed a logic hardware teaching lab, they were faced with several alternatives. One was to teach all the students in each year to solder and then let them loose on a handful of TTL and CMOS chips each. This would have meant a plethora of supply problems, technicians and even minor burns.

What they opted for instead was to use — you guessed it — a computer.

The setup works roughly like this: A computer terminal is situated in the centre of the 'lab' and is surrounded by 16 benches, each provided with an oscilloscope, a signal generator and other relevant test equipment and peripherals. Each bench also has a perspex case with several dozen sockets and LEDs in it. The student goes to the central console, tells the machine which bench he wishes to use and which logic elements he requires. He then goes to the bench and sticks labels on the perspex case. Each label is printed with the relevant logic symbol. By connecting patchcords between the sockets on the 'breadboard,' the student can build up a logic network. The LEDs indicate the state of the various outputs. Each of the boards also has various 'utilities' — several clocks, a random logic output and handswitches to provide inputs.

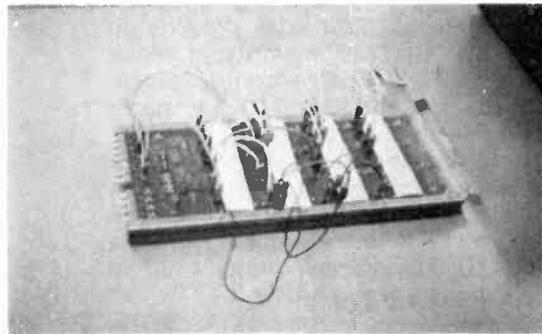
All of these functions are provided by the computer — the sockets all lead into it's bus and it is the computer which drives the LEDs. This means that not only is there no possibility of the students damaging ICs which would then have to be replaced, but also that any component can be 'synthesised' — the department has even designed an imaginary CPU for use with the system.

The computer also calculates propagation delays — the students learn the pitfalls of race hazards in digital systems. It is even possible to simulate faulty components — as a fault-finding exercise. Another system (experimental as yet) can pretend to be linear components as well. Clearly the teaching possibilities offered by such a system are tremendous — what price blobboards now?

— Phil Cohen



Martin Cripps telling the machine what it's supposed to be!



What the students see. The wires disappear into the table — some conjuring trick!

Our thanks to Roy Francis and Martin Cripps of Imperial College for their time and trouble.

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**LCD Multimeter Kit — Measures Voltage (AC/DC), Current, Resistance, Temperature\*.**

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# LOUDSPEAKER PRINCIPLES

ON PAPER most loudspeakers look to be terrible pieces of design. Distortion averaging 1%-2% — and what's worse varying with frequency. Efficiency only rarely exceeding 1% — so that the vast majority of those carefully nurtured, 0.002% THD amplifier watts pumped in down those non-inductive £10 a metre cables turn into nice, safe, un-musical heat!

The purpose of any loudspeaker is to convert an incoming complex electrical signal into compressions and rarefactions in the air—sound waves — which can be perceived as being as close to the original signal as possible. The different methods now being used to realise this end form the basis of this article.

## What Is Left Undone

You will find references throughout this article to frequency divider — crossover — networks. Unfortunately there is too much to be said on that subject to allow a full and proper treatment of it within this article, and we shall return to it in a companion article later.

Forgive us our evasion.

Loudspeakers of whatever variety interact crucially with the surroundings they are used in — the living room, studio or whatever. When judging performance it is vital to remember this, and even moving a speaker around in a room can significantly alter performance. Some manufacturers are becoming sensitive to this themselves — notably AR — and are producing designs specially tailored to a particular location, or allowing adjustment of output to suit varied positioning (AR 10π, AR9).

Such adjustments are generally carried out within the crossover network, and alter the electrical inputs to the units to compensate for specific emphasis placed on certain frequencies — usually the bass — by the loudspeakers position.

## And What Is Not

We have concentrated on the major fundamentally different systems in commercial use today, and tried to explain how they operate what their advantages are, and what are their drawbacks. Many minor variations have been left out simply through lack of space.

Forgive us our omissions.

The types covered are:

1. Moving coil — and methods of loading
2. Electrostatic
3. Isodynamic
4. Ribbon
5. Piezo-electric
6. Motional Feedback Control

**Every hi-fi must have not one but two. Loudspeakers are perhaps the weakest link in the precarious hi-fi chain. Many methods of improving the sound we hear have been tried. Few have succeeded well enough to reach production. Ron Harris explains the innermost secrets of those that made it!**

## MOVING COIL

This system dominates the field at present, and is certain to do so for the foreseeable future. The principle is an exact reverse of the microphone principle, and takes its being from the fact that a wire carrying a current  $I$  in a magnetic field of flux density  $B$  will experience a force,  $F$ , where

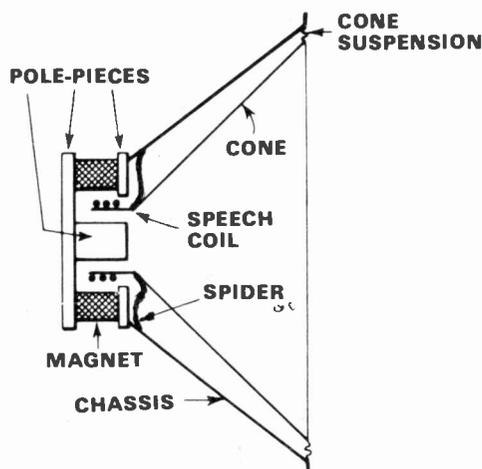
$$F = B.I.k \quad k = \text{a const.}$$

A coil of wire carrying the audio is sited within an intense magnetic field, and is attached to a 'cone' as shown in the diagram. The cone is held in position by the edge suspension and 'spider'.

When a signal passes through the coil the force produced tries to push it out of the field in one direction or another, and this movement is transferred to the air by the movement of the cone. The suspension system provides a 'return-to-rest' force. This movement is related more or less linearly to the input as long as the coil remains within a constant field.

If it moves out, then the relationship will change, introducing non-linearity or distortion. For this reason large and powerful magnets are employed, which have as great a depth of field as possible.

Another solution is to use very long coils so that the number of turns of wire within the gap between the pole pieces remains relatively constant.

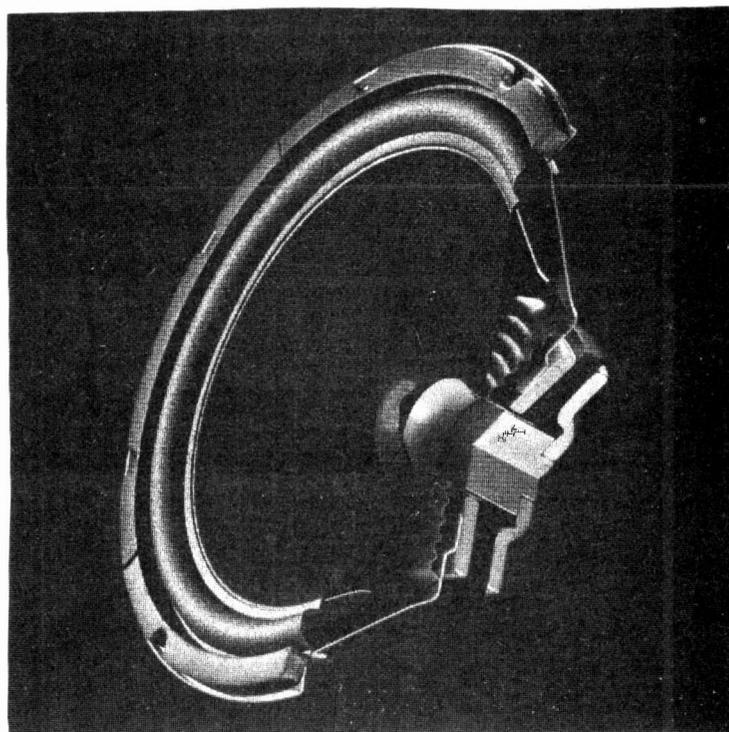


Basic schematic of moving coil loudspeaker. In practice the coil winding would be longer relative to the magnets, so that it did not move out of the field.

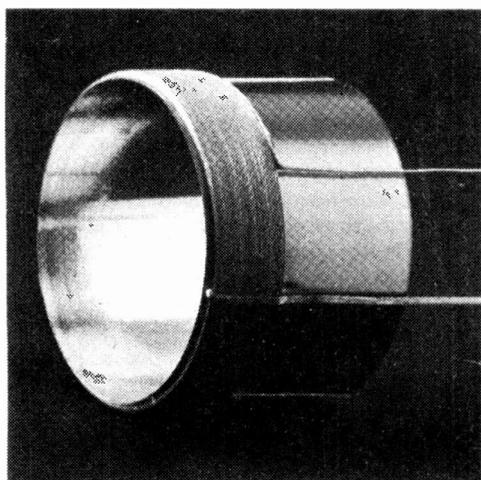
### Heated Exchange

Heat is generated in the coil and must be conducted away, usually by the magnet assemblies and chassis. AR speakers now incorporate a heat conducting fluid which is present in the gap and the coil is immersed in this. Heat conduction is thus improved and power handling raised. The fluid also acts as a damper to aid movement control.

The speaker chassis must be as rigid as possible, since the only reason the coil and cone move and it doesn't is that it weighs more! Any resonances present in the structure will act to transfer energy from the coil movement and hence distort the output.



Cutaway photo of a moving coil unit — in this case a Bose driver. If you look carefully you should be able to identify the voice coil, magnet assembly, spider and cone assembly.



Close-up of a voice coil. This is a machine wound unit belonging to a Bose driver. Note the winding is butted very close to the edge of the paper former, and the precise nature of the winding necessary for linearity.

### Cone-ventional?

The greatest drawback of this system is the cone itself. This is usually either doped paper or Bexetrene — an erstwhile packing material someone fell over once! It should act as a piston to the air, with the entire surface moving together to produce the required air movement.

However, since it is driven only at the centre, unless the material is possessed of infinite rigidity(!) flexing or

rippling will take place — once again deviating from the input signal. The larger the cone the worse the effect as the frequency rises, since the centre driven portion may well be oscillating with a period smaller than the time taken for the energy to be transmitted through the cone material to the outside edge.

Hence the centre of the cone leads the outside by a number of cycles, all of which appear as ripples in the cone. This is the reason for dividing up the incoming electrical signal, and for employing smaller coned drive units for higher, less energetic, frequencies.

To handle the high end of the audio spectrum, dome units have almost entirely replaced the coned variety, as they spread the sound more evenly, giving a better dispersion across the listening area. Also domes can be produced smaller, and a hemispherical dome, edge driven, will tend to act more as an integral surface than a centre driven cone.

### Getting A Hangover

Since the cone has mass, and therefore inertia (Dr. Who excepted) it cannot respond instantaneously to changes in direction called for by changes in polarity of the electrical signal. This inability to get back in time is called 'overhang' and is another problem facing designers. To minimise it driver mass has to be as small as possible, while rigidity has to be as high as possible.

This has led over the years to many experiments with metal cones, mylar cones, polyester et etc etc. Anywhere other than bass units most of these have proved successful. ▶

An integral part of a moving coil loudspeaker design is the method of housing the units, and thus putting an acoustic-loading upon the actual units. A brief discussion of the various methods is thus required at this point.

### Housing Shortages

There are basically six methods of providing a home for drive units and at the same time augmenting its performance. These are:

- (i) Finite Baffle
- (ii) Acoustic Suspension (sometimes called Infinite Baffle)
- (iii) Bass Reflex
- (iv) Auxiliary Bass Radiator
- (v) Transmission Line
- (vi) Horn Loading

All of these apply primarily to moving coil units with the exception of horn loading which can be used to enhance efficiency of several types. In order then:—

### Finite Baffle

Since the vibrating cone is emitting sound waves in both directions, unless prevented the two waves will interact causing cancellation and reduction in acoustic output. The effect is reduced by placing the speaker in the centre of a large solid board to make it difficult for a compression produced in front to cancel the rarefaction produced behind the speaker.

Obviously an infinitely large piece of wood prevents this entirely, but such things don't grow on (ANY) trees(!?) and so the finite baffle is an attempt to do the best that can be done.

Once the sound wavelength approaches the baffle size destructive interference takes place and response rolls off.

This method is responsible for those hardened enthusiasts mounting their bass units flush into walls and sides of houses!

Sinclair marketed a finite baffle speaker some years ago but this seems to have ceased to be.

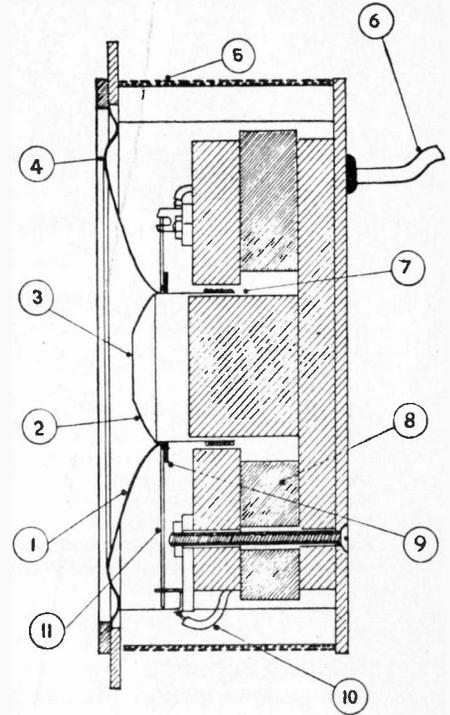
### Acoustic Suspension

Here the rear radiation from the units is (hopefully) entirely suppressed by totally enclosing the unit in a box, and radiating through a hole in that box (sounds odd when phrased like that eh?).



**The AR9.** Coming from one of the 'founder' manufacturers it represents Acoustic Researches state of the art. The cabinet is treated around the baffle with absorption material to prevent diffraction and re-radiation effects that lesser enclosures suffer from. It also stands an endearing 53in high!

**Schematic of a Jordan Watts driver module.** Numbers refer to: 1. Metal cone contoured to hyperbolic law. 2. Phase correcting dome. 3. Resistive termination to dome centre. 4. Resistive termination to cone edge. 5. Acoustic damping. 6. Direct input signal cable. 7. Coil completely immersed in magnetic field. 8. High efficiency "Feroba" magnet. 9. Resistive termination at junction of cone, coil and suspension. 10. Connections to coil via suspension. 11. Silvered beryllium copper suspension cantilevers.



Damping of the cone movement occurs due to the compliance of the trapped air, and the suspension system now consists of both the actual cone suspension plus the air load.

In order to preserve bass response the enclosure should be fairly large and hence present a good air load allowing high levels of energy to be applied. Bass units designed for this type of loading have a high cone mass and high compliance. In addition they are generally of the long voice coil variety. The air load then applies most of the restoring force required by the design. Efficiency is reduced since the cone mass is increased and compliance (total) is low.

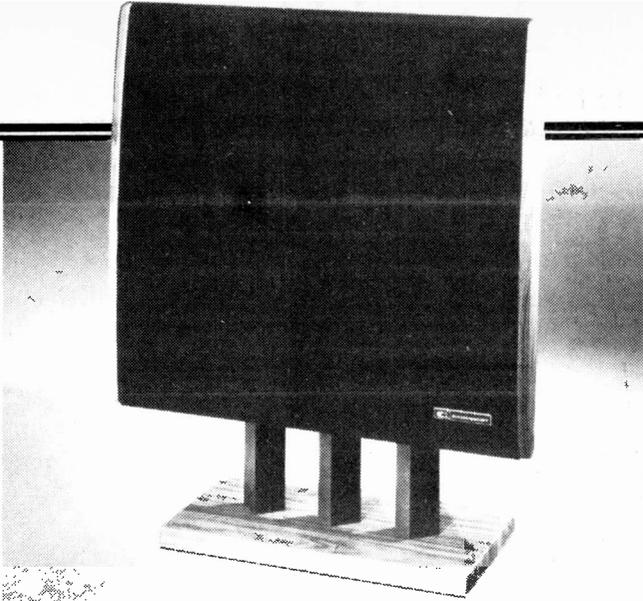
### Bass Reflex

The aim of this method is to raise efficiency at low frequencies and thus decrease the required enclosure size for a given bass output. This is accomplished by addition of a vent, or port, in the front panel of the enclosure. This allows a controlled movement of air between cabinet and room. The effect of careful design of vent dimensions and placement is to produce an effective addition to bass response below a certain frequency, such that the air moving out of the vent aids the air movement produced by the bass driver.

Above the operating frequency the vent has no effect on performance (they hope).

### Auxiliary Bass Radiator

Basically a variation on the above principle, but with the vent 'plugged' with a driverless unit or suspended mass. This is tuned to provide antiphase radiation in the required frequency band. Above this band the unit acts like part of the enclosure wall. Perfected and practised by Celestion, and perhaps epitomised by the Ditton 66 design.



**The DQ10.** This design makes use of what the makers term a 'phased array'. This means that the driver units are staggered so that their effective radiator 'points' are equi-distant from the listener which eliminates the time delay distortion (phase linear?) flat baffle designs are prone to. In addition each driver is mounted on its own optimum sized baffle to minimise diffraction problems.

## Transmission Lines

This is another method of 'losing' the rear radiation of a drive unit, or making it think it is working into an infinitely long column. This is achieved by having a maze of woodwork inside the enclosure which is filled with graduated damping material. In this way total column length can be far greater than enclosure dimensions.

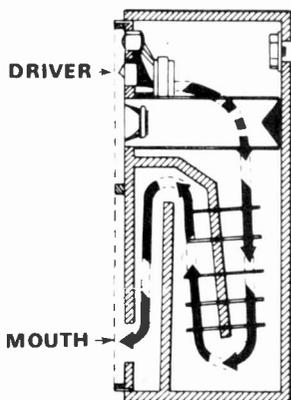
If the far end of the column is open then help is afforded to the bass performance in much the same way as bass reflex cabinets.

The design is usually for almost total absorption of the rear wave — and this leads to a gradual and smooth fall off in bass response due to the almost constant velocity working conditions for the cone.

Conversely to both acoustic suspension and basis reflex loading methods, transmission line methods lower the bass resonance of the drive units and hence enhance LF performance.

IMF have championed this technique for long time passing now, and as exemplified in their products transmission line bass possesses a 'solid' quantity totally different to that from the other methods. It is more extended and more realistic. Used in a large enough room there is no better way to replay the lower registers.

Oh for a successful combination of transmission line bass and electrostatic HF!



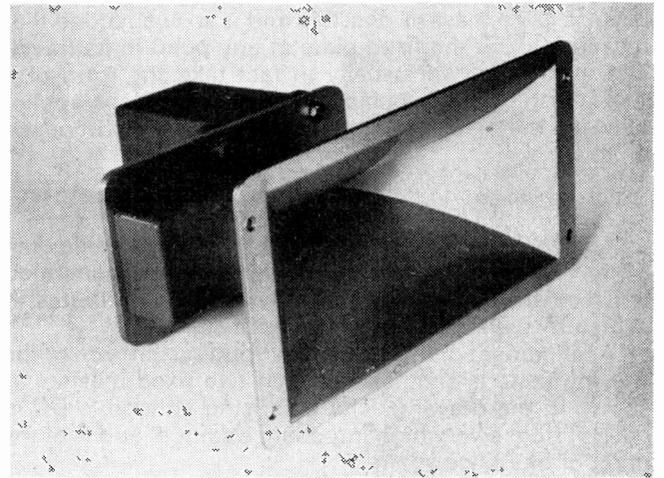
The basic principle behind the transmission line speaker enclosure. The air from the rear of the cone gets 'lost' down the line.

**KEFs 105 linear phase design.** The upper two enclosures are rotatable to aid stereo imagery. Note the rounded edges to prevent re-radiation and the staggered drivers with respect to the listener.

## Horn Loading

A method of designing to considerably reduce required driver excursion for a given acoustic output. The driving element is coupled to its air load by a gradually 'flaring' throat — usually exponential in cross section.

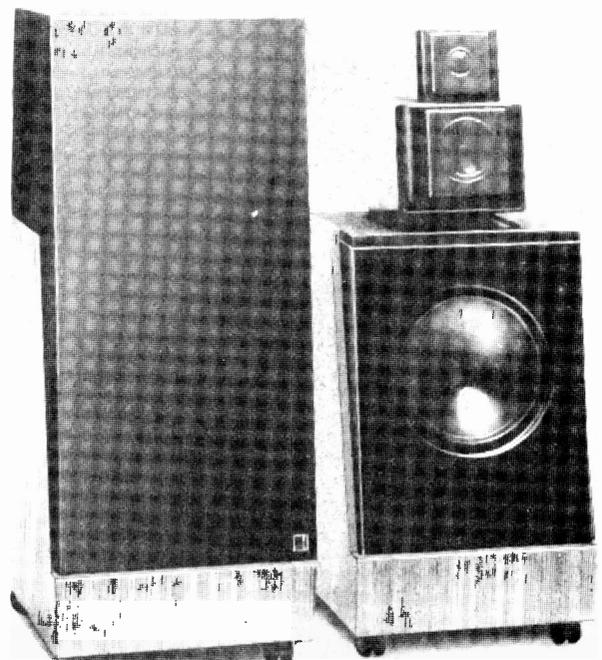
The horn converts the high pressure, low velocity sound energy present in the region of the driver into low pressure high velocity waves for propagation. The advantages of this type of loading are good damping of the driver, low distortion but a limited frequency response.



**The Decca London ribbon unit, loaded by a catenoidal horn.** The flare can be clearly seen in this photo leading down to the ribbon itself somewhere in that block at the back!

To design a single horn to cover the entire audio spectrum is a confused exercise, and one yielding impractical results for domestic use, since an exponential horn to reproduce 30 Hz has a mouth of 1.5m diameter and is some 4m long! Folding the horn back and forth within an enclosure can reduce dimensions, and the American firm Klipsch market units which employ the room walls as extensions of the horn to reach lower frequencies. Usually though, the system is used to load MF and HF units within a system.

Advantages of this principle are phenomenal efficiency  $\approx 10\%$  compared with 1% for bass reflex for bass reflex and 0.1% for transmission lines, and an attack unmatched by any other cone driver recipies. ▶



# ELECTROSTATIC

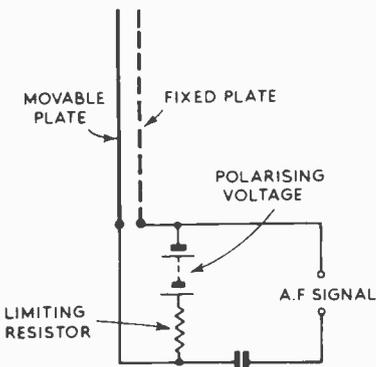
As we have seen the moving coil design suffers because the cone area is unevenly driven by the electrical music signal. The electrostatic principle, developed by both David Tombs and Peter Walker (of the Acoustical Manufacturing Company) is an attempt to produce a unit in which the entire surface of the unit is driven by the input signal.

At its most basic the design consists of two plates as shown in the diagram. The moveable plate is made to have as low a mass as possible and is so suspended that it cannot touch the fixed plate at any point in its travel. The fixed plate will usually in fact take the form of a metal 'mesh'. A high polarising voltage  $\approx 5\text{kV}$  is applied between the plates, and the audio signal superimposed on this.

An electrostatic force—such as that which holds dust on to LPs and LPs onto turntables—is thus generated between the plates and the moveable one vibrates in sympathy with variation in the input signal.

A refinement of this is the push-pull system where the moving plate is situated between two fixed meshes as shown in the drawing. The polarising voltage is DC in nature, from a very high impedance source, and is of the order of  $5\text{kV}$  once again.

The outer plates (meshes) are fed from a step-up transformer connected to load the incoming signal. This applies a high voltage electrical AC signal to these plates (the music signal) and causes the center plate to move in sympathy with this. Distortion is greatly reduced using this push-pull arrangement and can equal  $0.5\%$  in a good design.



**Scheme of operation for electrostatic loudspeakers. On the top we have the basic single ended design, and below that the commercially employed, much-improved push-pull scheme as employed by Quad and Koss amongst others.**

This system first appeared on the market many many years ago in the form of the Quad electrostatic system—which remains largely unsurpassed for lack of colouration and mid-range clarity.

The advantage of driving the plate evenly over its whole area show up as a linear frequency response—no rippling or 'break-up'—very low distortion and a good transient performance due to low driver mass.

However this system does have inherent drawbacks. Consider the Quad system as an example. It is noted for its mid-range clarity and its high frequency accuracy—but also for its lack of extreme bass and its beaming of top end signals—poor vertical dispersion.

The reason for this is its physical size. Since the push-pull radiator is by nature a dipole radiator—sound emitted both front and back, some cancellation at frequencies whose wavelength exceeds the plate dimension is inevitable.

The Quad is also very room sensitive for this same reason. Rear radiation can be dumped, but not without acoustically loading the plate—an undesirable excursion into non-linearity. At high frequencies there is low energy in the wave to absorb, and so this is easier to affect without adverse consequences on the drive plate.

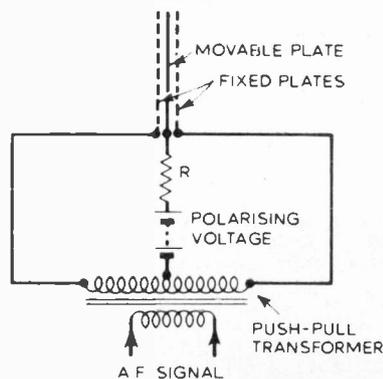
KLH made a brave attempt to reach the theoretical size of plate for good bass response with their superb KLH9 full range units. These are almost exactly door sized—and you need **two** per channel! And they cost £2000 a pair. And they are probably unbeatable by any speaker on the market for sheer accuracy and delicacy. Their size endows them with a hefty bass punch too. Units to sell your soul for. (Anyone listening down there?)

## Loading Problems

Another less serious drawback is that transformer into which the electrical signal is fed: This presents an awkward load to the amplifier, and can produce some nasty effects from transistor amps.

Modern designs however—Lecson, Quad and the rest, can cope perfectly and experience no traumas when presented with the wickedly reactive termination characteristic of electrostatic speakers.

Many attempts have been made to marry together electrostatic mid-high drivers with cone bass units. B&W DM70 was perhaps the first (and the best!) but not have been entirely successful. Perhaps its simply that the superior distortion and colouration properties of the electrostatics will always show up the bass units!



## ISODYNAMIC

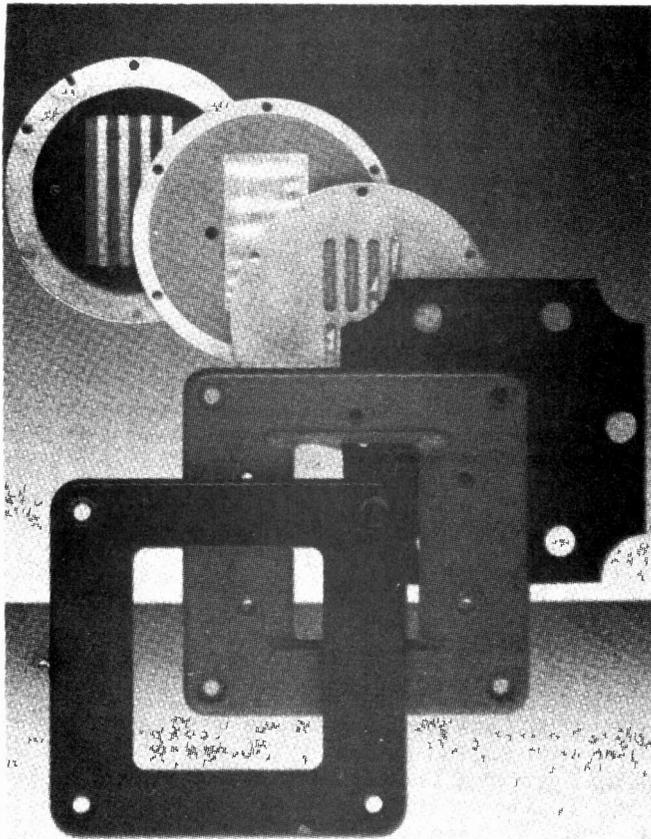
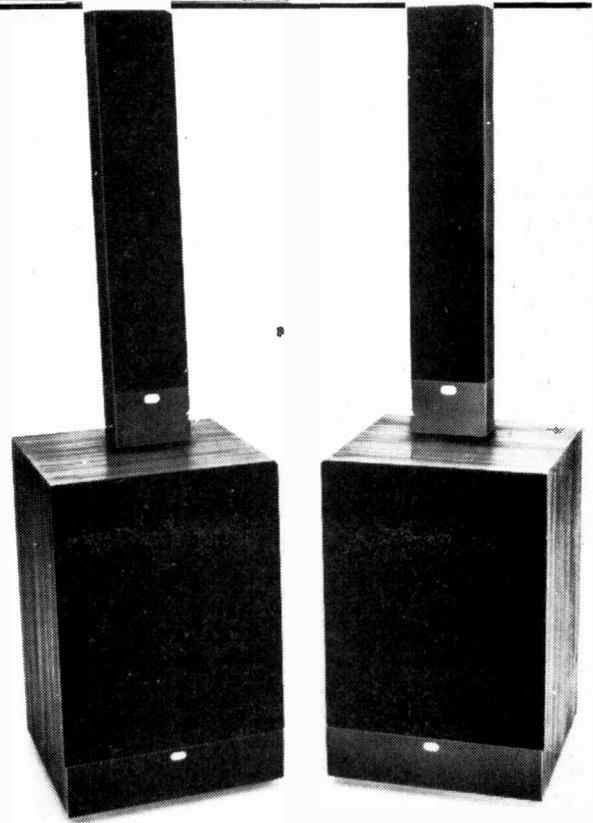
With the release of the Stathearn 21000 speakers, and the new Wharfedale series incorporating Isodynamic tweeters, this approach is gaining ground. It certainly has a lot of promise, which we shall undoubtedly see exploited as time goes on.

The principle was pioneered by Wharfedale with their Isodynamic headphones some six years ago or so. It is really an attempt to gain the advantages of the electrostatic system, without the need for high voltages and attendant drawbacks.

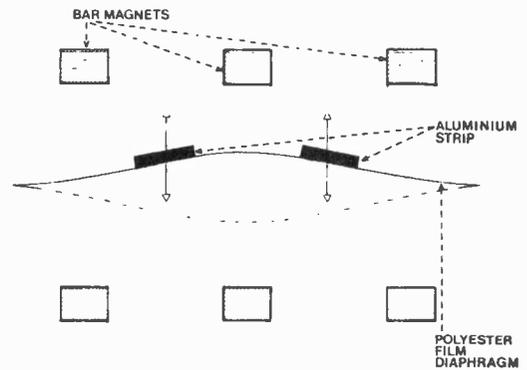
A drive unit built to this principle consists of a thin sheet of mylar, or some such material, with a conductive track bonded onto it in a pattern which covers the surface in as symmetrical a manner as possible. This conductor acts as the voice coil of the speaker, and when an electrical signal is passed through it it responds to nearby magnets by moving the diaphragm in sympathy.

Once again colouration is low, and driver mass small—but also once again to obtain bass means large areas, and conductors capable of handling large currents. Stathearns units are above 500Hz operators only and are transformer coupled to the input. Wharfedale employ their invention in high frequency units only.

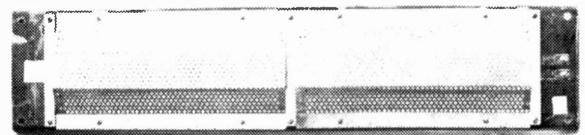
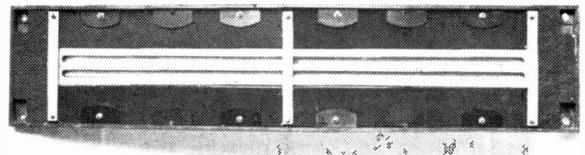
A pity—but one we might see rectified sometime in the future.



Exploded view of the Wharfedale Isodynamic tweeter. The driver plane — second from the rear — uses a material 25 microns thick with an etched aluminium circuit.



The 21000 from all angles. At the top we have the full system. Below that the diagram shows the operating principle of the SLC1. The polyester diaphragm acts as the speaker cone. Below this caption two internal views of the unit. The radiating areas can be seen in the top diagram, and the lower rear view illustrates the damping material to control rear radiation.



## RIBBON

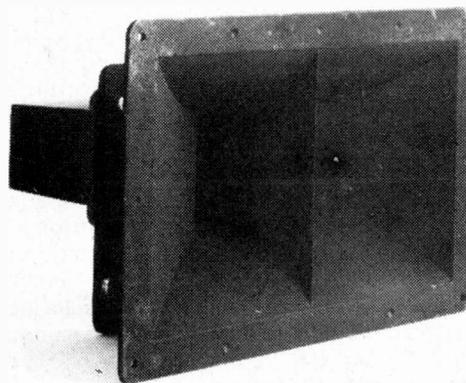
If we take the voice coil of moving coil speakers, and make this the active element, instead of the cone, we would do away with a lot of the causes of colouration in the process. Mass would be much smaller, break-up or rippling would be greatly reduced, if not eliminated and thus transient handling improved.

The ribbon loudspeaker does exactly this. A very thin metal 'ribbon' is suspended between the magnet pole faces and the signal passed through it. It will vibrate with the signal, and thus produce the sound output.

Acoustic output is low, and horn loading is usually employed to alleviate this problem.

Once again obtaining bass is a major problem, and moving coil units will take over from the ribbon as the frequency decreases.

Decca market an excellent example of this principle, which operates above 2.5kHz.



Decca's ribbon loudspeaker. This features a ribbon element one tenth the thickness of human hair, and is horn loaded to increase efficiency. An 'acoustic lens' can also be fitted to aid sound dispersion.

## PIEZO-ELECTRIC

In the July 1976 edition of ETI we reviewed the Motorola KN 6006A, the first piezo-electric unit to be released commercially. Since that time many commercial loudspeaker enclosures have employed piezo-electric tweeters for their total insensitivity to crossover networks, phenomenal transient response and clean subjective sound quality.

Piezo-electrics have been around in hi-fi for a long time now in the guise of crystal/ceramic cartridges. The principle of operation is based upon the fact that stress a piezo-electric crystal and a voltage proportional to the applied force is produced across its ends.

Conversely therefore if we apply a varying voltage across the ends of the crystal, mechanical deformation occurs, sympathetic to that voltage. No magnets are required, and no coil is used.

In the Motorola design two thin slices of ceramic material—lead zirconite-lead titanate in case it makes your life the fuller for knowing are epoxied onto a brass separator, and nickel electrodes deposited on to a facilitate connection. In order that the discs respond correctly to the input, they are polarised in opposite senses, so that on application of a common signal one disc expands and the other contracts—acting in the same direction therefore on the air load.

### Pros . . . . .

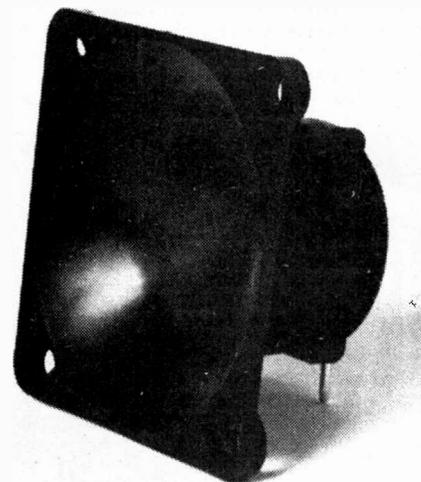
Since the impedance curve for the unit shows a steep rise in value with falling frequency, the unit does not need a crossover to reject low frequencies.

A perfect tweeter.

Since there is no voice coil or cone the driver mass is significantly lower than an equivalent conventional speaker.

Being composed of a ceramic material heat dissipation is less of a problem also, and the Motorola can stand 35V RMS for protracted periods with no signs of distress.

Due to the nature of its impedance, it is difficult to compare efficiency with normal units, suffice it to say that 4V RMS produces 105dB at 18ins distance, and that this can be considered efficient!



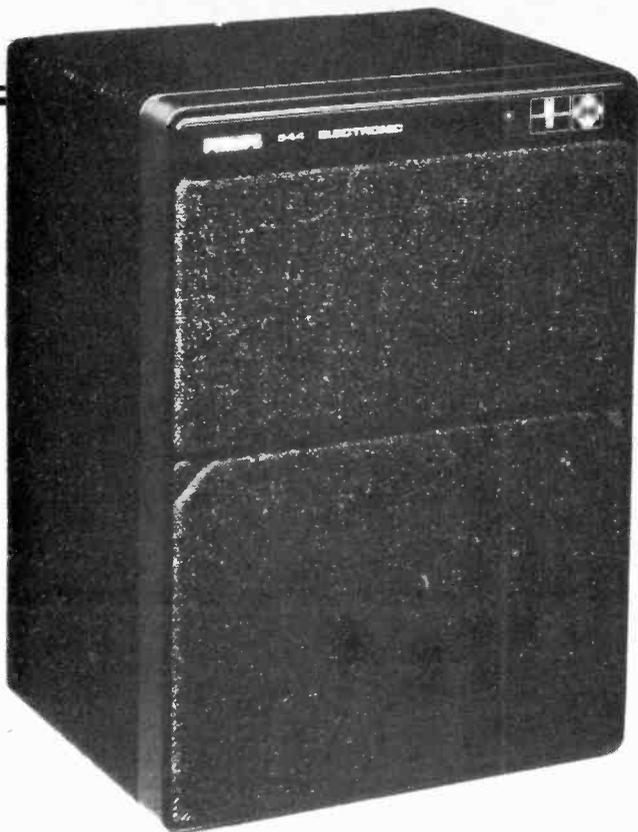
Motorola's KN 6006 piezo-electric high frequency driver. The actual driver is the small section at the rear, and the horn is to increase acoustic efficiency.

### . . . . . And Cons.

Some amplifiers may not like the load any more than electrostatic units, but since these things are normally used with a good deal of attenuation and response shaping circuitry between them and the valued output stages this should not be too great a problem.

Subjectively these units have always sounded a little 'hard' to me, and never as smooth as a good dome unit like the Isophon or Celestion 2000 designs. Still personal taste and all that . . . . .

Once again acoustic efficiency is low, and horn loading is employed.



### MOTIONAL FEEDBACK

Although this perhaps only a modification of earlier systems, the performance gains at LF are such that it warrants a closer look.

Motional feedback is a form of feedback control of the driver cone in moving coil systems. The power amplifier are mounted within the enclosure, a separate amp for each drive unit, and so signal feed is from a preamplifier. The system is marketed by Philips.

The main advantage of this extra complication lies at the bottom end of the range where the output for given enclosure volume is considerably enhanced. The complication lies in the sensor fitted onto the driver.

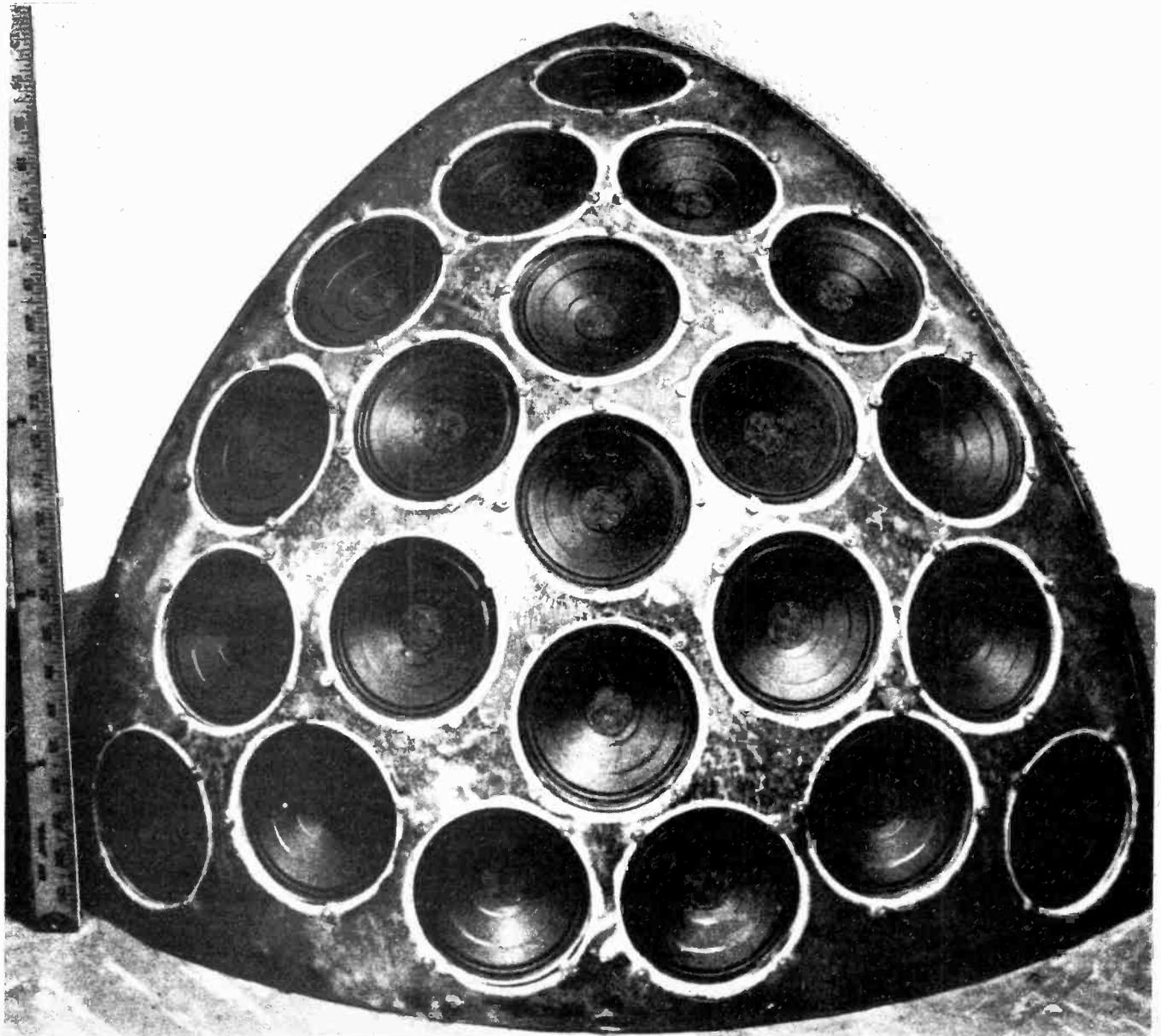
This is mounted on a small PCB and is a ceramic acceleration sensor. This generates a signal proportional to the actual driver output, and this is compared electronically to the incoming audio. Correction is applied to remove any errors present. Cross over is carried out at small signal level, and active filters with all their inherent superiority are applied.

There is a 'slave' output which allows the enclosures to be stacked up to increase power handling and effective output.

**ETI**

**Philips loudspeaker RH 544 Motional Feedback design. This unit incorporates a separate bass power amplifier, and a lower power amplifier for mid-high frequencies. Bass performance is exceptional for the tiny enclosure size, but other areas of output are undistinguished.**

**This is one-eighth of the perfect speaker! Many experts consider that elusive device to consist of a pulsating sphere operating in free field conditions. Bose built this approximation to test pulse waveform response. From here sprung the excellent Base 901 series III loudspeaker.**





# CAR TACHOMETER

**We've been contemplating a digital car tacho, but have been put off by resolution and response speed problems. However this Phase Locked Loop design overcomes these quite neatly — so here it is!**

WE HAD OFTEN considered the design of a digital tacho for automobile use, but had rejected several schemes as we were unable to get both good resolution and response time — the two seemed to provide a very good demonstration of Heisenberg's Uncertainty Principle.

Consequently, we were rather pleased when Mike Pratt of SM Electronics came to us with his phase-locked loop based design which got round the problem. Would we like to do it as a project, he asked? Obviously, we said yes, and here it is.

This tacho features a fast response time, coupled with 10 Hz resolution, through the use of a phase locked loop frequency multiplier. It can be set up, by means of a single link, to work on 4, 6 or 8 cylinder motors.

## Design Features

To measure the revolutions per minute of a motor is simply a matter of counting the number of ignition pulses over a given time. With a four-cylinder, four-stroke motor there is such a pulse twice per revolution. Therefore if we count these pulses for 30 seconds we will have revs/min with a one cycle resolution. Obviously this is much too long a sample period for practical use in a motor car and some compromise has to be made.

The usual solution is to use a 100 rev resolution and a sample time of 0.3 seconds (on 4 cylinders). We considered this inadequate which is why we have not published a design until now.



In this design an oscillator is used which is phase locked to the ignition pulses except at a higher frequency (x8 for 4 cylinder) allowing a short sample time (0.375sec) with a 10 rev resolution. By using a different multiplication factor compensation for different numbers of cylinders can be made. Unfortunately with the multiplication factors used (x8, x6, x4) the sample time for 6 cylinders is not exactly the same as that used for 4 and 8 cylinder motors. Altering the ratios to x12, x8 and x6 would enable a 0.25 sample time to be used for all ranges, but this is not possible with the divider IC utilised in this design.

## Construction

Assemble the PCB with the aid of the overlay ensuring the components are

orientated correctly. The tantalum capacitors normally have a + mark indicating the positive lead, or a dot on the side. When soldering the CMOS ICs (4, 6, 7) earth the tip of the soldering iron.

Note that there is one feedthrough or link between the two sides of the board near C10

## Calibration

Initially place a link between the point 'C' and the terminal corresponding to the number of cylinders. Now with the power supply connected feed a 50 Hz signal of between 12 and 30 V into the points input using the 0 V as common. Now adjust RV1 until the display reads 1500 RPM for 4 cylinders, 1000 for 6 or 750 for an eight cylinder car. ▶

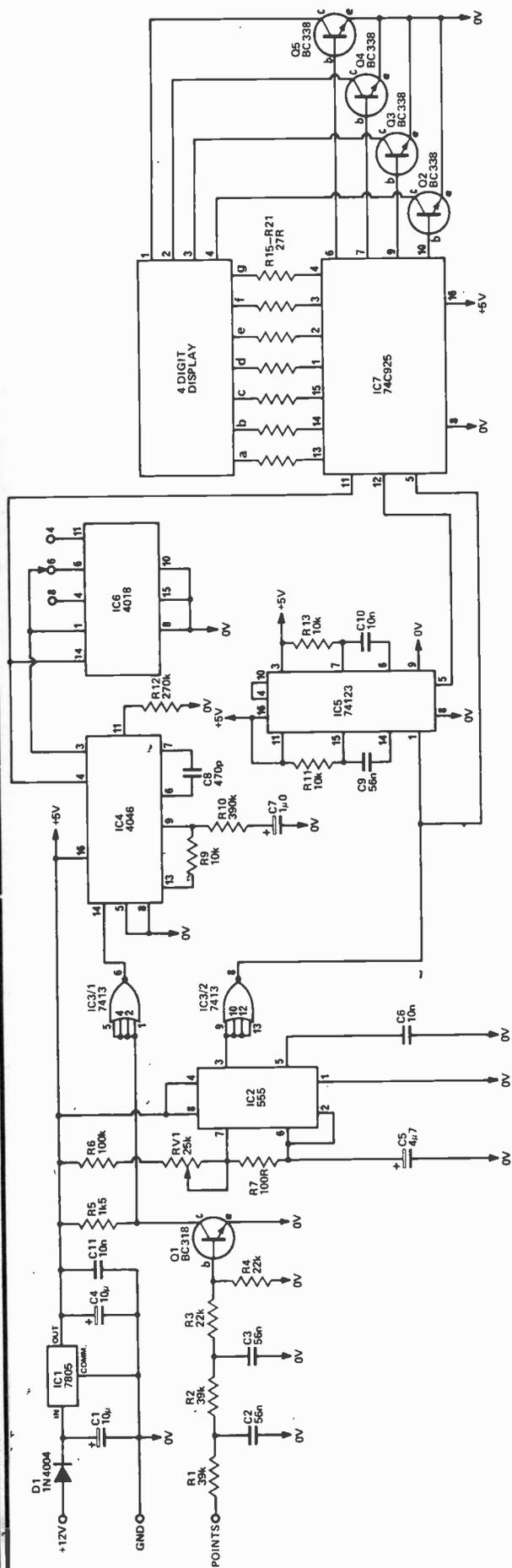
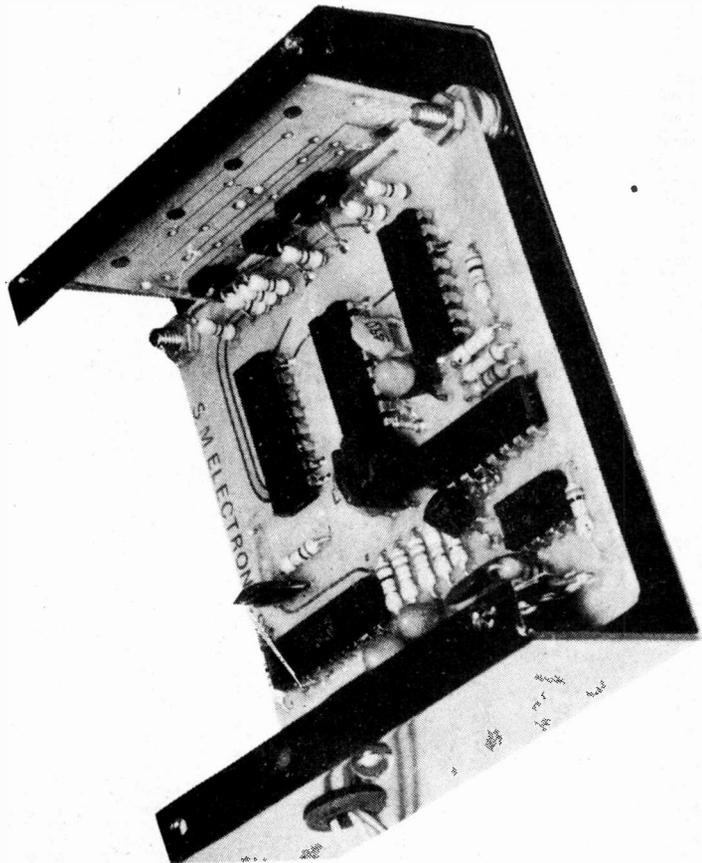


Fig. 2. Full circuit diagram for the digital car tacho unit.



### HOW IT WORKS

The output from the points of the distributor is basically a 0 to 12V square wave with a 200 volt pulse on the rising edge. A filter network, R1-R4, C2, 3 is used to remove the high voltage pulse (and points bounce) and Q1 buffers it giving a +5 to 0V output on its collector. As the filter network removes the sharp edge of the input a schmitt trigger is needed on the output of Q1 to give fast edges. IC3/1 is used for this.

The output of IC3/1 is connected to the input of the phase-locked loop IC (4046). This IC has an internal voltage controlled oscillator and its output is divided by 4, 6 or 8 by IC6 and this lower frequency is fed back to the phase-locked loop IC. The IC then compares this frequency to that at its input and adjusts the internal oscillator until it is the same. The result is a frequency which is an exact multiple of the input.

The time base is generated by IC2 (555) which has a negative output pulse, about 300  $\mu$ s wide every 375 ms (or 333 ms for 6 cylinder). This is inverted by IC3/2 and is used as the strobe pulse for the 4 digit counter IC7. This pulse also triggers the first of the monostables in IC5 which gives a 200  $\mu$ s delay before triggering the second half of IC5; this gives a 40  $\mu$ s pulse to reset IC7 back to zero.

IC7 is a 4 digit counter with a latch (store) and seven segment decoders to drive the digits but the segment drivers are internal. As we need only a three digit counter, i.e. for good resolution, with the right hand permanently zero the least significant digit is connected to the second right digit, etc, with the most significant digit connected to the right hand digit. Provided one does not exceed 9990 RPM this digit will remain on 0 as intended!

The 555 timer, the TTL and the 74C925 needs a regulated +5V and IC1 provides this with D1 preventing damage due to reverse polarity inputs.

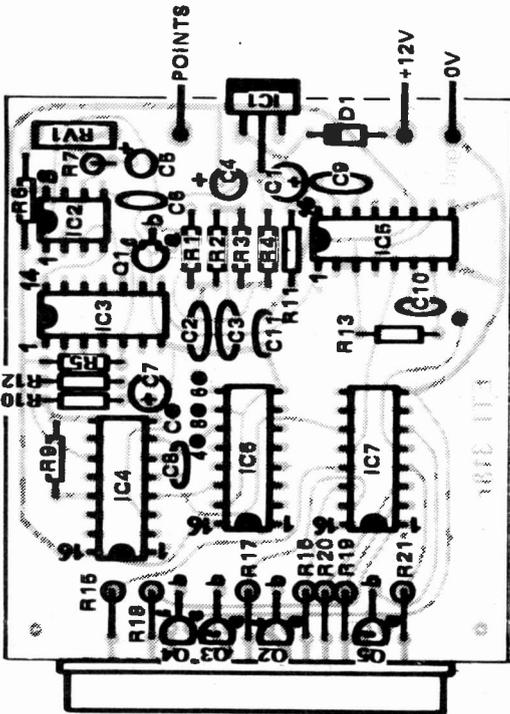


Fig. 1. The component overlay for the board. The board is double sided although only the lower surface is shown here. Note the link between the two surfaces of the board near C10.

## SPECIFICATION

**Range**  
 100 to 9990 RPM  
**Resolution**  
 10 RPM  
**Reading rate**  
 4 or 8 cylinders  
 6 cylinders  
**Power supply**  
 7 to 15V @ 400mA  
 Suitable ignition systems standard  
 CDI  
 transistor assisted  
 'it will not operate on  
 'pointless' systems

## PARTS LIST

|                |                        |
|----------------|------------------------|
| RESISTORS      | all 1/4 W, 5%          |
| R1,2           | 39k                    |
| R3,4           | 22k                    |
| R5             | 1k5                    |
| R6             | 100k                   |
| R7             | 100R                   |
| R8             | not used               |
| R9             | 10k                    |
| R10            | 390k                   |
| R11            | 10k                    |
| R12            | 270k                   |
| R13            | 10k                    |
| R14            | not used               |
| R15-R21        | 27R                    |
| POTENTIOMETER  |                        |
| RV1            | 25k trim               |
| CAPACITORS     |                        |
| C1             | 10u 25V tantalum       |
| C2,3           | 56n polyester          |
| C4             | 10u 25V tantalum       |
| C5             | 4u 7 25V tantalum      |
| C6             | 10n polyester          |
| C7             | 10u 25V tantalum       |
| C8             | 470p ceramic           |
| C9             | 56n polyester          |
| C10            | 10n polyester          |
| C11            | 10n ceramic            |
| SEMICONDUCTORS |                        |
| IC1            | 7805 regulator         |
| IC2            | 555 timer              |
| IC3            | 7413 dual schmitt      |
| IC4            | 4046 PLL               |
| IC5            | 74123 dual mono        |
| IC6            | 4018 divide by n       |
| IC7            | 74C925 4 digit counter |
| Q1             | BC318                  |
| O2-Q5          | BC338                  |
| D1             | 1N4004                 |
| Display        | NSB5881                |
| MISCELLANEOUS  |                        |
| PCB            | Case to suit           |

## BUYLINES

The components employed here are all readily available from any of the major mail order companies advertising in this issue. Note that the counter is a CMOS chip, and not a standard bi-polar TTC chip. The standard component will not operate on this mode.

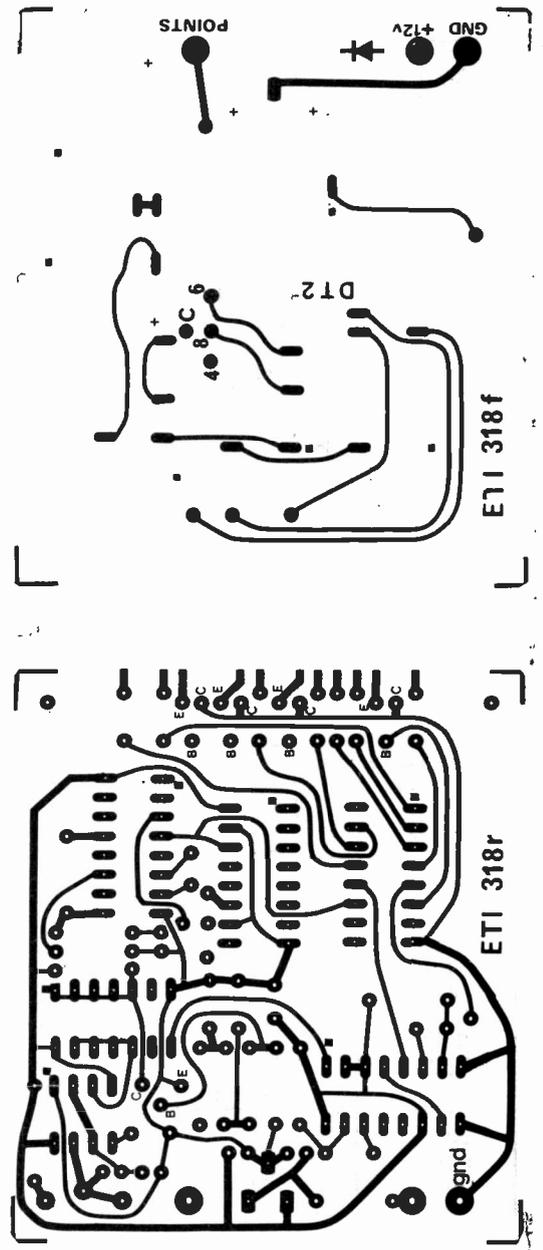


Fig. 3. PCB foil patterns shown full-size.

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|------------|--------------------------|------------------------|------|----------------|---------------|-----------------|-------|-------|
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|            | Graphic Equaliser PSU    | 602                    | .55  | 1.29           | —             | —               | 1.84  |       |
|            | R.F. Attenuator          | 603                    | —    | .26            | 1.54          | 1.35            | 3.15  |       |
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|            | General Purpose Pre-Amp  | 608                    | .55  | .92            | 3.95          | 1.65            | 6.97  |       |
| NO         | G.S.R. Monitor           | 609                    | .85  | 3.13           | —             | —               | 3.98  |       |
|            | Burglar Alarm            | 610                    | .70  | 4.70           | 7.10          | 3.95            | 16.45 |       |
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|            | 100 watt High Power Amp  | 619                    | 1.30 | 9.16           | —             | —               | 10.46 |       |
|            | High Power Amp PSU       | 620                    | 1.10 | 5.66           | 7.89          | —               | 14.65 |       |
|            | LED Dice                 | 624                    | .50  | 2.92           | .66           | 1.65            | 5.73  |       |
|            | Marker Generator         | 626                    | .80  | 3.68           | 1.49          | .90             | 6.87  |       |
|            | Skeet                    | 627                    | 1.60 | 11.12          | .97           | 4.53            | 18.22 |       |
|            | Flash Trigger            | 628                    | .65  | 3.48           | .84           | 1.65            | 6.62  |       |
|            | Disco Lightshow          | 629                    | 3.05 | 12.79          | 5.85          | —               | 21.69 |       |
|            | Pink Noise Generator     | 630                    | .60  | 1.00           | —             | 1.65            | 3.25  |       |
|            | Nov 76                   | 541 Train Controller   | T001 | .75            | 5.27          | 5.84            | 3.95  | 15.81 |
|            | Jan 77                   | 444 5-watt Stereo      | T002 | 2.00           | 14.03         | 6.84            | 3.45  | 26.32 |
|            | Feb 77                   | 448 Stereo Disco Mixer | T003 | 1.60           | 13.74         | .87             | —     | 16.21 |
|            | Dec 77                   | Clock B                | T004 | 2.10           | 11.31         | —               | —     | 13.41 |
|            | Jan 78                   | House Alarm A          | T005 | 2.00           | 10.93         | 3.05            | 9.50  | 29.37 |
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| Apr 78     | Gas Monitor              | T012                   | .80  | 10.11          | 1.10          | 1.35            | 13.36 |       |
| May 78     | Star Trek Radio          | T013                   | .84  | 6.19           | .93           | —               | 7.96  |       |
| Jun 78     | Stars & Dots             | T014                   | 1.83 | 5.33           | 11.49         | 5.00            | 23.65 |       |
| Jun 78     | Spectrum Analyser        | T015                   | 1.83 | 35.76          | 18.02         | —               | 55.61 |       |
| Jul 78     | Wein Oscillator          | T016                   | .89  | 6.36           | 4.80          | 2.40            | 14.45 |       |
| Jul 78     | UFO Detector             | T017                   | 1.45 | 10.80          | .80           | —               | 13.05 |       |
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| Sep 78     | Stop Timer               | T022                   | 2.30 | 14.27          | 11.04         | 1.65            | 29.26 |       |
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## SYSTEM 68

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|                                  |      |
|----------------------------------|------|
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| 630                              | .60  |
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| Spirit Level                     | .85  |
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| Experimenters Power Supply       | .90  |
| 555 Timer Board                  | .60  |
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# POWER SUPPLIES

One more from Tim Orr. This time he takes us through a series of different methods for powering up circuits. On the way he explains the theory behind each.

THE JOB OF producing stable regulated power rails has been much simplified by the introduction (about seven years ago), of three terminal fixed voltage regulators. These devices can make the power supply design problem relatively simple, but even so the designer must be fully aware of a lot of other important details that can cause poor results. Firstly, consider a simple unregulated power supply, fig. 1.

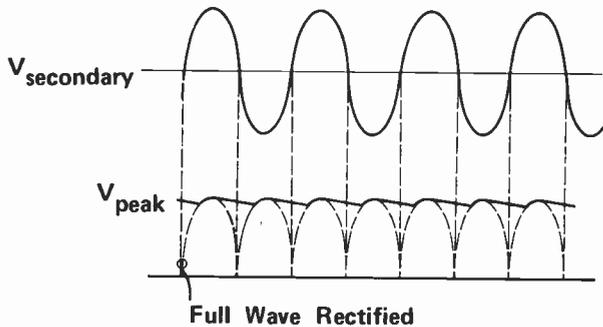
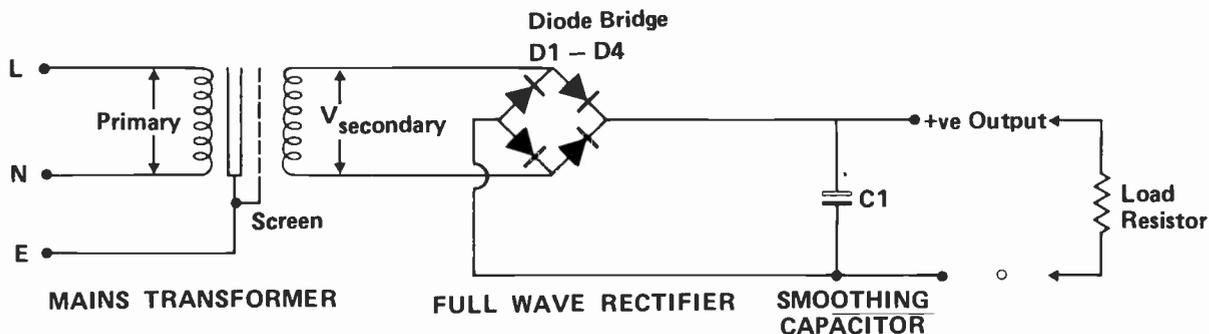


Figure 1. Below: an unregulated power supply. Above: The output (with a load resistor).



This piece of hardware has three sections, a step down, isolating transformer, a diode bridge and a smoothing capacitor. The transformer is driven from the mains, the voltage of which varies depending on where you live (it's 250V/RMS in Fulham). Some transformers have got a copper screen which isolates the primary winding from the secondary windings. For the purpose of safety, this should be connected to earth.

Also, for maximum safety, connect the 220/240/250 tapping to mains LIVE. Another type of mains transformer uses what is known as a split bobbin, the primary is wound on one bobbin, the secondary on another. Thus the two windings are inherently physically isolated, and so no safety screen is included. These two transformer types are generally constructed on what is known as an 'E' core; take one to bits and you will find that it is

The function of a mains isolating transformer is to physically separate the user end of a piece of equipment from the 'potentially' (!) lethal mains voltage. The transformer also provides a suitable voltage which can be rectified and smoothed and connected to a voltage regulator. This is the secondary voltage of a transformer and it is measured in VRMS at a particular loading.

That is, if the transformer is rated at 15V at 10VA, then the output voltage will be 15V when the load upon the transformer secondary is 10VA (10 watts).

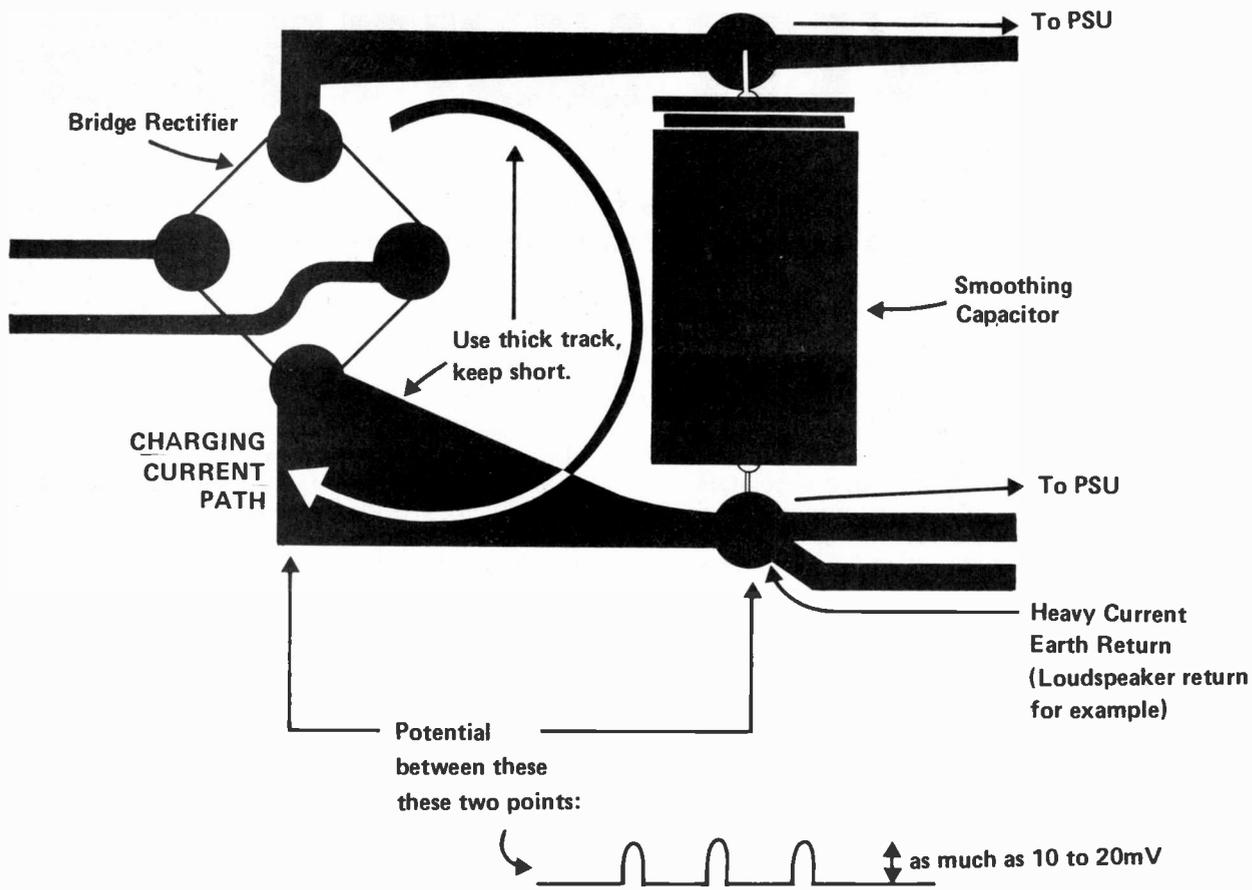
If the load is removed the output voltage will rise. The percentage change from load to no load is known as the TRANSFORMER REGULATION and is typically of the order of 20%.

To convert the  $V_{RMS}$  voltage to a DC voltage it must be multiplied by 1.4142. Thus a 15VRMS (loaded) transformer secondary will generate 21V2 DC when full wave rectified and smoothed, which will rise to 25V45 DC when the load is removed (assuming 20% regulation see Fig. 1).

Thus care has to be taken when selecting a transformer such that the smoothing capacitor working voltage is not exceeded. Also, make certain that the polarity on this capacitor is correct, they can LITERALLY explode if wired up backwards!

constructed out of lots of 'E' shaped laminations. These 'E' laminations are butted into 'I' laminations, and clamped together. This butting together of the laminations can cause magnetic field problems. The wider the gap between the 'E' and 'I' laminations, the larger the magnetic field around the transformer.

The magnetic field generates a significant amount of induced hum in nearby electronics, this can be overcome by using a low leakage toroidal transformer which is constructed from circular laminations. The primary and secondary windings are wound through the centre of the toroid (see if you can imagine how). The toroidal transformer, by virtue of its 'continuous' laminations results in a low stray field and a low profile design, making it ideally suited for audio amplifier applications.



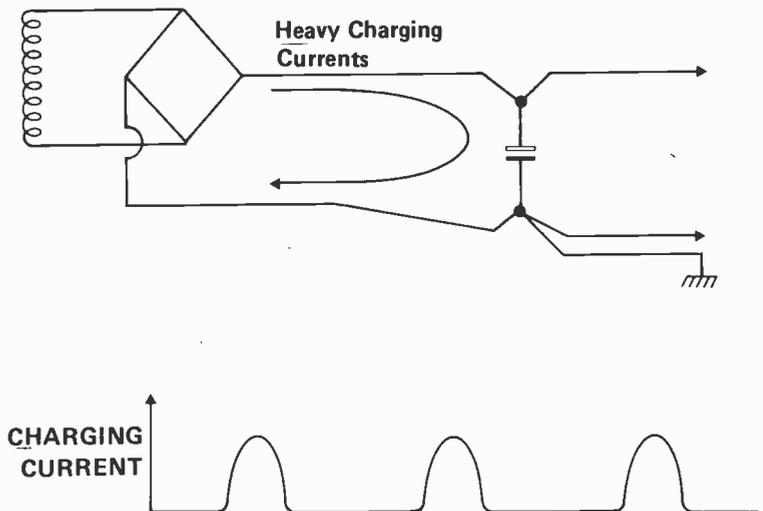
When a load is placed upon the power supply shown above, the output voltage appears as a DC voltage on top of which is a ripple voltage. This can be thought of as two separate periods, a charge period where the capacitor is charged up by the power supply and a discharge period where the load discharges the capacitor.

This charging and discharging generates a ripple voltage which has a period of 10 ms (100 Hz). A load current of 100 mA, and a 1000µF capacitor will result in a ripple voltage (Vpp) of about 7V.

As a rule of thumb I usually allow 1 to 1V5 maximum ripple if a voltage regulator is being used. This will generally result in an output ripple of less than 1 mV. If this ripple were to be obtained by just using a larger capacitor, then a 700,000µF-capacitor would be required!

Generally the discharge period is much longer than the charge period. This means that the transformer is only supplying power for short periods, in fact during the charge period. During these periods the smoothing capacitor is rapidly charged, and it is quite common for these current surges to exceed several amps. This can cause mains BUZZ problems when laying out printed circuit board designs for power supplies.

The correct layout is shown below the circuit. If the current surge is 1 A and the track resistance is 20 milliohms then the voltage developed will be 20 mVpp.



## Voltage regulators

A voltage regulator takes a varying unregulated input voltage and produces a fixed regulated output voltage. There is a wide range of fixed voltage three terminal regulators to choose from, with a choice of maximum current handling, output voltage and positive or negative operation. The data sheets for these devices contain lots of seemingly complex pieces of information and so a glossary of terms is now included.

## Ripple Rejection

The ratio of the ripple voltage at the regulator input to that at the output, generally expressed in dB. Typically of the order of 60 dB (1000 to 1), that is 1 Vpp of ripple at the input ends up as 1 mVpp at the output.

## Temperature Coefficient

The output voltage change for a change in regulator temperature, expressed in mV/°C.

## Input Voltage range

The range of voltages over which the regulator will function normally. For example, a 12V regulator may work from 14V5 to 30V. At 14V5 the regulator will 'drop out' and lose its regulation. Regulators generally need 2 to 2V5 in excess of their output voltage. At 30V the regulator will go 'pop' (time to buy a new one).

## Output voltage

The voltage at the output terminal with respect to ground. Generally within  $\pm 5\%$  of stated value.

## Line Regulation

The ratio of the change in the output voltage caused by a change in the input voltage, typically of the order of 0.2%.

## Load Regulation

The output voltage change for a specific change in output load current.

## Short Circuit Current

The output current when the output is shorted to ground.

## Output Noise Voltage

The RMS noise voltage measured at the regulators output, not including any ripple.

## Power Dissipation

The maximum power that the regulator can safely generate on a particular heatsink.

As a rule of thumb the regulator case should not exceed about 80°C (which is hot to touch). However, always run the device at as low a temperature as possible. It is thermal ageing that eventually kills electronic devices and for higher temperatures the ageing process is disproportionately faster.

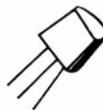
Some applications of voltage regulators are given below.

The table below relates the secondary voltage of a transformer to the peak voltage at rated load and the off load voltage, which will be considerably higher.

TABLE ONE

| V secondary at rated load | V peak at rated load | V peak off load transformer regulation 20% |
|---------------------------|----------------------|--|
| 5 VRMS                    | 7V07                 | 8V48                                       |
| 6 VRMS                    | 8V48                 | 10V18                                      |
| 9 VRMS                    | 12V72                | 15V26                                      |
| 10 VRMS                   | 14V14                | 16V97                                      |
| 12 VRMS                   | 16V97                | 20V36                                      |
| 15 VRMS                   | 21V21                | 25V45                                      |
| 20 VRMS                   | 28V28                | 33V93                                      |
| 25 VRMS                   | 35V35                | 42V42                                      |
| 30 VRMS                   | 42V43                | 50V92                                      |
| 35 VRMS                   | 49V50                | 59V40                                      |
| 40 VRMS                   | 56V57                | 67V88                                      |

T092 plastic



or

T05 metal



(100mA rating)

T05 metal



or

T0202 plastic power

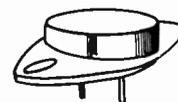


(200mA rating)

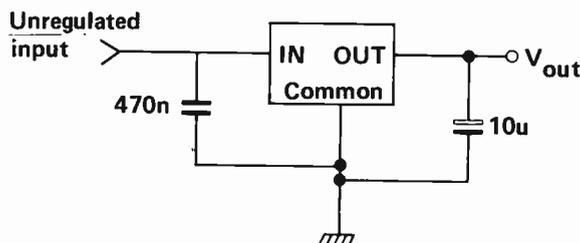
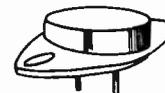
T0202 TO220 (500mA)



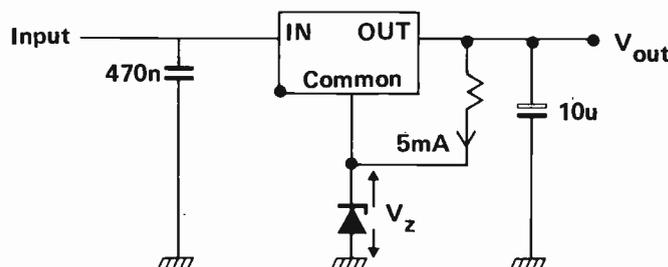
T03 metal (2A)



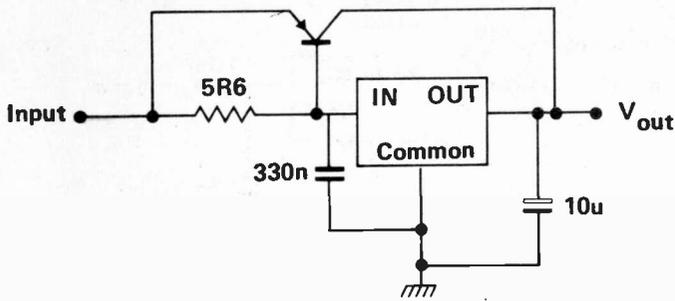
T03 metal (3A)



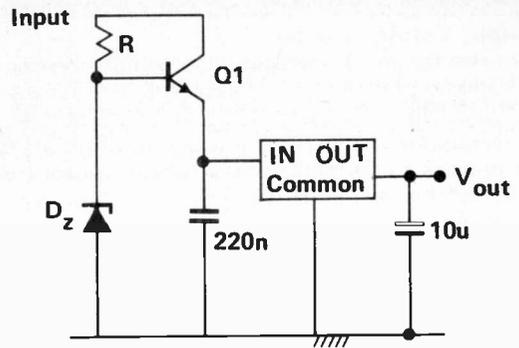
A) This circuit shows a conventional arrangement of a three terminal device. It is advisable to use a decoupling capacitor connected close to the input terminals. This prevents high frequency instability. If this capacitor is left out then regulation can sometimes be greatly reduced. The decoupling capacitor on the output helps reduce the impedance at high frequencies, where the regulator loses its performance. For best results use a tantalum capacitor.



B) The output voltage of a regulator can be increased by applying a voltage to the common terminal. This can be done by using a zener diode.



C)  
The output current can be increased by using a bypass transistor. When the current flowing through the voltage regulator exceeds 100 mA (the voltage across the 5R6 being 560 mV), the bypass transistor begins to turn on. This transistor takes all currents in excess of 100 mA and yet the output still remains regulated. However a few extra components are needed to get current limiting in the transistor path.

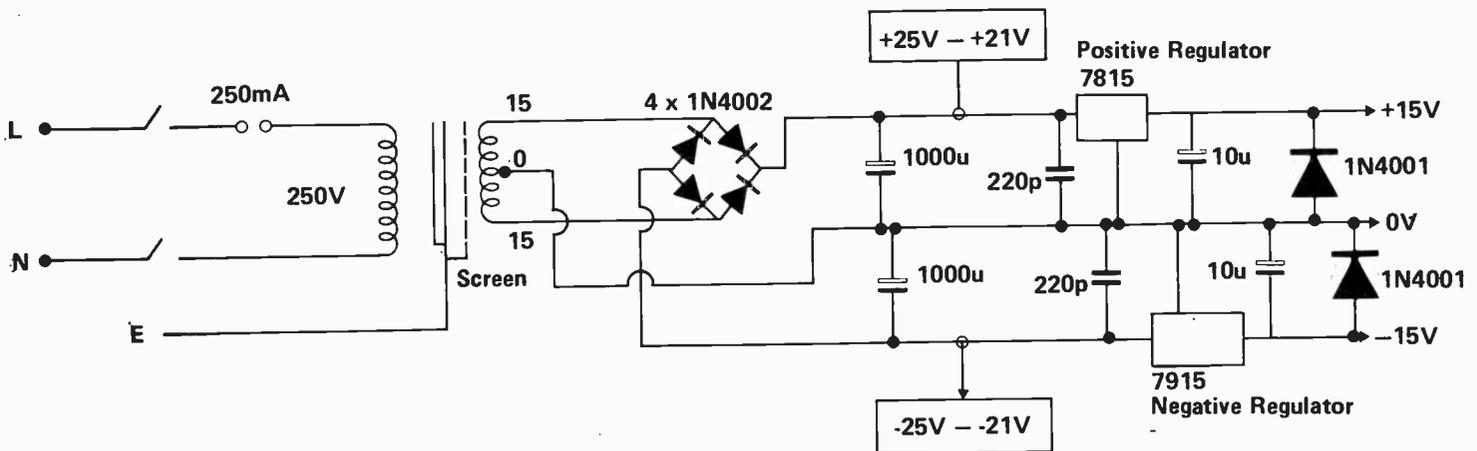


D)  
A high voltage unregulated supply can cause problems when using regulators. It may at times exceed the maximum voltage rating of the regulator. A simple voltage regulator  $D_z$  and Q1 can be used to overcome this problem.  $D_z$  should be chosen so that it is about 6V greater than the regulator output voltage. This technique has the added advantage that the power dissipated in the regulator is less (the rest being dissipated in Q1), and the regulator is presented with a semiregulated voltage, so the output will have less ripple.

### Dual Power Supply

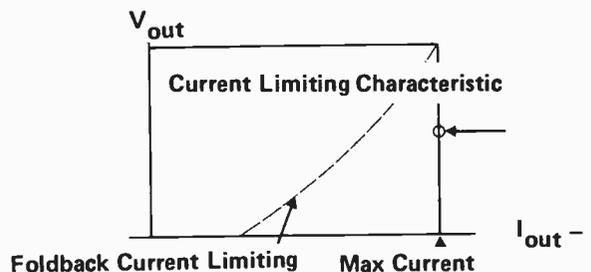
The circuit shows a complete regulated dual power supply. The unregulated rails are obtained from a split secondary transformer, a bridge rectifier and two smoothing capacitors. A positive and a negative regulator have been used to generate the + and - rails. These regulators should be mounted on heat sinks

and they should be insulated. The pin out of the negative regulator is different to that of the positive regulator. The two diodes at the output prevent latching up situations (on load) whereby one side starts up faster than the other and forcibly reverse biases it, preventing it from operating.



### Tracking Regulator

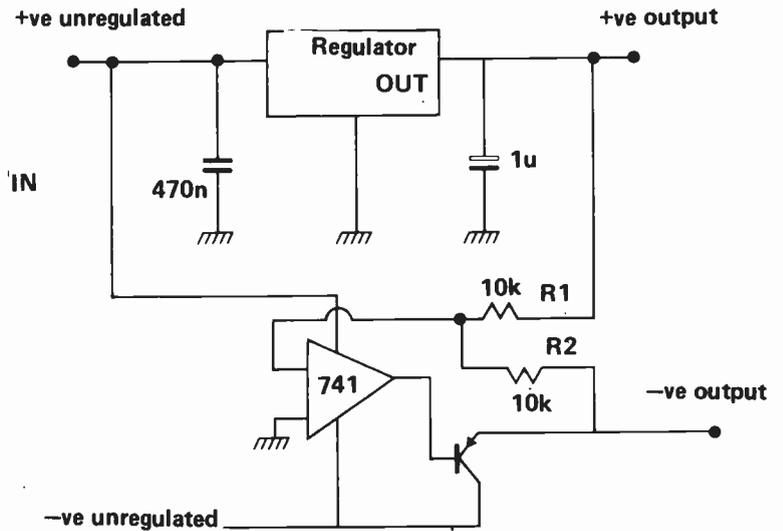
Instead of using a negative voltage regulator to obtain the negative rail, an op amp and a power transistor can be used. The resistor ratio, R1, R2 determines the negative rail voltage. The negative rail is not, however, current limited. The internal current limiting of the regulator is shown. When the load current exceeds the current limit, the output voltage drops to almost 0V. This makes the regulator short circuit protected. Another type of current protection is known as 'FOLD BACK' current limiting (shown dotted). This serves to reduce the short circuit current. These devices protect the power supply from abuse. Another type of protection device is the overvoltage clamp, which



protects the 'non-power supply electronics' from an increase in the power supply voltage. These are two terminal heavy current devices which are placed across the power supply. When the supply voltage exceeds a certain level a thyristor is triggered on and clamps the rail to ground. This is intended to pop a fuse and so disconnect the faulty power supply (which is better than replacing a £1,000 worth of IC's).

$$\text{-ve output} = -(\text{+ve output} \times R2/R1)$$

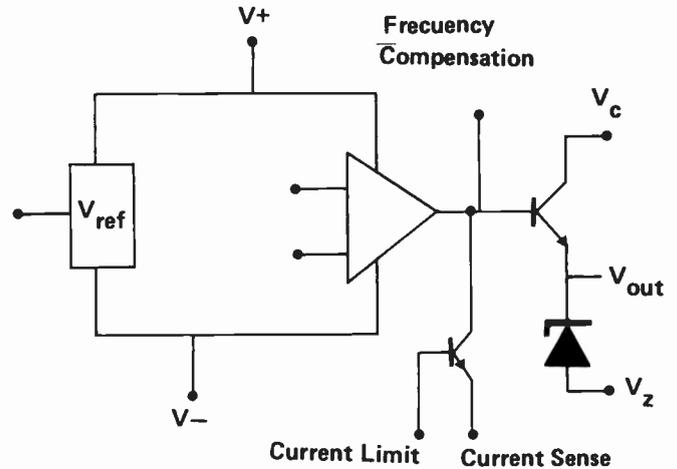
With foldback the short circuit power dissipated in the regulator is less than that with current limiting.



## 723 Voltage Regulator

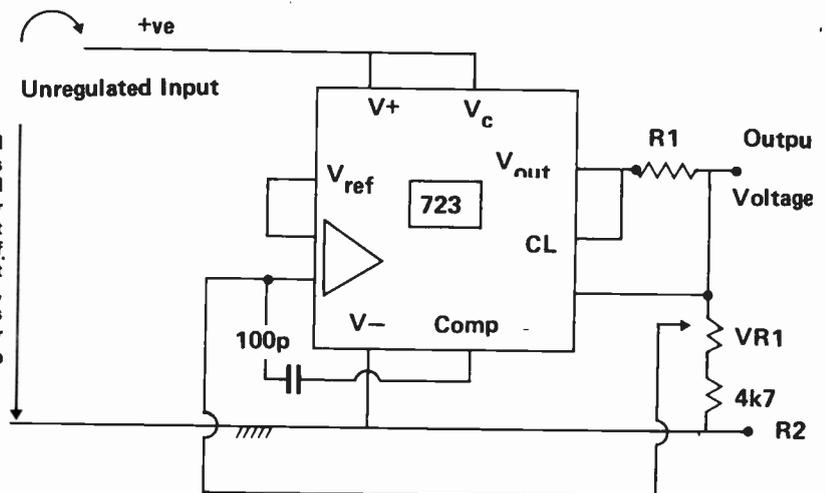
The 723 is an industry 'standard' device. Many manufacturers produce it and the device itself is versatile. It comes in a 10 pin TO5 can or a 14 DIL pack. The device contains a precision voltage reference, with a temperature coefficient of 50ppm/°C, an error amplifier, an internal transistor capable of handling 100 mA and a current limiting mechanism. By using a few external resistors, a capacitor and maybe an external power transistor, a wide variety of regulator designs can be realised.

Left is shown the block diagram of the 723 regulator. As pinouts vary depending upon package, no pin numbers are shown.



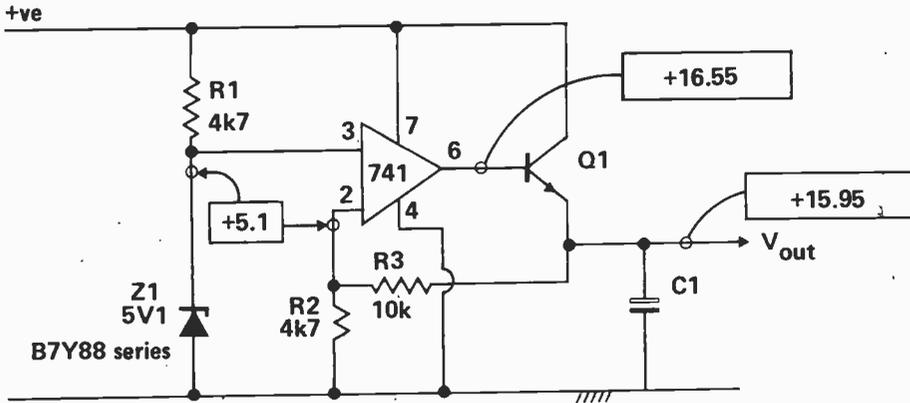
## Adjustable Positive Voltage Regulator

By using a variable feedback path (RV1), a variable regulated output voltage can be generated. The voltage reference is connected to the non-inverting input of the error amplifier and the output voltage (via RV1), to the inverting input. The error amplifier drives the output transistor and hence the output voltage is controlled by the feedback voltage from VR1. A 100pF capacitor is used to stabilise the device. R1 is used as a current limit control. When the current through R1 (the load current), exceeds 100 mA a voltage of 560 mV is set up across it. This is just about sufficient to turn on the current limiting transistor which in turn shorts out the regulating transistor, causing the output voltage to collapse towards 0V.



## Regulated Power Supply

Sometimes it is necessary to make a simple power supply using discrete components when a non-standard voltage is required.



Left: Circuit diagram of discrete component PSU. Voltage measurements are taken with high impedance voltmeter.

The circuit shown uses all the basic elements of a voltage regulator, that is, a reference voltage Z1, an error amplifier and a series control Transistor Q1. The zener diode, Z1 sets up a reference voltage of 5V1. This diode has a temperature coefficient of  $-1.2\text{mV}/^\circ\text{C}$  (a 5V6 zener is best at  $-0.2\text{mV}/^\circ\text{C}$ ). The resistor ratio of R3 and R2 sets the output voltage and the op amp provides the error correction (the regulation).

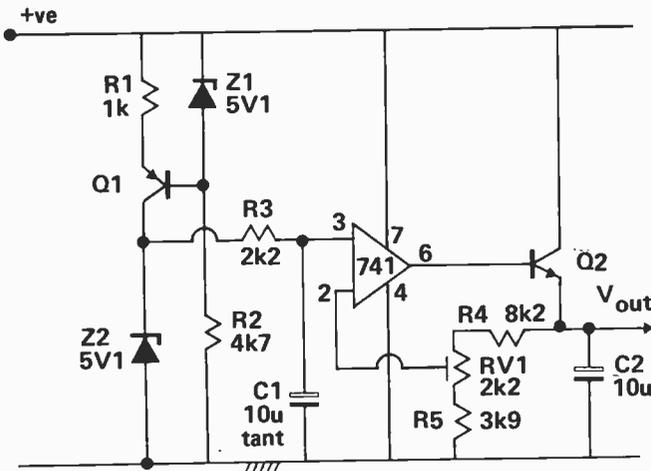
C1 is used to reduce the output impedance at high frequencies. The zener diode has a slope resistance of  $76\Omega$ , and so any fluctuations in the unregulated rail will be attenuated by the ratio of 76:7:0.016

R1 4700

Therefore a 1 Vpp ripple will end up as 16 mVpp, but will be multiplied by the gain of the R3, R2 network to nearly 50mV.

## Improved Regulated power supply

This power supply has various improvements over that shown. The reference zener Z2 is run at almost constant current by the R12, Q1 Z1 network. This makes Z2 much less sensitive to ripple and unregulated supply fluctuations. The filter R3 C1 (7 HZ low pass), further reduces any ripple voltage and noise from the zener diode. The preset VR1 allows the output voltage to be varied.



If a precision power supply is required then a precision voltage reference should be used. These can be obtained with temperature coefficients as low as  $10\text{ppm}/^\circ\text{C}$ . When using this level of stability, high stability resistors ( $\text{TC} = 10\text{ppm}/^\circ\text{C}$ ), and a low drift op amp should be used. Also, to reduce mains carried interference (mainly sharp clicks due to electric motors and thyristors turning on), a mains filter should be used. This is a passive inductor capacitor low pass filter network which attenuates high frequency spikes and clicks.

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| 20-12-0-12-20   | 700(DC)    | 221      | 3.10    | 70  |
| 0-15-20-0-15-20 | 1A 1A      | 206      | 4.20    | 85  |
| 0-15-27-0-15-27 | 500 500    | 203      | 3.65    | 70  |
| 0-15-27-0-15-27 | 1A 1A      | 204      | 4.75    | 95  |

### 12 AND/OR 24 VOLT

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| 0.5  | 111      | 1.95    | 55   |
| 1.0  | 213      | 2.30    | 70   |
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| 16   | 17       | 9.25    | 1.10 |
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| Amps | Ref. No. | Price £ | P&P  |
|------|----------|---------|------|
| 0.5  | 112      | 2.45    | 70   |
| 1.0  | 79       | 3.05    | 70   |
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| 3.0  | 20       | 5.80    | 1.00 |
| 4.0  | 21       | 6.85    | 1.00 |
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| Amps | Ref. No. | Price £ | P&P  |
|------|----------|---------|------|
| 0.5  | 102      | 3.20    | 70   |
| 1.0  | 103      | 4.20    | 85   |
| 2.0  | 104      | 6.10    | 1.00 |
| 3.0  | 105      | 7.85    | 1.00 |
| 4.0  | 106      | 9.80    | 1.10 |
| 6.0  | 107      | 14.95   | 1.30 |
| 8.0  | 118      | 15.75   | 1.50 |
| 10.0 | 119      | 20.50   | 2.00 |

### 60 VOLT (Pri. 220-240V)

| Amps | Ref. No. | Price £ | P&P  |
|------|----------|---------|------|
| 0.5  | 124      | 3.40    | 70   |
| 1.0  | 126      | 4.65    | 85   |
| 2.0  | 127      | 6.50    | 1.00 |
| 3.0  | 125      | 9.15    | 1.10 |
| 4.0  | 123      | 11.25   | 1.30 |
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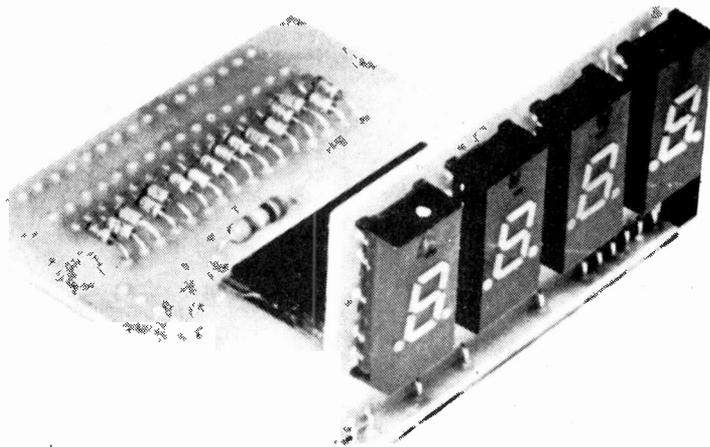
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# DIGITAL MODULE

- \* 4 digit
- \* up/down counting
- \* drives LEDs directly
- \* latch
- \* presettable
- \* second register
- \* equal and zero outputs
- \* DC to 2MHz
- \* 5V operation



THE THREE DIGIT display we previously published has proved to be one of our most popular projects. We have used it in a number of projects and we know of several commercial companies using it in their own equipment.

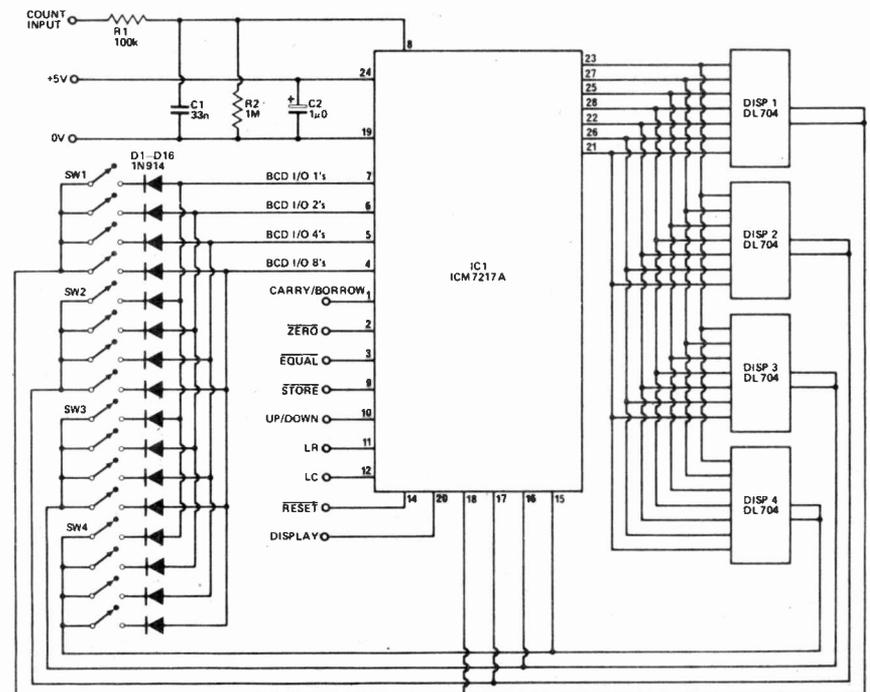
Many people have asked us for a 4 digit version and we have been looking round at ICs available. We have chosen this Intersil device because we believe it offers the best versatility at the moment. Apart from being a 4-digit counter-decoder driver needing no external components except the displays, it also is an up-down counter and can be preset to any number. In addition, it has a separate register which also can be set to any number and comparators which give outputs when the counter is equal to the register and when it is zero — all in one IC!

## Mod Build

The unit is built on two small PCBs which are connected together with short links of tinned copper wire. Be careful to orientate the IC correctly as it is expensive!

The preset system is designed to use a 4 digit BCD thumbwheel switch

Fig 1. Full circuit diagram of the counter module. The How It Works section for this is given overleaf — but as this is really a "How To Use It" section it don't matter — does it?



## SPECIFICATION

|                   |            |
|-------------------|------------|
| Number of digits  | 4          |
| Readout           | LED        |
| Maximum frequency | 2MHz       |
| Input impedance   | 100k       |
| Output drive      | 1 TTL load |
| Supply voltage    | 4.5 – 5.5V |
| Supply current    |            |
| low power mode    | 500µA      |
| all eights        | 100mA      |

(closed = '1') but individual switches can be used if required. Input is in BCD, therefore the switches will have the weighted values 8, 4, 2 and 1. If the preset is not needed then the diodes can be left out. If a preset is needed, but always to a fixed number, links can be inserted to replace the "on" switches and the other diodes left out.

ETI

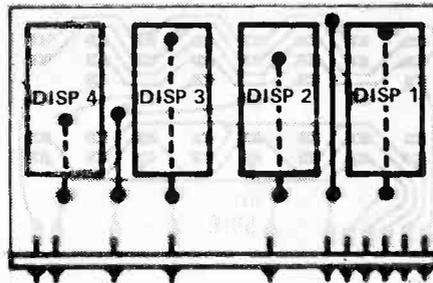


Fig. 2. The positioning of the displays and the links which must be installed before the displays.

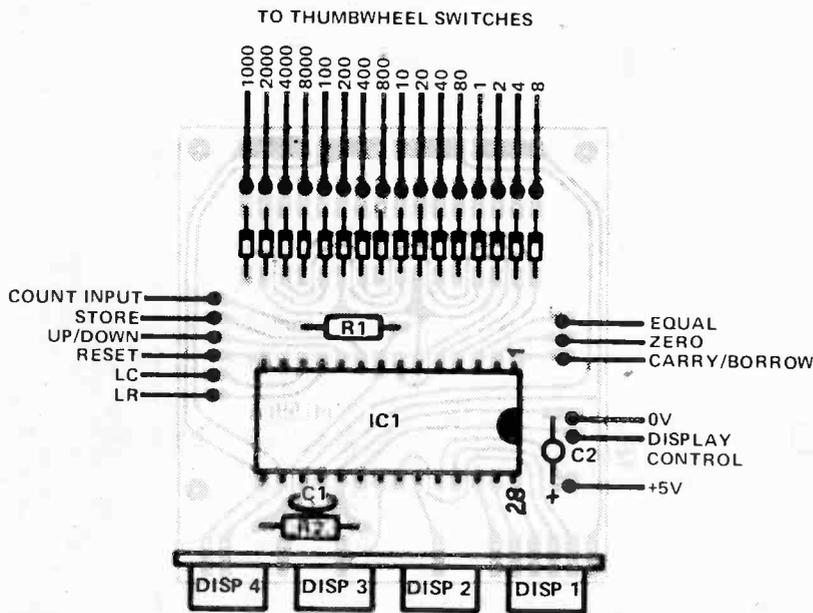
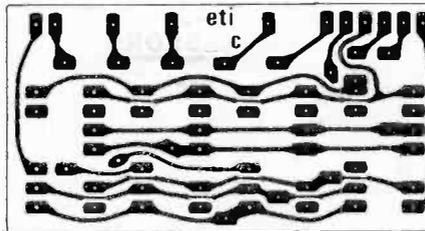
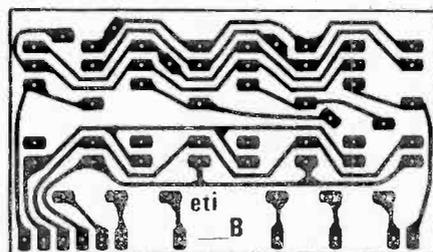
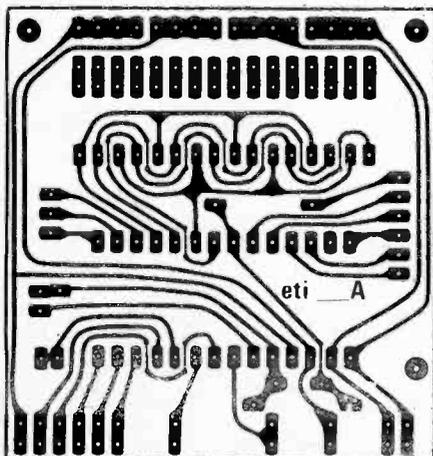


Fig. 3. The component overlay for the main board. The common connection from each of the thumbwheel switches goes to the track next to the other connections.



Full patterns for the digital module project. Shown full size. Board C — above — is to fit high brightness displays such as employed in our digital dial project.



## HOW IT WORKS

### Count Input — Pin 8

The counter is incremented or decremented on the leading edge of this input. A schmitt trigger is provided with a 500 mV hysteresis on a 2 V trigger point. For high speed operation, or operation from a digital output, delete R2 and C1 and short out R1. Maximum frequency of operation is about 2 MHz.

### Up-Down — Pin 10

If this pin is left open or taken to +5 V the counter will be incremented by the count input. If it is taken to 0 V the counter will be decremented by the count input.

### Reset — Pin 14

If this pin is left open or taken to +5 V the counter is free to be incremented or decremented. If it is taken to 0 V the counters will be reset to zero and held there until reset is taken high again.

### Store — Pin 9

If this input is left open or taken to +5 V the latches are "closed" and the information which was in the counters at the time the store input went high will be remembered, decoded and displayed. The counters can be reset, incremented or decremented without affecting the display.

If it is taken to 0 V the counter contents will continuously be displayed for as long as this input is at 0 V. Any change in the counter contents will be shown on the display.

### Load Counter — Pin 12

This is a 3 level input. If it is left open the counter works normally. If it is taken to +5 V the counter is loaded with the BCD data which is set on the thumbwheel switches. If the latch is open, this number will also be displayed. If this input is taken to 0 V the BCD I/O pins become high impedance. If a 3 level input is to be controlled by other logic outputs they must be tristate devices.

### Load Register — Pin 11

This is also a 3 level input. If it is left open the counter works normally. If it is taken to +5 V the register is loaded with the BCD data. If taken to 0 V the circuit goes to a low power state with the multiplexing oscillator stopped, the display off and the BCD I/O pins in a high impedance state. The operation of the counter is unaffected except that there is no display.

## BUYLINES

Since this project is based entirely upon the one chip—ICM 7217A — this is all there is to cause problems! Since it appears in most peoples catalogues we cannot foresee any trouble here. Displays can be any type really — but for outdoor work use high brightness types.

# PROJECT: Digital Module

## Display Control - Pin 20

This is also a 3 level input. If it is left open, leading edge blanking occurs. If all digits are zero then all are blanked. If it is connected to +5 V the display is completely blanked irrespective of the value. If taken to 0 V all digits are ON irrespective of value.

## Scan - Pin 13

The internal multiplexing frequency is nominally 10 kHz giving a digit repetition rate of 2.5 kHz. With a 20 pF capacitor from this point to 0 V the frequency drops to 5 kHz and with 90 pF it is about 1 kHz.

## BCD I/O - Pin 4-7

This is a multiplexed data port, normally an output which can drive 1 TTL load. It becomes an input when either LC or LR is at +5 V. Pin 7 is the least significant bit.

## Digit Drives - Pins 15-18

These are used both to drive the LEDs and to provide data indicating which digit is being presented at the BCD I/O port. Pin 18 is the least significant digit.

## Zero - Pin 2

If the value of the counter is zero this output will be at 0 V.

## Equal - Pin 3

If the value of the counter is equal to the value of the register this output will be at 0 V.

## Carry/Borrow - Pin 1

When the counter goes from 9999 to 0000 or from 0000 to 9999 a 500 ns positive pulse occurs on this output. This is connected to the count input of a second unit when an eight digit display is needed.

# PARTS LIST

## RESISTORS (all 1/2W 5%)

R1 100k  
R2 1M

## CAPACITORS

C1 33n polyester  
C2 1u0 35V tantalum

## SEMICONDUCTORS

IC1 ICM 7217A  
D1-D16 1N914  
DISPLAYS DL704

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## CMOS

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| 4033                 | £1.45  | 4089   | £1.50  |
| 4034                 | £1.96  | 4093   | 63p    |
| 4035                 | £1.11  | 4094   | £1.90  |
| 4036                 | £2.45  | 4095   | £1.05  |
| 4037                 | £1.00  | 4096   | £1.05  |
| 4038                 | £1.08  | 4097   | £3.72  |
| 4039                 | £2.45  | 4098   | £1.10  |
| 4040                 | £1.05  | 4099   | £1.45  |
| 4041                 | 40p    | 4096T  | N/S    |
| 4042                 | 75p    | 4100   | £2.50  |
| 4043                 | 94p    | 4101   | £1.61  |
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| 40194                | £1.18  | 40194  | £1.18  |
| 40257                | £1.48  | 40257  | £1.48  |
| 4160                 | £1.08  | 4160   | £1.08  |
| 4161                 | £1.08  | 4161   | £1.08  |
| 4162                 | £1.08  | 4162   | £1.08  |
| 4163                 | £1.08  | 4163   | £1.08  |
| 4174                 | £1.08  | 4174   | £1.08  |
| 4175                 | 99p    | 4175   | 99p    |
| 4176                 | 99p    | 4176   | 99p    |
| 4177                 | 99p    | 4177   | 99p    |
| 4194                 | £1.08  | 4194   | £1.08  |
| 4405                 | £6.59  | 4405   | £6.59  |
| 4409                 | £6.59  | 4409   | £6.59  |
| 4410                 | £5.73  | 4410   | £5.73  |
| 4411                 | £9.58  | 4411   | £9.58  |
| 4412VL               | £17.14 | 4412VL | £17.14 |
| 4412FL               | £12.92 | 4412FL | £12.92 |
| 4415V                | £7.50  | 4415V  | £7.50  |
| 4415F                | M/S    | 4415F  | M/S    |
| 4419                 | £2.68  | 4419   | £2.68  |
| 4422                 | £5.00  | 4422   | £5.00  |
| 4431                 | TBA    | 4431   | TBA    |
| 4432                 | £5.32  | 4432   | £5.32  |
| 4435                 | £2.93  | 4435   | £2.93  |
| 4436                 | £1.19  | 4436   | £1.19  |
| 4440L                | £11.58 | 4440L  | £11.58 |
| 4450                 | £2.67  | 4450   | £2.67  |
| 4451                 | £2.67  | 4451   | £2.67  |
| 4452                 | TBA    | 4452   | TBA    |
| 4461                 | £2.18  | 4461   | £2.18  |
| 4462                 | £2.42  | 4462   | £2.42  |
| 4490P                | £6.54  | 4490P  | £6.54  |
| 4490VP               | £4.92  | 4490VP | £4.92  |
| 4700                 | £1.75  | 4700   | £1.75  |
| 4500                 | £5.56  | 4500   | £5.56  |
| 4501                 | 17p    | 4501   | 17p    |
| 4502                 | 91p    | 4502   | 91p    |
| 4503                 | 88p    | 4503   | 88p    |
| 4504                 | £5.71  | 4504   | £5.71  |
| 4505                 | 51p    | 4505   | 51p    |
| 4506                 | 55p    | 4506   | 55p    |
| 4507                 | 51p    | 4507   | 51p    |
| 4508                 | £2.48  | 4508   | £2.48  |
| 4509                 | 99p    | 4509   | 99p    |
| 4511                 | £1.38  | 4511   | £1.38  |
| 4512                 | 81p    | 4512   | 81p    |
| 4514                 | £2.65  | 4514   | £2.65  |
| 4515                 | £2.99  | 4515   | £2.99  |
| 4517                 | £3.82  | 4517   | £3.82  |
| 4518                 | £1.02  | 4518   | £1.02  |
| 4519                 | 51p    | 4519   | 51p    |
| 4520                 | £1.08  | 4520   | £1.08  |
| 4521                 | £1.88  | 4521   | £1.88  |
| 4522                 | £1.08  | 4522   | £1.08  |
| 4524                 | N/S    | 4524   | N/S    |
| 4526                 | £1.08  | 4526   | £1.08  |
| 4527                 | £1.52  | 4527   | £1.52  |
| 4528                 | 99p    | 4528   | 99p    |
| 4529                 | £1.14  | 4529   | £1.14  |
| 4530                 | 85p    | 4530   | 85p    |
| 4531                 | £1.45  | 4531   | £1.45  |
| 4532                 | £1.27  | 4532   | £1.27  |
| 4534                 | £5.13  | 4534   | £5.13  |
| 4536                 | £3.69  | 4536   | £3.69  |
| 4537L                | £13.23 | 4537L  | £13.23 |
| 4538                 | £1.25  | 4538   | £1.25  |
| 4539                 | 91p    | 4539   | 91p    |
| 4541                 | £1.14  | 4541   | £1.14  |
| 4543                 | £1.59  | 4543   | £1.59  |
| 4549                 | £3.69  | 4549   | £3.69  |
| 4552                 | £10.55 | 4552   | £10.55 |
| 4553                 | £3.07  | 4553   | £3.07  |
| 4554                 | £1.19  | 4554   | £1.19  |
| 4556                 | 78p    | 4556   | 78p    |
| 4557                 | £3.86  | 4557   | £3.86  |
| 4558                 | £1.14  | 4558   | £1.14  |
| 4559                 | £3.69  | 4559   | £3.69  |
| 4561                 | 65p    | 4561   | 65p    |
| 4562                 | £5.33  | 4562   | £5.33  |
| 4566                 | £1.59  | 4566   | £1.59  |
| 4568                 | £2.38  | 4568   | £2.38  |
| 4569                 | £2.57  | 4569   | £2.57  |
| 4572                 | 25p    | 4572   | 25p    |
| 4580                 | £5.74  | 4580   | £5.74  |
| 4581                 | £2.62  | 4581   | £2.62  |
| 4582                 | 98p    | 4582   | 98p    |
| 4583                 | 76p    | 4583   | 76p    |
| 4584                 | 43p    | 4584   | 43p    |
| 4585                 | £1.01  | 4585   | £1.01  |
| 4599                 | £2.06  | 4599   | £2.06  |

## VIDEO

UM 1263 Sound Modulator £2.50 [+12 1/2% VAT]  
UM111E36 UHF Ch.36 Vision Modulator £2.50 [+12 1/2% VAT]  
UM1231 UHF Ch.36 Vision Modulator wide bandwidth (for computers etc.) £4.70 [+8% VAT]

## VEROBOARD

0.1" Pitch with copper strips  
2 1/2" x 1 1/2" (pack of 5) 59p  
2 1/2" x 3" 41p  
2 1/2" x 5" 49p  
2 1/2" x 7" £1.52  
3 1/2" x 3" 49p  
3 1/2" x 5" 56p  
3 1/2" x 7" £1.95  
4 1/2" x 7" £2.52  
0.1" Plainboard (no strips)  
3 1/2" x 2 1/2" 28p  
3 1/2" x 5" 45p  
3 1/2" x 7" 51p  
Terminal pins £1.50/500  
V-DIP board 98p  
DIP breadboard £2.42  
Spot face cutter 82p  
Pin insertion tool 99p

## QUARTZ

32.768 KHz (Watch) £3.23  
60 KHz £9.85  
100.0 KHz £3.23  
200.0 KHz £3.92  
204.8 KHz £3.92  
262.144 KHz £3.92  
307.2 KHz £3.92  
312.5 KHz £3.92  
455.0 KHz £4.95  
1.000 MHz £3.62  
1.008 MHz £3.92  
1.8432 MHz £3.62  
2.000 MHz £3.62  
2.09152 MHz £3.23  
2.4576 MHz £3.62  
2.56250 MHz £3.62  
3.000 MHz £3.62  
3.2768 MHz £3.23  
3.579545 MHz £1.95  
4.000 MHz £2.90  
4.032 MHz £3.23  
4.096 MHz £3.23  
4.194304 MHz £3.23  
4.433619 MHz £1.25  
4.608 MHz £3.23  
4.800 MHz £3.23  
4.915 MHz £3.23  
5.000 MHz £3.23  
5.120 MHz £3.23  
5.185 MHz £3.23  
6.000 MHz £3.23  
6.144 MHz £3.23  
6.400 MHz £3.23  
6.55360 MHz £3.23  
7.000 MHz £3.23  
7.168 MHz £3.23  
7.680 MHz £3.23  
7.86432 MHz £3.23  
8.000 MHz £3.23  
8.388608 MHz £3.23  
8.375 MHz £3.92  
9.800 MHz £3.23  
10.000 MHz £3.23  
10.700 MHz £3.23  
11.000 MHz £3.92  
12.000 MHz £3.92  
14.31818 MHz £3.23  
18.000 MHz £3.23  
18.432 MHz £3.23  
20.000 MHz £3.23  
20.134 MHz £3.23  
27.648 MHz £3.23  
38.5666 MHz £3.23  
48.000 MHz £3.23  
100.000 MHz £3.23  
116.000 MHz £3.23

## SOLDERLESS PINS

100/1000 50p/£3.50

## OIL SOCKETS

8/14/16 pin 10p/12p/13p  
18/20/22 pin 18p/20p/25p  
24/28/40 pin 30p/40p/50p

## TIMER ICs

NE555/556 29p/49p

## OP-AMPS

CA 3130E 84p  
CA 3140E 125p  
UA 741 (Texas) 22p  
6X741 (Texas) £1.00

## SPECIAL

MSB 3801 Multilayered 4x0.3" common cathode prime quality £2.95

## LED DISPLAYS

DL-704E/707E £5p  
DL-727E/728E £2.80  
DL-747E/750E £1.00  
FND 500/560 £1.20  
7.680 MHz £3.23  
7.86432 MHz £3.23  
8.000 MHz £3.23  
8.388608 MHz £3.23  
8.375 MHz £3.92  
9.800 MHz £3.23  
10.000 MHz £3.23  
10.700 MHz £3.23  
11.000 MHz £3.92  
12.000 MHz £3.92  
14.31818 MHz £3.23  
18.000 MHz £3.23  
18.432 MHz £3.23  
20.000 MHz £3.23  
20.134 MHz £3.23  
27.648 MHz £3.23  
38.5666 MHz £3.23  
48.000 MHz £3.23  
100.000 MHz £3.23  
116.000 MHz £3.23

## LIQUID CRYSTAL DISPLAY

4x0.5" Digital dot pin OIL £8.95

## CLOCK CHIPS

AY-51224A £2.60  
MK 50253 £5.50  
MK 50262/50366 16.50  
MC 14440 (ICD) £11.58

## SIX DECIMAL COUNTERS

MK 50395/6/7 £8.75  
MK 50398 £6.20

## SPECIAL: 280 DATA PACK

A set of the following 5 280 data manuals and all the related data we can find of interest to the 280 user

c80-page 280 CPU Technical Manual £3.45  
c200-page CMOS Databook (Motorola) £3.50  
CMOS Databook (National) £2.30  
MC 145008 ICU Handbook (Motorola) £2.25  
Understanding Microprocessors (Motorola) £2.75  
M6800 Microprocessor Applications Manual (Motorola) £9.95  
A Guide to SC/MP Programming (Kamtron) £3.50  
A Guide to Kitbug (Kamtron) 75p  
SC/MP Technical Description (National) £2.76  
SC/MP Microprocessor Applications Handbook (National) £3.45  
SC/MP Programming & Assembly Manual (National) £3.00  
AMI Reference Manual (National) £3.45  
16-page data for IMS 8154 ISP-BA/650 (National) 50p  
20-page data for SC/MP II (National) 50p  
CDP 1802 MPU User Manual (RCA) £4.50  
CDP 1802 Subroutines (RCA) £4.50  
COSMAC MPU Guide (RCA) 75p

## 74C

|       |       |        |       |        |       |        |        |
|-------|-------|--------|-------|--------|-------|--------|--------|
| 74C08 | 24p   | 74C09  | 85p   | 74C193 | £1.10 | 74C918 | £1.06  |
| 74C22 | 24p   | 74C53  | 85p   | 74C195 | £1.04 | 74C921 | £1.83  |
| 74C04 | 24p   | 74C85  | £1.04 | 74C200 | £6.78 | 74C922 | £3.66  |
| 74C08 | 24p   | 74C107 | £1.22 | 74C271 | £1.36 | 74C923 | £3.73  |
| 74C10 | 24p   | 74C150 | £4.12 | 74C901 | 54p   | 74C924 | TBA    |
| 74C14 | £1.41 | 74C154 | £3.67 | 74C902 | 54p   | 74C925 | £4.84  |
| 74C20 | 24p   | 74C157 | £2.20 | 74C903 | 54p   | 74C926 | £4.84  |
| 74C30 | 24p   | 74C160 | £1.10 | 74C904 | 54p   | 74C927 | £4.84  |
| 74C32 | 24p   | 74C161 | £1.10 | 74C905 | £7.26 | 74C928 | £4.84  |
| 74C42 | 92p   | 74C162 | £1.10 | 74C906 | 54p   | 74C929 | £11.93 |
| 74C48 | £1.38 | 74C163 | £1.10 | 74C907 | 54p   | 74C948 | TBA    |
| 74C73 | 54p   | 74C164 | £1.04 | 74C908 | 96p   | 80C95  | 54p    |
| 74C74 | 56p   | 74C165 | £1.04 | 74C909 | £1.63 | 80C96  | 61p    |
| 74C76 | 54p   | 74C173 | £1.10 | 74C910 | £6.78 | 80C97  | 54p    |
| 74C83 | £1.29 | 74C174 | £1.31 | 74C911 | TBA   | 82C19  | £4.13  |
| 74C85 | £1.29 | 74C175 | 90p   | 74C912 | £7.13 | 88C29  | £1.93  |
| 74C86 | 64p   | 74C192 | £1.10 | 74C914 | £1.41 | 88C30  | £      |

**SAME AS  
ETI OFFER**

**5 FUNCTION LCD**

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



**£7.65**

Guaranteed same day despatch Very slim, only 6mm thick.

**SPECIAL TO ETI READERS GENUINE SOLAR ALARM WATCH**

**Solar + alarm LCD watch**

New advance in High On quartz technology!

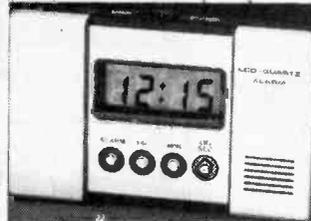


\* Hours, mins, secs displayed.  
\* Day, date, day of week.  
\* 24 hour penetrating alarm.  
\* Quality metal bracelet.  
\* Powered from solar panel.  
\* With battery back-up.  
\* Back-light + auto calendar.  
**£24.95**

**\* QUARTZ LCD ALARM \***

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

**£17.65**



Guaranteed same day despatch

**THOUSANDS SOLD 11 FUNCTION SLIM CHRONO**

6 digit 11 functions  
\* Hours, mins, secs.  
\* Day, date, day of week.  
\* 1/100, 1/10, secs, 10 x secs, mins.  
\* Split and lap modes.  
\* Back light, auto calendar.  
\* Only 8 mm thick.  
This same watch is being sold for £22.00 in newspaper and magazine special offer ads.



**Metac Price £12.65**

Guaranteed same day despatch

**SEIKO SUPERIOR WATCHES**

World famous piercing alarm chronograph  
Please ring for delivery details



**ALARM CHRONO**  
List price £130  
**Metac Price £98**

**SEIKO SUPERIOR WATCHES**

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**CHRONOGRAPH**  
List price £85  
**METAC PRICE £68**

**SEIKO**

SUPERIOR WATCHES 6 digit, 7 function watch with 4 alarms & volume control.  
Please ring for delivery details.



**MULTIPLE ALARM**  
List price £120  
**METAC PRICE £98**

**SEIKO**

SUPERIOR WATCHES Full spec. calculator + 6 function watch.  
Please ring for delivery details.



**CALCULATOR WATCH**  
List price £165  
**METAC PRICE £125**

**HANIMEX Electronic LED Alarm Clock**

Same as ETI offer  
Thousands sold



**Feature and Specification**  
\* Hour/minute display  
\* Large LED display with p.m. and alarm on indicator  
\* 24 Hours alarm with on-off control  
\* Display flashing for power loss indication  
\* Repeatable 9-minute snooze  
\* Display bright/dim modes control  
Size 5.15 x 3.93 x 2.36 (131mm x 100mm x 60mm)  
Weight: 1.43 lbs (0.65 kg).

Guaranteed same day despatch

**£8.65**

**GENUINE SOLAR**

5 function LCD

\* Solar panel with battery back-up.  
\* Back light + auto calendar.  
\* Hours, mins, secs, day, date.  
\* Quality metal bracelet.

**£10.95**

Guaranteed same day despatch



**LADIES LCD**

Only 25 x 20 mm and 6 mm thick. 5 function: hours, mins, secs, day, date, + back light and auto cal. Elegant metal bracelet in silver or gold. State preference.

**£10.95**

Guaranteed same day despatch



**ALARM LCD**

6 digit 7 functions + penetrating alarm.  
Hours Mins Secs Day Date Alpha Day Year.  
Back light + 200 year calendar.

**ONLY £21.95**



**THE METAC DIGITAL CLOCK \* COMPLETE KIT \***

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

**PRICE £6.65**



**MICRO CASSETTE RECORDER**

Hand-held only 2 1/2 x 5 x 1 1/2 inch. Identical to well known models being sold at £35

**OUR PRICE £24**



**SINCLAIR SCIENTIFIC PROGRAMMABLE**  
+ free program library worth £4.00

**ONLY £11.65 FROM METAC**

All products carry full 12 months guarantee. Please add 30p p&p with all orders. All prices include VAT.

Shops open 9.30 to 6.00 daily.

Trade enquiries welcome. **Delivery: One week.** Except where same day delivery is stated.

**COMPONENTS**

2N3055 transistors 50p  
.2 inch LED's, red 12p  
green 15p  
yellow 15p  
orange 15p

DL 704 displays 80p  
DL 707 displays 80p  
Watch batteries 70p (state type)  
Mercury tilt switches 50p  
Crystal mic. inserts 50p

Also useful for sonic applications and sound transmitters (buzzers etc)

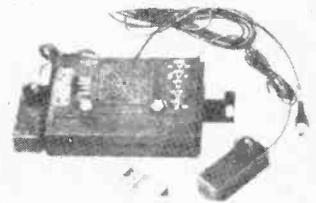
**GENUINE SOLAR CHRONOGRAPH**

**£16.95**

6 digit, 11 function.  
Hours Min Secs  
1/100 1/10 Secs Mins  
Split & lap modes,  
Auto cal + back light.  
Powered from solar panel with battery back-up.



**TV GAMES**



Black & white £8.95 Colour £12.95. 4 games, 2 ball speeds, 2 ball angles, 2 bat sizes.



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**METAC Electronics & Time Centre**

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LONDON W2  
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Barclay & Access welcome  
Phone or Send Card Number  
with order



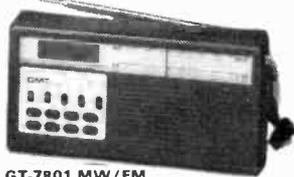
### SUPERIOR INDUCTION BALANCE METAL DETECTOR



- ★ Visual meter with audible indication.
- ★ Distinguishes between gold, silver, copper, bronze and non-ferrous metals and useless metal objects such as bottle tops, etc.
- ★ Range up to 10 inches on a single coin. Three feet for large objects.
- ★ Battery lasts 50 hours.
- ★ Telescopic 2-3 1/2 foot stem.
- ★ Volume & tuning controls.

**METAC PRICE £28.65**

### LCD CLOCK RADIO



**GT-7801 MW/FM LCD CLOCK RADIO.** Radio with earphone and DC jack. IC controlled clock gives minimum 15,000 hrs. battery life from UM3x1. Features Wake to music or alarm, sleep timer, snooze, dual time zones, stop watch function, time lock-on/off, back light. 190 x 97 x 43mm.

**METAC PRICE £22.95**

### FLUORESCENT DISPLAY CLOCK RADIO



- ★ Mains operated
- ★ Soft glow green display
- ★ MW/FM radio
- ★ Alarm with 9 min. snooze feature
- ★ Programmable play-to-sleep setting

**METAC PRICE ONLY £19.95**

### DIGITAL LED CLOCK



- ★ Automatic brightness control
- ★ Weekend alarm cancel
- ★ 9 minute snooze alarm

**OUR PRICE £10.95**

### MILITARY STYLE RADIO

Medium wave. Long battery life. Good sound reproduction.



**SPECIAL OFFER**

**£2.45**

### CASIO SPORTS WATCH

Model F-100  
Black plastic case. (Epoxy based glass filled nylon.) Stop-watch. 11 functions.

**METAC DISCOUNT PRICE £23.95**

### CASIO CHRONOGRAPH 45CS-22B

**£49.95**

### CASIO WORLD TIME WATCH 29cs-11B

**£59.95**



### METAL DETECTOR

**8FO** Principal Audible indication Telescopic stem Ideal for beginners but also excellent for finding hidden pipes and wires



**ONLY £11.95**

### CBM ALARM WATCH

Superb 6 digit, 8 function alarm watch, with snooze repeater and conference warning bleep. (It beeps once 4 seconds before alarm sounds giving option to cancel). Hours - Mins - Secs. - Day - Date - Month - Back Light - Auto Call.



Top quality CBM finish

**METAC PRICE £29.95**

### CBM EXTRA LARGE DIGIT 5 FUNCTION LCD

- ★ Hours mins secs
- ★ Month date Auto calendar
- ★ Back-light
- ★ Real leather strap
- ★ Big digits in a slim 9mm thin case
- ★ Digits 50% larger than all other watches.



**METAC SPECIAL OFFER £9.95**

### CBM CALCULATORS

**METAC Discount price**  
72 Step programmable model PR100 **£36.85**  
Full scientific 3 memory model 4912 **£12.14**  
Full scientific 9 memory model 9190 **£24.95**



### RADIO CONTROLLED CAR

A fabulous new toy will give hours of fun. Forward and reversing controls. Outdoor range 150 ft. Indoor range 50 ft. A scale model of Bertoni's famous Lancia sports car. List price as sold in well-known mail order catalogues and top stores. £16.

**METAC SPECIAL CHRISTMAS PROMOTION OFFER**

**£11.95**



### AQ-1000 CALCULATING ALARM CLOCK PLUS 3-WAY STOPWATCH

- ★ Calculator with  $\frac{1}{2}$ ,  $\sqrt{\quad}$  & memory.
- ★ Continuous clock with
- ★ Hrs, mins, secs, day, month, day of week
- ★ Alarm
- ★ Stop-watch with 1/10 secs to 40 hrs + lap and split-time modes, 1st and 2nd.
- ★ Batteries last 1 year continuous operation
- ★ Dimensions 1 1/4" x 2 1/4" x 4 1/4" in.
- ★ Complete with leatherette wallet.

LIST PRICE £21.95

**METAC SPECIAL EXCLUSIVE PRICE**

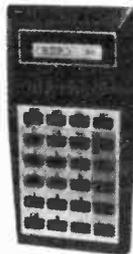
**£19.95**

Cannot be found cheaper anywhere else



### GOOD QUALITY CALCULATOR MODEL 3000

x + - memory constant, per cent, 8 digits with red display.



**METAC SPECIAL OFFER £3.95**

### ALARM CHRONOGRAPH WITH DUAL TIME ZONE FACILITY

- Constant LCD display of hours and minutes, plus optional seconds or date display, plus day of the week and am/pm indication.
- Perpetual calendar, day, date, month and year.
- 24 hour alarm with on/off indication.
- 1/100 second chronograph measuring net, lap and first and second place times.
- Dual time zone facility. Night light.



### Telephone Special 24-hour phone service

Credit-card customers are welcome to buy by phone — simply phone 01-723 4753 with your credit-card number to place your order.

- Fully adjustable bracelet.

Please note Metac are probably the only people with this watch in stock. A very good alarm watch.

**METAC PRICE ONLY £29.95**

### PLEASE NOTE

All our products carry full money back 10-day reassurance.

Watches are despatched by **FIRST-CLASS POST**. They are fitted with new batteries, and include guarantee and instructions.

Battery fitting service is available at our shops for no extra charge. We stock most watch batteries and this service is available to all.

Metac have been selling electronic watches probably longer than anyone else in the UK. We take care of your watch not just this year but next year and the years after that.



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Tel. (032 72) 76545

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Tel. (01) 723 4753

Barclay & Access welcome  
Phone or Send Card Number with order



# A HISTORY OF ELECTRONICS IN MEDICINE

THE USE OF ELECTRICITY FOR medical purposes dates back to the Ancient Greeks who used the electric eel to treat various maladies. In 1759 Wesley collected case histories of the use of electricity. The first recorded use of electricity for treatment in a hospital in London was in 1767.

Not quite 200 years ago, in 1786 to be precise, Professor Luigi Galvani — an anatomist at the University of Bologna, Italy — discovered by chance that the muscles of a dead frog contracted under the influence of an electrical quantity.

He wrongly assumed that animal electricity stored within the muscle caused this to happen. It was, in fact, the result of dissimilar metals forming a primary electric cell which energised the nerves of the muscle. Volta of the University of Paris proved it and subsequently gave the world the voltaic battery, in 1800.

The contribution of these two men provided, in the simple primary cell, a workable basis for using electricity in practical ways not previously possible with the electro-static form of electricity. Galvani's work on "animal fluid" was amongst the earliest electro-medical studies. The apparatus he used was crude by today's standards — see Fig. 1.



Fig. 1. Artist's idea of Galvani experimenting with frogs' legs in the 1780s. Note the friction electrostatic generator on the left and the Leyden jar on the right (Funk and Wagnells).

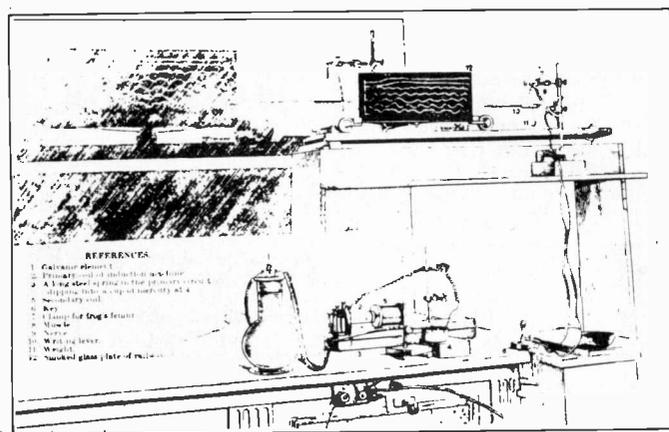


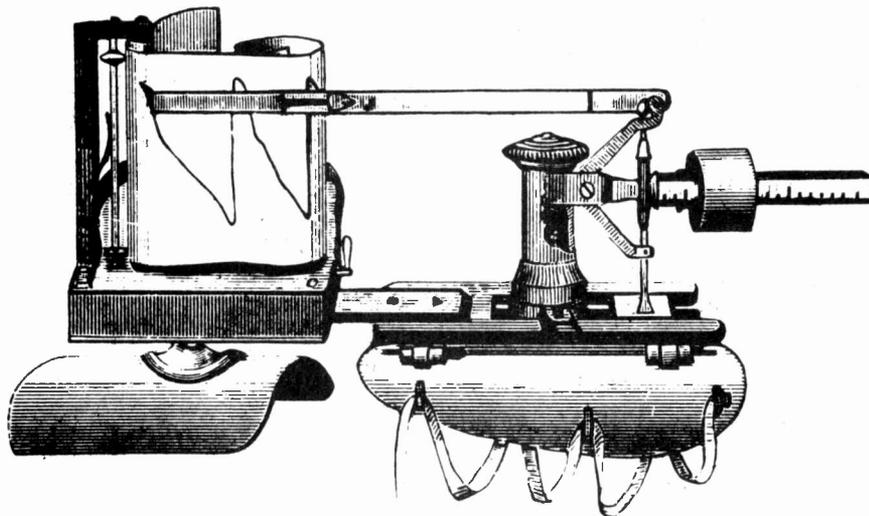
Fig. 2. Apparatus used by McKendrick to give lectures on life in motion to Royal Institution, London, audiences around 1890.

## Body Electric?

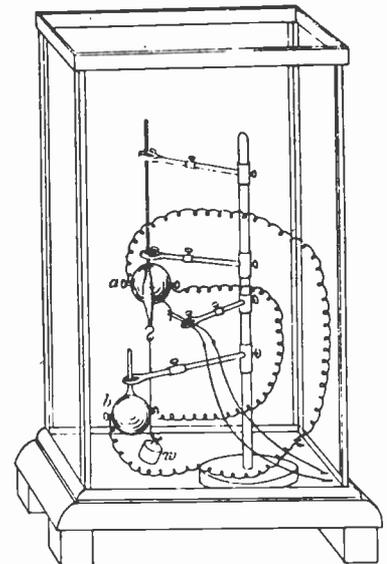
Research into physiological electric quantities gradually became more sophisticated as the 19th century passed. This development, however, had to wait for suitable experimental inventions such as the electromagnetic galvanometer which became available in its crudest form around 1830. A typical laboratory electro-medical instrumentation set-up of the 1890s is shown in Fig 2. A smoked glass plate moved steadily across the end of a mechanical pen secured to the end of a frog's leg muscle. The muscle was energised by high-voltage generated from a vibration induction coil which was energised by a chromate primary single cell of the Grenet kind. Smoked screen recorders are still in use today in some medical research measurements, blood flow parameters being one example.

The sphygmometograph (as a pulse measuring instrument was known in that time) was originated by Marey in 1860. A later design by Verdin is shown in Fig 3. Electronic method was little used in medicine in early times, as powerful electric signal amplification was not obtainable until the beginning of the 20th century —

**Electricity has long been used for medical purposes, here's the story of the past and a look into the future. By Peter Sydenham.**



**Fig. 3. Verdin's apparatus of the 1890s for recording action of the pulse.**



**Fig. 4. Schematic of McKendrick's 1891 method for measuring heat generation in muscle.**

when the thermionic valve was invented by Fleming (in 1904).

Figure 4 shows experimental equipment for measuring heat production of muscular contraction around 1880. Thermocouples, forming a thermopile, drive the crude galvanometer.

**Ion Therapy**

Another aspect of medicine where electricity is used is for therapeutic treatment. Since the very early 1800s output of the various kinds of electric current generator, namely the Faraday induction coil, the galvanic chemical battery, the sinewave rotating generator and the friction statical generator have been applied to appropriate parts of the body to provide a cure for all sorts of ailments.

X-ray equipment was born in 1895 when Roentgen discovered X-rays in a chance situation using photographic plates. There is probably no case in instrument history where application was more rapid. Edison, and others, had equipment in use in hospitals within months. Figure 5 shows contemporary American X-ray plant of 1899.

Measurement and recording of heart performance also began around 1900. Professor Einthoven of Holland devised a rapid response, high sensitivity detection instrument in 1903 — the string galvanometer. Soon after this was coupled to a photographic recording system, by the Cambridge Instrument Co., to produce an electrocardiograph. The first installation of this was made in 1909. By 1945 cardiographs were available in portable form. Figure 6 shows the interior of a 1930s. Both Brothers portable electro-cardiograph invented and made in Adelaide, South Australia — possibly one of the first portable units devised anywhere. It used a loud speaker drive unit (right) to mark a rotating smoked disk.

The record was viewed by the physician using an optical magnifier. Amplification to drive the stylus from skin electrode signals was obtained by thermionic tubes.

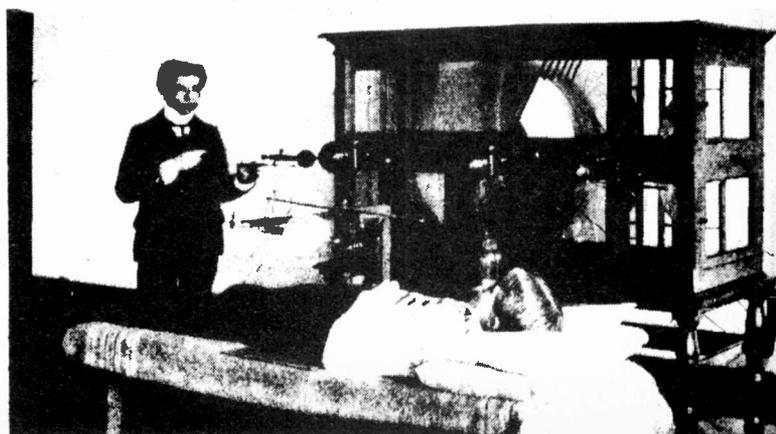
As with all disciplines, electronic method opened the door to new accomplishments. In medical electronics it happened from the 1920s onward. Equipment for researching physiology at Oxford University, in 1949 is shown in Fig 7. The unit, advanced for its time, incorporated amplifiers, a temperature control unit, stimulators to induce responses, a time base and a cathode ray tube display unit.

Electronic equipment used in medicine has come a long way during the past 50 years. This can be seen by comparing the apparatus pictured above, which covers the 1800s to 1930s period, with modern equipment such as that used in pathological testing and nuclear medicine.

**Future**

Against this background let me now suggest developments we can expect to experience over the next quarter century.

**Fig. 5. Complete X-ray apparatus in use in America around 1900. Note the lack of safety devices and precautions.**



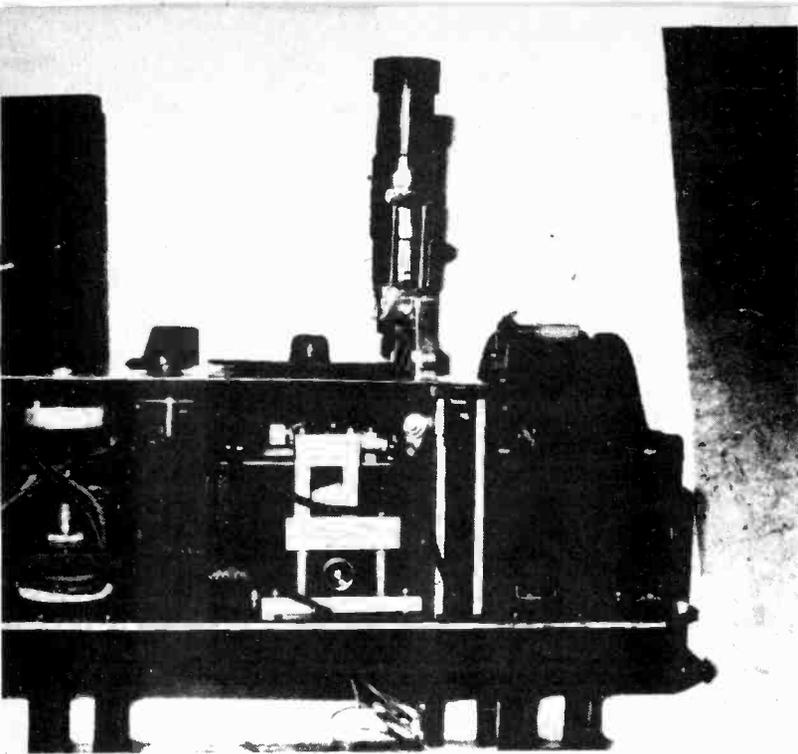


Fig. 6. Interior view of a Both portable electro-cardiograph machine made in Adelaide around 1930.

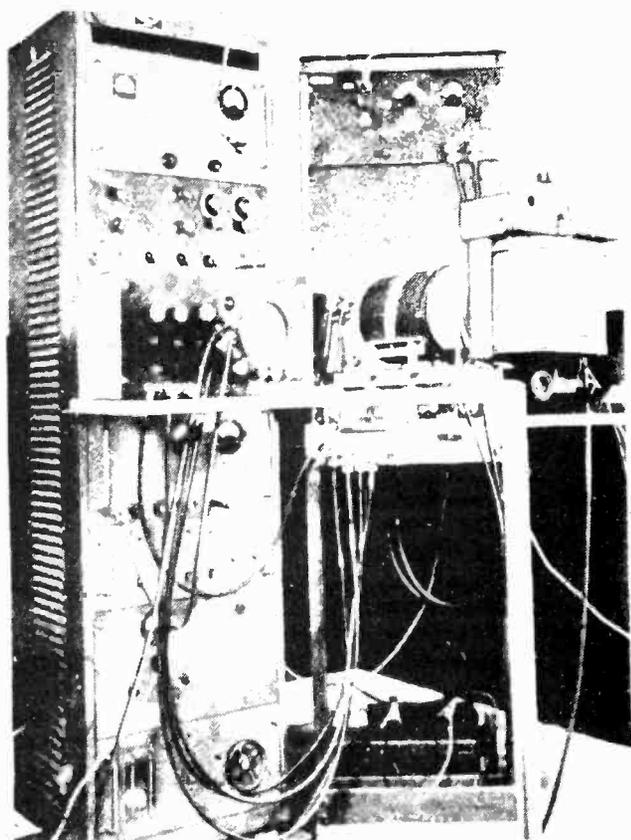


Fig. 7. E Electro-physiological research equipment used by Dickinson at Oxford University in 1949.

## Monitoring

The largest proportion of electro-medical equipment is concerned with measurement; for detection of abnormal states. At present comparatively few of the incredibly great range of medical measurements needed can be made in situ on the body and without disturbing its functions. Samples of tissue, blood, urine, etc. are removed for analysis in the pathological laboratory. This process, although performed faster today than ever before, can still take several hours before a diagnosis is available to the physician in order that he or she can decide corrective action. Analysers now exist that handle many measurements of a sample entirely automatically once the sample is loaded into the analyser. But the sample must first be extracted from the body and then be transported to the machine, processes which consume time and in some circumstances alter the sample from its original state.

It is realistic to expect the transport step to be eliminated in the future with most local clinics having their own units for analysis of samples. The next stage in progress will come about by the invention of units that measure parameters such as blood count, albumin, etc. by contact externally to a suitable vein or artery. Direct measurement like this would also provide more accurate measurement as the blood would be in its normal working state. Furthermore, it would then be possible rapidly to optimize drug dosage and to investigate changes in parameters as they happen. The concept of in-situ measurement will apply to numerous other tests.

In special cases some people have already been equipped with sensors of critical body parameters. The outputs are telemetered to a remote observer. Examples of this are in space-medicine, in fitness studies and in a few heart disease cases.

## Microbody

Considering the low-cost data processing power already available, and coupling this with inexpensive micro-miniature sensors we can expect to see developed in the future, it is possible that individuals will one day be able to obtain self-monitors that provide warning when body parameters exceed allowable limits.

Better measurements always leads to better control. As an example, respiratory tract problems, such as hay fever and asthma, are hard to combat effectively because of the lack of detailed data about each individual's characteristics in the various circumstances encountered. Not all people are allergic to the same pollens — we could benefit greatly if an easy way existed that determined the allergic pollens involved.

At present, a pollen count is usually taken by drawing the ambient air over a sticky surface for many minutes — hours sometimes. The surface is then observed with a microscope, the technician counting all pollen grains together to obtain the total pollen count. This process is now sometimes carried out using computer-controlled video TV camera systems, but the systems are still barely able to group the various kinds of pollen grain. (They are typically a micrometre in diameter or smaller — counts of a few grains per cubic metre can cause unwanted symptoms.)

A development that could help is a sensor that provides a virtually instant count of the individual kinds of pollen grain present — a real-time sampling analyser.

With such a device the sufferer could test for the hostile situation *before* symptoms arise and take remedial action in time. Technologically such an instrument appears feasible. It is, however, cost and physical size that holds up its development and its practical everyday use at present.

A likely parallel already existing is the Coulter counter that analyses the size and number of cells in a blood sample. Blood-cell counting of several years ago required the blood to be smeared on a microscope slide and the cells counted by eye under a microscope. Today the machine makes the measurements in a few seconds by counting particles as they pass a small orifice — but it is neither portable nor inexpensive. Figure 8 shows a Coulter counter installation as used in the larger pathological laboratories.

Development of personal monitors will almost certainly pass first through a telemetry method in which a central computer processes the data, perhaps with the help of the trained physician to begin with. A direct self-contained method will then be developed in which the specific data processing requirements that have emerged from experience, are integrated into the unit.

## Sensors

The human body is a vastly complicated chemical process plant. It has sensors feeding information to the brain for central processing. In turn, the brain sends signals to actuators — the muscles which cause the body to function and to do work. Nerves are the hardwired data channels for receiving and sending control information.

Slight deficiencies in the senses of sight and hearing have been aided using instruments — spectacles and hearing aids. The latter began as acoustic horns which provided sound pressure gain without active amplification. The advent of the telephone led to amplifierless hearing aids in the 1900's which used several mouthpieces coupled to the ear pieces (Fig 9). Then came electronic units which provided active signal gain from miniature thermionic tubes. Today we have integrated semi-conductor circuitry. We have still a way to go, however, before we are able to compensate for a failed action of the inner ear mechanism.

Vision, until very recently, was aided only by optical lens compensation. But this applies only where the eye is still largely operative as an optical-to-electrical transducer. Quite recently experiments have been reported in which a miniature video camera provides electronic signals that drive cells in the brain to provide illusion of sight. The method is still crude compared with the performance of natural process. Given time for research it seems reasonable to assume that quite compact and useful artificial eyes will soon be available for blind people. Bionic man is not so fantastic! Interestingly, once the bionic eye is developed it is an easy matter to provide greater than natural visual acuity and to offer sensitivity to other than the visible light band — infra-red for instance.

Providing electronic replacements for the sense of smell will most likely be a much later development. We know too little about the olfactory senses and have no really compact and cheap smell sensors at this time to expect great progress to occur in the near future.

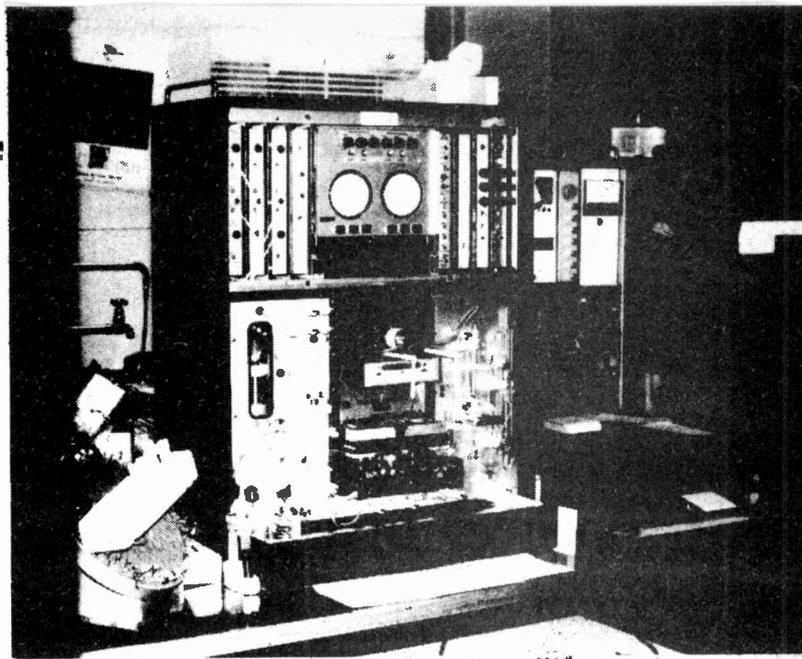


Fig. 8. Coulter counter unit of today that analyses blood sample particles providing a printout (IMUS, Adelaide).

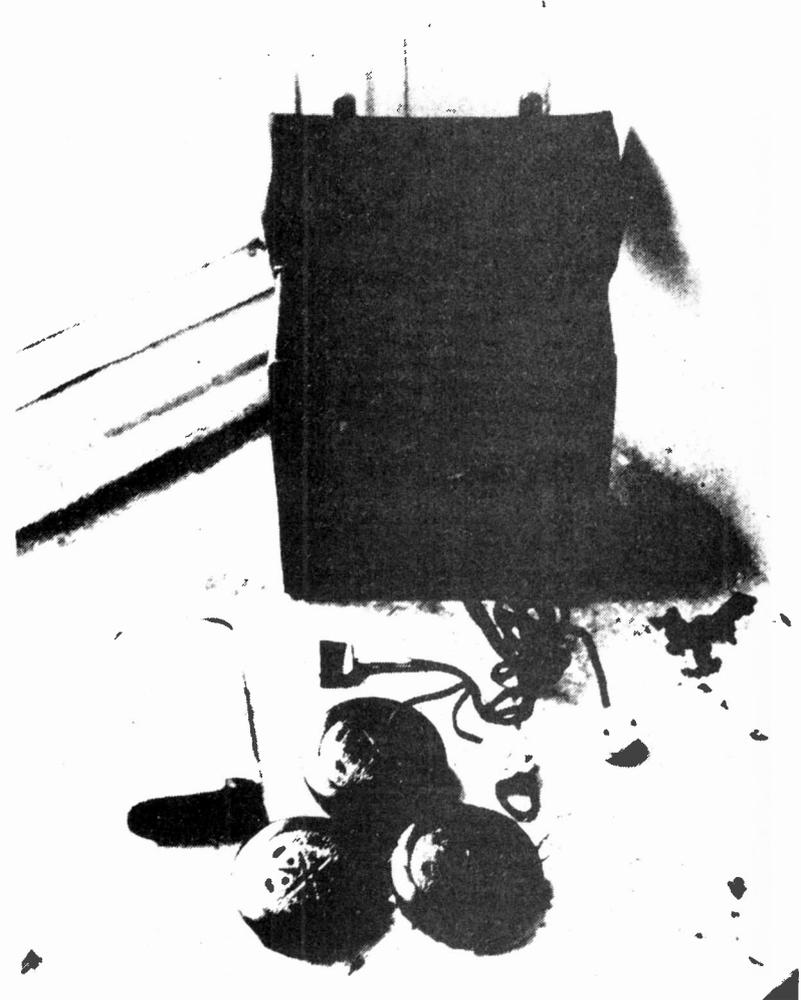


Fig. 9. 1900's hearing aid. The three receivers, which fit into the case, provide signal to the two earpieces. No active amplifier was involved. (Birdwood Mill Museum, S.A)

# FEATURE : Electronics in Medicine

Animals, such as dogs, possess a sense of smell vastly much more sensitive than humans. Ants track each other by a scent trail! Yet man has not yet produced small and inexpensive chemical analysers (small is a largely chemical process) that can meet the complex sensing requirements of smell detection.

## Scanners

X-ray and nucleonic diagnostic methods have the valuable feature that certain internal structures of the body can be seen. But all such methods lack the spatial resolution we obtain by visual examination with the unaided eye or through a microscope. A nuclear radiation source set-up within the body provides a rather diffuse output picture. Resolution is improved by increasing the number of individual elements at the sensing stage. The gamma camera, for example, provides two-dimensional pictures using over thirty scintillometers connected in such a way as to provide many more picture elements. The latest development senses the body area by scanning multiple sensors thereby collecting yet more data in a given time. Sophisticated processing is then used to provide video screen outputs which contain much more useful information than ever before. Similar techniques apply to X-ray, nucleonic and ultrasonic signal transmission. Now that vastly more powerful data processing capability exists the future development will be to incorporate many more sensors of the same kind and make more effective use of three-dimensional data. Other variables, such as, say, thermal emission will also be incorporated along with systematic experience gained into the processing, all this to providing data conversion for a more meaningful measurement process.

## Surgery

Electrical methods in surgery traditionally include endoscopes with which to see into inaccessible places and cauterizing probes for sealing blood flow, cutting and destroying cells where need be. The recent introduction of the laser as a cutting tool has most valuable properties. Selection of the appropriate wavelength decides which kind of body tissue will be cut. For example, it is possible to weld the retina of the eye through the pupil without need for surgery. The radiation is only absorbed by retinal material, the pupil and fluid of the eye ball being transparent to the wavelength used.

The selective property of narrow-band radiation will enable some highly precise surgical operations in the future. An operation might go as follows: a rigid framework holds the patient fixed with respect to an x-y-z translating pulsed laser operating head. Wired to the control unit of the translator are electrodes fixed to the body. These sense when low-power sensing pulses are energising the specific part of the body required to be operated upon. The unit scans until sensing signals (operated by a non-cutting wavelength source) verify the location of the beam. Once at such a point the laser is switched to full cutting power continuing to cut as the time-multiplexed sensing signals indicate position is satisfactory.

Looking back, electro-medical apparatus has only been with us for a mere 50 years. In the last 10 years of which we developed inexpensive and very powerful data processing methods. The next 25 years are likely to unfold undreamed of aids to medicine many of which we would regard as miraculous if we heard about them today.

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.222<br/>2N2277 .30 .277 .222<br/>2N2278 .30 .277 .222<br/>2N2279 .30 .277 .222<br/>2N2280 .30 .277 .222<br/>2N2281 .30 .277 .222<br/>2N2282 .30 .277 .222<br/>2N2283 .30 .277 .222<br/>2N2284 .30 .277 .222<br/>2N2285 .30 .277 .222<br/>2N2286 .30 .277 .222<br/>2N2287 .30 .277 .222<br/>2N2288 .30 .277 .222<br/>2N2289 .30 .277 .222<br/>2N2290 .30 .277 .222<br/>2N2291 .30 .277 .222<br/>2N2292 .30 .277 .222<br/>2N2293 .30 .277 .222<br/>2N2294 .30 .277 .222<br/>2N2295 .30 .277 .222<br/>2N2296 .30 .277 .222<br/>2N2297 .30 .277 .222<br/>2N2298 .30 .277 .222<br/>2N2299 .30 .277 .222<br/>2N2300 .30 .277 .222</p> | <p><b>TTL</b></p> <p>7400 .03 .036 .034<br/>7401 .19 .171 .144<br/>7402 .45 .398 .336<br/>7403 .84 .736 .64<br/>7404 .120 .108 .912<br/>7405 .45 .398 .336<br/>7406 .118 .106 .896<br/>7407 .86 .778 .686<br/>7408 .86 .778 .686<br/>7409 .86 .778 .686<br/>7410 .86 .778 .686<br/>7411 .86 .778 .686<br/>7412 .86 .778 .686<br/>7413 .86 .778 .686<br/>7414 .86 .778 .686<br/>7415 .86 .778 .686<br/>7416 .86 .778 .686<br/>7417 .86 .778 .686<br/>7418 .86 .778 .686<br/>7419 .86 .778 .686<br/>7420 .86 .778 .686<br/>7421 .86 .778 .686<br/>7422 .86 .778 .686<br/>7423 .86 .778 .686<br/>7424 .86 .778 .686<br/>7425 .86 .778 .686<br/>7426 .86 .778 .686<br/>7427 .86 .778 .686<br/>7428 .86 .778 .686<br/>7429 .86 .778 .686<br/>7430 .86 .778 .686<br/>7431 .86 .778 .686<br/>7432 .86 .778 .686<br/>7433 .86 .778 .686<br/>7434 .86 .778 .686<br/>7435 .86 .778 .686<br/>7436 .86 .778 .686<br/>7437 .86 .778 .686<br/>7438 .86 .778 .686<br/>7439 .86 .778 .686<br/>7440 .86 .778 .686<br/>7441 .86 .778 .686<br/>7442 .86 .778 .686<br/>7443 .86 .778 .686<br/>7444 .86 .778 .686<br/>7445 .86 .778 .686<br/>7446 .86 .778 .686<br/>7447 .86 .778 .686<br/>7448 .86 .778 .686<br/>7449 .86 .778 .686<br/>7450 .86 .778 .686<br/>7451 .86 .778 .686<br/>7452 .86 .778 .686<br/>7453 .86 .778 .686<br/>7454 .86 .778 .686<br/>7455 .86 .778 .686<br/>7456 .86 .778 .686<br/>7457 .86 .778 .686<br/>7458 .86 .778 .686<br/>7459 .86 .778 .686<br/>7460 .86 .778 .686<br/>7461 .86 .778 .686<br/>7462 .86 .778 .686<br/>7463 .86 .778 .686<br/>7464 .86 .778 .686<br/>7465 .86 .778 .686<br/>7466 .86 .778 .686<br/>7467 .86 .778 .686<br/>7468 .86 .778 .686<br/>7469 .86 .778 .686<br/>7470 .86 .778 .686<br/>7471 .86 .778 .686<br/>7472 .86 .778 .686<br/>7473 .86 .778 .686<br/>7474 .86 .778 .686<br/>7475 .86 .778 .686<br/>7476 .86 .778 .686<br/>7477 .86 .778 .686<br/>7478 .86 .778 .686<br/>7479 .86 .778 .686<br/>7480 .86 .778 .686<br/>7481 .86 .778 .686<br/>7482 .86 .778 .686<br/>7483 .86 .778 .686<br/>7484 .86 .778 .686<br/>7485 .86 .778 .686<br/>7486 .86 .778 .686<br/>7487 .86 .778 .686<br/>7488 .86 .778 .686<br/>7489 .86 .778 .686<br/>7490 .86 .778 .686<br/>7491 .86 .778 .686<br/>7492 .86 .778 .686<br/>7493 .86 .778 .686<br/>7494 .86 .778 .686<br/>7495 .86 .778 .686<br/>7496 .86 .778 .686<br/>7497 .86 .778 .686<br/>7498 .86 .778 .686<br/>7499 .86 .778 .686<br/>7500 .86 .778 .686</p> | <p><b>1+25+100+</b></p> <p>7501 .20 .178 .15<br/>7502 .40 .355 .298<br/>7503 .23 .205 .173<br/>7504 .34 .307 .258<br/>7505 .35 .313 .264<br/>7506 .89 .803 .677<br/>7507 .44 .393 .331<br/>7508 .45 .398 .336<br/>7509 .45 .398 .336<br/>7510 .45 .398 .336<br/>7511 .45 .398 .336<br/>7512 .45 .398 .336<br/>7513 .45 .398 .336<br/>7514 .45 .398 .336<br/>7515 .45 .398 .336<br/>7516 .45 .398 .336<br/>7517 .45 .398 .336<br/>7518 .45 .398 .336<br/>7519 .45 .398 .336<br/>7520 .45 .398 .336<br/>7521 .45 .398 .336<br/>7522 .45 .398 .336<br/>7523 .45 .398 .336<br/>7524 .45 .398 .336<br/>7525 .45 .398 .336<br/>7526 .45 .398 .336<br/>7527 .45 .398 .336<br/>7528 .45 .398 .336<br/>7529 .45 .398 .336<br/>7530 .45 .398 .336<br/>7531 .45 .398 .336<br/>7532 .45 .398 .336<br/>7533 .45 .398 .336<br/>7534 .45 .398 .336<br/>7535 .45 .398 .336<br/>7536 .45 .398 .336<br/>7537 .45 .398 .336<br/>7538 .45 .398 .336<br/>7539 .45 .398 .336<br/>7540 .45 .398 .336<br/>7541 .45 .398 .336<br/>7542 .45 .398 .336<br/>7543 .45 .398 .336<br/>7544 .45 .398 .336<br/>7545 .45 .398 .336<br/>7546 .45 .398 .336<br/>7547 .45 .398 .336<br/>7548 .45 .398 .336<br/>7549 .45 .398 .336<br/>7550 .45 .398 .336<br/>7551 .45 .398 .336<br/>7552 .45 .398 .336<br/>7553 .45 .398 .336<br/>7554 .45 .398 .336<br/>7555 .45 .398 .336<br/>7556 .45 .398 .336<br/>7557 .45 .398 .336<br/>7558 .45 .398 .336<br/>7559 .45 .398 .336<br/>7560 .45 .398 .336<br/>7561 .45 .398 .336<br/>7562 .45 .398 .336<br/>7563 .45 .398 .336<br/>7564 .45 .398 .336<br/>7565 .45 .398 .336<br/>7566 .45 .398 .336<br/>7567 .45 .398 .336<br/>7568 .45 .398 .336<br/>7569 .45 .398 .336<br/>7570 .45 .398 .336<br/>7571 .45 .398 .336<br/>7572 .45 .398 .336<br/>7573 .45 .398 .336<br/>7574 .45 .398 .336<br/>7575 .45 .398 .336<br/>7576 .45 .398 .336<br/>7577 .45 .398 .336<br/>7578 .45 .398 .336<br/>7579 .45 .398 .336<br/>7580 .45 .398 .336<br/>7581 .45 .398 .336<br/>7582 .45 .398 .336<br/>7583 .45 .398 .336<br/>7584 .45 .398 .336<br/>7585 .45 .398 .336<br/>7586 .45 .398 .336<br/>7587 .45 .398 .336<br/>7588 .45 .398 .336<br/>7589 .45 .398 .336<br/>7590 .45 .398 .336<br/>7591 .45 .398 .336<br/>7592 .45 .398 .336<br/>7593 .45 .398 .336<br/>7594 .45 .398 .336<br/>7595 .45 .398 .336<br/>7596 .45 .398 .336<br/>7597 .45 .398 .336<br/>7598 .45 .398 .336<br/>7599 .45 .398 .336<br/>7600 .45 .398 .336</p> | <p><b>TTL</b></p> <p>7601 .16 .144 .122<br/>7602 .16 .144 .122<br/>7603 .16 .144 .122<br/>7604 .16 .144 .122<br/>7605 .16 .144 .122<br/>7606 .16 .144 .122<br/>7607 .16 .144 .122<br/>7608 .16 .144 .122<br/>7609 .16 .144 .122<br/>7610 .16 .144 .122<br/>7611 .16 .144 .122<br/>7612 .16 .144 .122<br/>7613 .16 .144 .122<br/>7614 .16 .144 .122<br/>7615 .16 .144 .122<br/>7616 .16 .144 .122<br/>7617 .16 .144 .122<br/>7618 .16 .144 .122<br/>7619 .16 .144 .122<br/>7620 .16 .144 .122<br/>7621 .16 .144 .122<br/>7622 .16 .144 .122<br/>7623 .16 .144 .122<br/>7624 .16 .144 .122<br/>7625 .16 .144 .122<br/>7626 .16 .144 .122<br/>7627 .16 .144 .122<br/>7628 .16 .144 .122<br/>7629 .16 .144 .122<br/>7630 .16 .144 .122<br/>7631 .16 .144 .122<br/>7632 .16 .144 .122<br/>7633 .16 .144 .122<br/>7634 .16 .144 .122<br/>7635 .16 .144 .122<br/>7636 .16 .144 .122<br/>7637 .16 .144 .122<br/>7638 .16 .144 .122<br/>7639 .16 .144 .122<br/>7640 .16 .144 .122<br/>7641 .16 .144 .122<br/>7642 .16 .144 .122<br/>7643 .16 .144 .122<br/>7644 .16 .144 .122<br/>7645 .16 .144 .122<br/>7646 .16 .144 .122<br/>7647 .16 .144 .122<br/>7648 .16 .144 .122<br/>7649 .16 .144 .122<br/>7650 .16 .144 .122<br/>7651 .16 .144 .122<br/>7652 .16 .144 .122<br/>7653 .16 .144 .122<br/>7654 .16 .144 .122<br/>7655 .16 .144 .122<br/>7656 .16 .144 .122<br/>7657 .16 .144 .122<br/>7658 .16 .144 .122<br/>7659 .16 .144 .122<br/>7660 .16 .144 .122<br/>7661 .16 .144 .122<br/>7662 .16 .144 .122<br/>7663 .16 .144 .122<br/>7664 .16 .144 .122<br/>7665 .16 .144 .122<br/>7666 .16 .144 .122<br/>7667 .16 .144 .122<br/>7668 .16 .144 .122<br/>7669 .16 .144 .122<br/>7670 .16 .144 .122<br/>76</p> |
|---|---|---|---|--|---|---|

# ELECTROVALUE Buying Guide

## Section 2

If you have already bought from Electrovalue, you will know just how large and varied our stocks are and how well your orders are looked after, whether you be beginner or a computer-minded expert. For those who have yet to know, we have been publishing a series of ads. month by month to give you up-to-date information and prices on the more important items we carry so that BY DETACHING AND SAVING THESE PAGES, YOU WILL HAVE A VALUABLE AND COMPREHENSIVE MONEY SAVING CATALOGUE. ALL MERCHANDISE IS BRAND NEW AND GUARANTEED. See below how easy it is to order — and how you save.

Be safe! Be satisfied! Buy it from Electrovalue

## Capacitors

Quantity prices available except for MDC.

| Product               | µF | Volts                        | Price |
|-----------------------|----|------------------------------|-------|
| <b>CERAMIC DISC ●</b> |    |                              |       |
| 500V: 1, 2, 5nF       | 3p | 4.7 16                       | 21p   |
| 50V: 0.02µF           | 3p | 4.7 40                       | 12p   |
|                       |    | 4.7 63                       | 12p   |
|                       |    | 4.7 100                      | 14p   |
|                       |    | 10 6.3                       | 21p   |
|                       |    | 10 25                        | 12p   |
|                       |    | 10 40                        | 12p   |
|                       |    | 10 63                        | 14p   |
|                       |    | 10 100                       | 15p   |
|                       |    | 22 10                        | 12p   |
|                       |    | 22 25                        | 12p   |
|                       |    | 22 40                        | 13p   |
|                       |    | 22 63                        | 15p   |
|                       |    | 22 100                       | 16p   |
|                       |    | 47 3                         | 12p   |
|                       |    | 47 10                        | 12p   |
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|                       |    | 47 40                        | 15p   |
|                       |    | 47 63                        | 16p   |
|                       |    | 47 100                       | 19p   |
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|                       |    | 100 25                       | 15p   |
|                       |    | 100 40                       | 16p   |
|                       |    | 100 63                       | 22p   |
|                       |    | 100 100                      | 28p   |
|                       |    | 220 3                        | 13p   |
|                       |    | 220 6.3                      | 15p   |
|                       |    | 220 10                       | 15p   |
|                       |    | 220 16                       | 17p   |
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|                       |    | 220 40                       | 24p   |
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|                       |    | 220 100                      | 47p   |
|                       |    | 470 10                       | 19p   |
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|                       |    | 470 40                       | 31p   |
|                       |    | 470 63                       | 45p   |
|                       |    | 470 100                      | 74p   |
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|                       |    | 1000 40                      | 45p   |
|                       |    | 1000 63                      | 76p   |
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|                       |    | 2200 16                      | 35p   |
|                       |    | 2200 25                      | 45p   |
|                       |    | 2200 40                      | 70p   |
|                       |    | 2200 63                      | 84p   |
|                       |    | 2200 100                     | 110p  |
|                       |    | 4700 16                      | 85p   |
|                       |    | 4700 25                      | 96p   |
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|                       |    | 10000 1000000000000000000    | 40p   |
|                       |    | 10000 1500000000000000000    | 40p   |
|                       |    | 10000 2000000000000000000    | 40p   |
|                       |    | 10000 3000000000000000000    | 40p   |
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Deflection Sensitivity — 100mV/division  
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Input Attenuator — (calibrated) — 9 steps 0.1, 0.2, 0.5, 1, 2, 5, 10, 20 50V/div  
Input Impedance — 1 Meg/40 pf in shunt  
Input Voltage — Max — 600V P.P.

##### HORIZONTAL AXIS (X)

Deflection Sensitivity — 0-400mV/division  
Bandwidth (between 3dB points) — 1Hz-350KHz  
Gain Control — Continuous, when time base in EXT position  
Input Impedance — 1 Meg  
Input Voltage — Max — 600V P.P.

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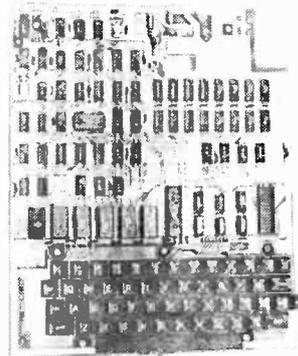
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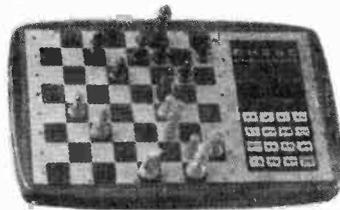
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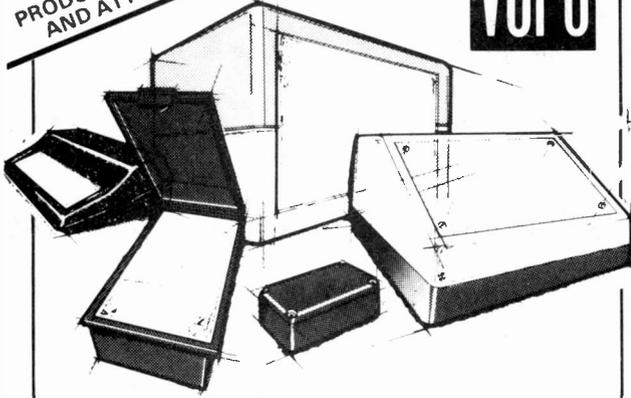
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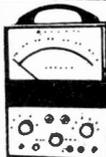
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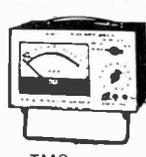
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# DIGITAL DIAL

**Most AM radio dials are pretty hopeless — especially portables and car radios. This application of our counter module can be a decided improvement.**

WITH MODERN RADIOS which are designed to be operated anywhere in the world, the local station call signs are no longer marked on the dial. Instead the dial is marked with frequencies making it more universal. Unfortunately the scaling on many receivers leaves a little to be desired, with many car radios lucky to have 3 or 4 markings. The use of pushbutton selection helps but when a cassette is fitted or you are out of your local area there is still the problem of knowing to what station you are tuned.

This project gives a direct readout of the station being received allowing for easy identification and selection. The display is remote from the receiver allowing it to be mounted on the dashboard for easy viewing.

## Design Features

This project is the first to employ our four digit module presented elsewhere in this issue. We will be using the module again over the next few months so don't lose track of it!

If this device is to be used outdoors i.e. in the car, it is recommended that high brightness displays, such as the Hewlett Packard HDSP 4133, be used. As these have a different pin-out a new display board is presented in this article.

The theory of operation is that we actually measure the frequency of the local oscillator in the radio and subtract the IF frequency. While we could have subtracted this using digital logic we chose to do it by resetting the display not to zero but to 9545 (10 000-455). The first 455 pulses in the timing period are then used getting to zero and in effect, only pulses after this are counted and displayed. This number can be loaded into the counter by



## SPECIFICATION

|                 |                                  |
|-----------------|----------------------------------|
| Frequency range | 500-1700 kHz                     |
| Accuracy        | ± 5 kHz                          |
| Sensor          | pickup coil or direct connection |
| Power supply    | 7-20VDC @ 80mA or 240VAC         |
| Display         | 4 digit LED                      |

selecting the appropriate diodes and using the "load counter" input instead of the reset line. The only difference is that as the data is entered into the counter serially the pulse used must be longer than 4 times the internal oscillator period. Also as the LC input is a three state input it cannot be driven by conventional two-state.

## Out of Tune

We initially tried capacitive coupling onto the tuning capacitor of our portable radio (oscillator section!) but the loading detuned the set too much. We then tried a pickup coil and found enough signal with it in the correct place not to require any electrical connection to the set. With

# PROJECT: Digital Dial

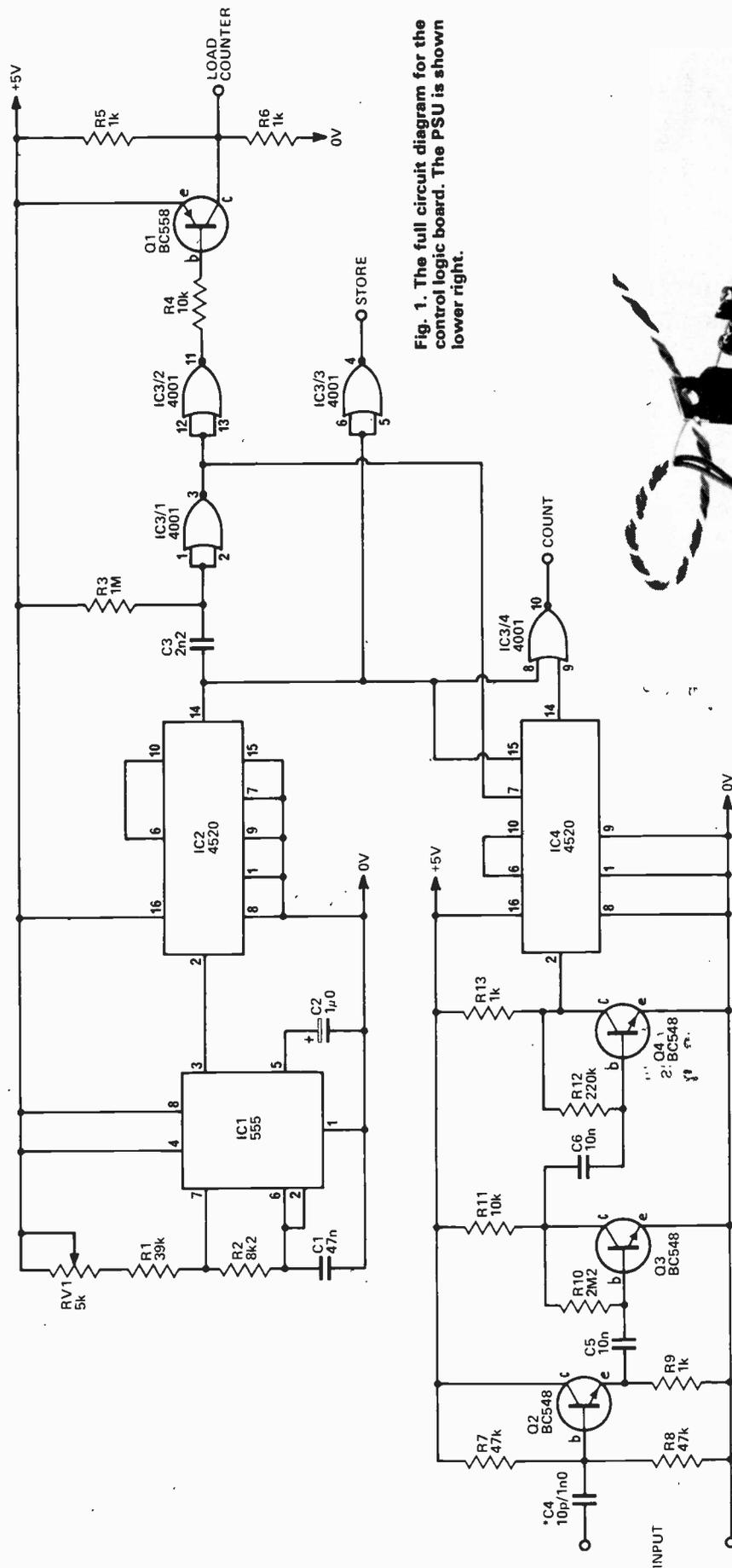
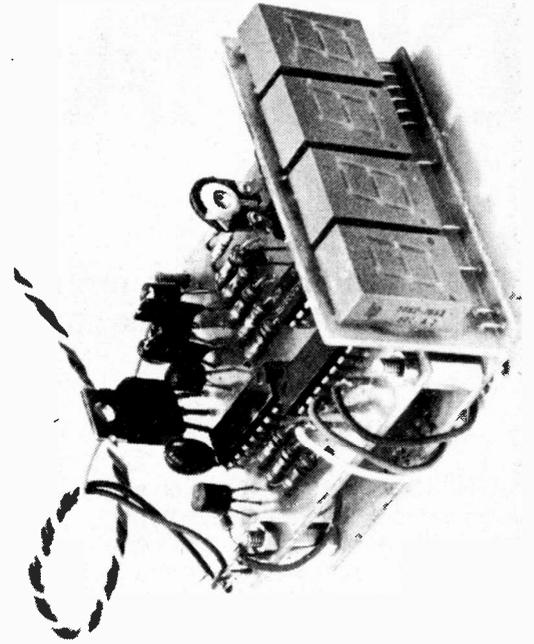
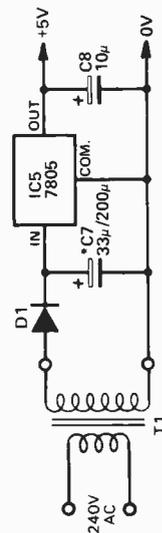


Fig. 1. The full circuit diagram for the control logic board. The PSU is shown lower right.



The photo to the right shows the module with the HP 5082-7663 displays. Suitable displays and their light outputs are given below.

| Type      | Colour | Size    | Light output         |
|-----------|--------|---------|----------------------|
| HDSP 4133 | yellow | 10.9 mm | 2100 $\mu$ Cd @ 20mA |
| HDSP 3733 | red    | 10.9 mm | 1800 $\mu$ Cd @ 20mA |
| 5082-7663 | yellow | 10.9 mm | 1500 $\mu$ Cd @ 20mA |
| 5082-7653 | red    | 10.9 mm | 1720 $\mu$ Cd @ 20mA |
| DL704     | red    | 7.6 mm  | 320 $\mu$ Cd @ 25mA  |



## HOW IT WORKS

A signal from the local oscillator in the tuner is picked up either by a pickup coil or by direct connection to the set. It is then amplified by Q2-Q4 to give a square wave on the collector of Q4. The gain of this amplifier is about 250 (48 dB). The frequency of this signal will vary from around 1 MHz to about 2 MHz and this signal is then frequency divided by 256 (2<sup>8</sup>) in IC4. This is used to clock the display module.

To measure the frequency we have to count the number of these pulses for 256/1000 seconds (256 because we divided the input by 256 and 1000 as we want a 1 kHz resolution). We used a 555 oscillator for the time base and its output is also divided by 256 (by IC2). This improves the stability of the time base by averaging out any short term variations in the 555 frequency.

The output of IC2 is a symmetrical square wave and when the output goes low a 1.5 ms wide pulse is generated by R3, C3 and IC3/1. This is inverted by IC3/2 which turns Q1 on for the 1.5 ms period. Two resistors are used to bias the output of Q1 to 2.5V to ensure that the three level input will work.

This pulse "loads" 9545 into the counters (in the display module). Counting now starts from this number and after 455 pulses it is passing through zero. 256 ms after the load pulse ended the output of IC2 goes high. This resets IC4 back to zero, inhibits any further clocking via IC3/4 and opens the latches via the strobe line allowing the total in the counter to be displayed. 257.5 ms later when the output of IC2 goes low again, the store is closed, the counter is once again preset to 9545 with the process starting again.

the car radio however the coils are shielded so well that reliable operation was not possible. However it was found that we could tap onto one side of the oscillator coil without affecting the operation.

We use a NE555 as the time base with its output being divided by 128 to improve stability. However if an accuracy of  $\pm 5$  kHz is to be maintained its frequency has to be better than 1/4% and a polystyrene capacitor for C1 and 2% resistors for R1 and R2 are recommended.

### Construction

The display board should be built according to the overlay in Fig. 4 which shows which diodes are required. Note that R1, 2 and C1 are not used in the display module and a link is used in place of R1.

The control card can now be assembled and wired to the display module. The two boards are

mounted one above the other using 9.6 mm spacers. Check that these screws do not touch any tracks and insulate them if too close.

Depending on whether the unit is going to be used with a car radio or portable the values of C4 and C7 will vary. The pickup coil is made by winding about 80 turns of 0.25 mm enamelled wire onto a 25 mm long piece of 10 mm ferrite rod with the end terminated onto a twisted pair of plastic covered wires long enough to go between the radio and the position of the display. Do not use coaxial cable for this as the capacitance is too high.

The case chosen has been left to the individual with our own being from a discarded digital clock. If you use the 240 V powered version be careful with the high voltage wiring. For the 12 V version the power can come from the radio via a twisted lead (3 wires).

When connecting into a car radio, tune the set to a local station and try the pickup wire on the terminals of the tuning coils in turn until one is found which will give a reading without moving it off station.

Permanently connect to this point. With a portable radio try moving the pickup coil around the set, probably in line with the aerial coil, until the best results are obtained.

### Calibration

Place the pickup coil in position such that reliable operation is obtained and tune to a known station (preferably near the top end of the dial). Now adjust RV1 until the digital dial agrees with that station. Check then with other stations.

Alternatively feed a known signal of between 1 and 2 MHz from an oscillator into the input and adjust RV1 until it reads 455 less than that frequency.

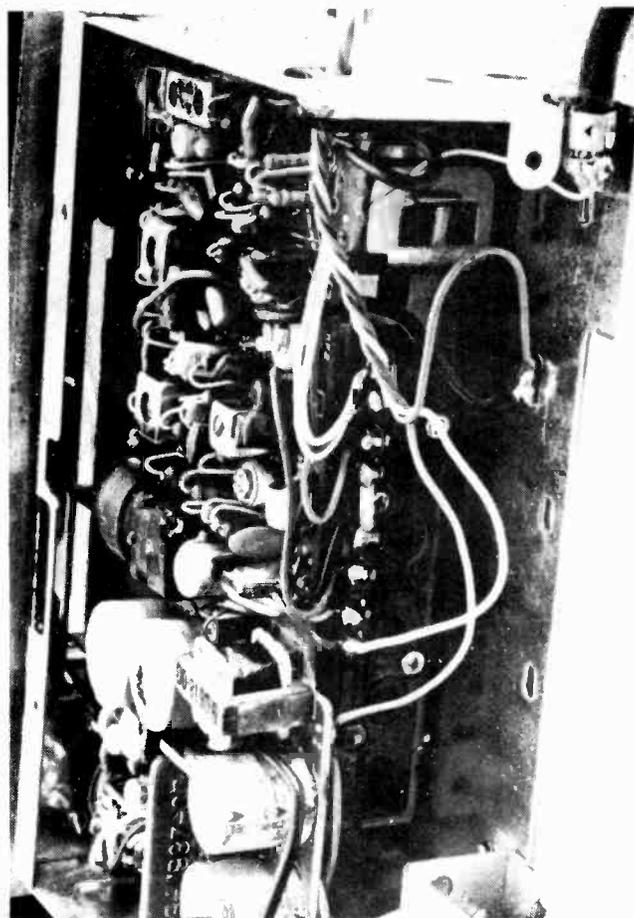
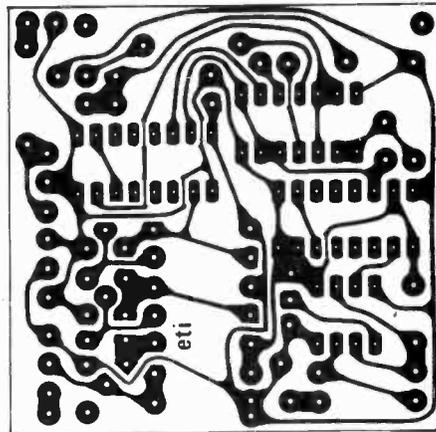
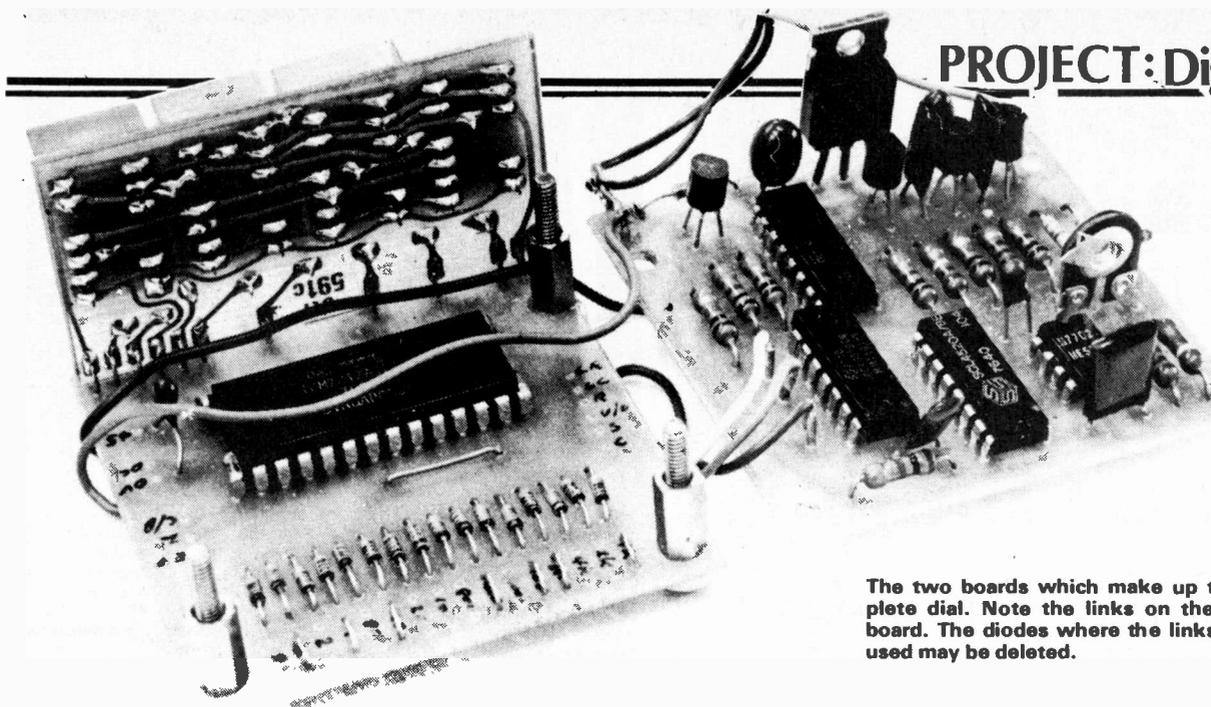


Photo showing where we tapped into the car radio.



Right: full site foil patterns for the Digital control board. Refer to the module article for details of those PCBs. Not shown here i.e. the two display boards and the third for high brightness seven segment types.

# PROJECT: Digital Dial



The two boards which make up the complete dial. Note the links on the display board. The diodes where the links are not used may be deleted.

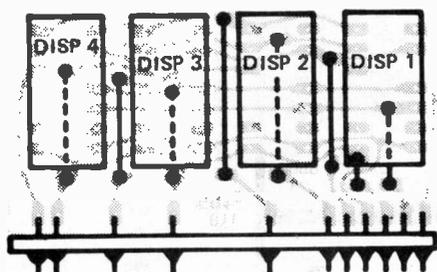


Fig 3(a) The overlay for the display board employing the high brightness displays. (b) Below that (left) the control board overlay.

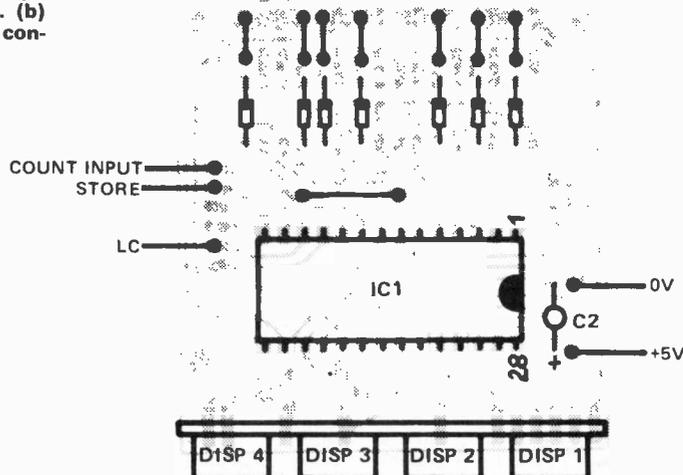
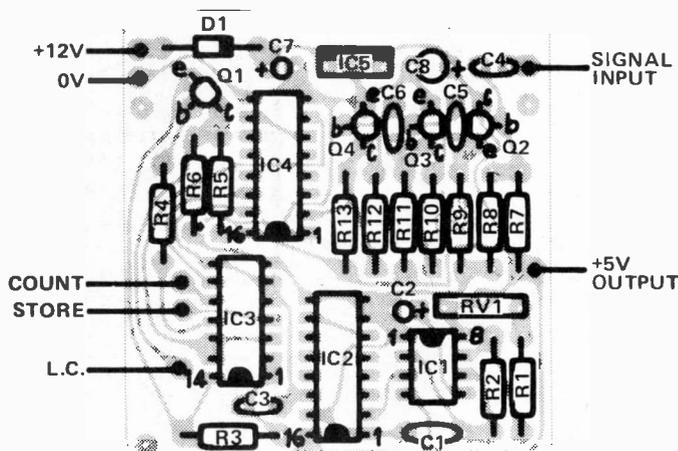


Fig. 4. The component overlay of the display module showing the diodes and links required.

## PARTS LIST

|               |                 |                |                      |
|---------------|-----------------|----------------|----------------------|
| RESISTORS     | all 1/2W, 5%    | *C7            | 33u tantalum         |
| R1            | 39k             | C8             | 10u 25V electrolytic |
| R2            | 8k2             | SEMICONDUCTORS |                      |
| R3            | 1M              | IC1            | 555                  |
| R4, 11        | 10k             | IC2            | 4520                 |
| R5, 6, 9, 13  | 1k              | IC3            | 4001                 |
| R7, 8         | 47k             | IC4            | 4520                 |
| R10           | 2M2             | IC5            | 7805                 |
| R12           | 220k            | Q1             | BC558                |
| POTENTIOMETER |                 | Q2-Q4          | BC548                |
| RV1           | 5k trimmer      | D1             | 1N4004               |
| CAPACITORS    |                 | MISCELLANEOUS  |                      |
| C1            | 47n polystyrene | *Transformer   | 240V-12V6, 150 mA    |
| C2            | 1u0 tantalum    |                |                      |
| C3            | 2n2 polyester   |                |                      |
| *C4           | 10p ceramic     |                |                      |
| C5, 6         | 10n polyester   |                |                      |

\*For 12 V operation delete transformer. For 240 V version C7 should be 220u 25 V. For use with pickup coil increase C4 to 1n0.

## BUYLINES

Any displays mentioned here are of course suitable and should be easily obtainable. The semiconductors are all available from Technomatic, or indeed from most other mail-order suppliers.

### Power Supply

The unit can be powered by an AC or DC voltage of between 7 and 20 volts. If an AC voltage is used the capacitor C7 should be increased to 220 u. A 240 V to 12V6, 150 mA transformer is recommended. **ETI**

# STEVENSON

## Electronic Components

### VEROBOARDS

| Size in.   | 0.1in. | 0.15in. | Veropins —   |
|------------|--------|---------|--------------|
| 2.5 x 1    | 14p    | 13p     | single sided |
| 2.5 x 3.75 | 42p    | 40p     | per 100      |
| 2.5 x 5    | 52p    | 50p     | 0.1in 35p    |
| 3.75 x 5   | 60p    | 60p     | 0.15in 40p   |
| 3.75 x 17  | 195p   | 180p    |              |

### TRANSFORMERS

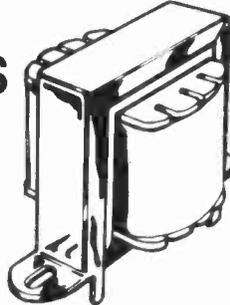
PRIMARY 240 Volts

| Code | Secondary                          |      |
|------|------------------------------------|------|
| A1   | 6 - 0 - 6 at 0.5A                  | 155p |
| A4   | 9 - 0 - 9 at 0.4A                  | 155p |
| B1   | 6 - 0 - 6 at 1A                    | 205p |
| B4   | 12 - 0 12 at 0.5A                  | 205p |
| B8   | 15 - 0 15 at 0.4A                  | 205p |
| C4   | 9 - 0 - 9 at 1.2A                  | 305p |
| C8   | 12 - 0 12 at 1A                    | 305p |
| D12  | 0 - 12 - 15 - 20 - 24 - 30 at 1.5A | 395p |
| E12  | 0 - 20 - 25 - 33 - 40 - 50 at 2A   | 525p |

### MINIATURE TRANSFORMERS

240 Volt Primary

Secondary rated at 100mA.  
Available with secondaries  
of: 6 - 0 - 6, 9 - 0 - 9  
and 12 - 0 - 12. 92p each



### CRYSTALS

WIRE ENDED TYPE

| Freq. MHz |      |        |      |        |      |
|-----------|------|--------|------|--------|------|
| 0.100     | 380p | 4.000  | 250p | 12.000 | 250p |
| 0.300     | 380p | 5.000  | 250p | 18.000 | 300p |
| 1.000     | 320p | 6.000  | 250p | 20.000 | 300p |
| 2.000     | 320p | 8.000  | 250p | 32.000 | 300p |
| 3.276     | 250p | 10.000 | 250p | 48.000 | 300p |

### LOUDSPEAKERS

|           |         |      |
|-----------|---------|------|
| 56mm dia. | 8 ohms  | 70p  |
| 64mm dia. | 8 ohms  | 75p  |
| 64mm dia. | 64 ohms | 75p  |
| 70mm dia. | 8 ohms  | 100p |
| 70mm dia. | 80 ohms | 110p |



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### TRANSISTORS

|        |     |        |     |        |      |
|--------|-----|--------|-----|--------|------|
| AC127  | 17p | BCY71  | 14p | ZTX109 | 14p  |
| AC128  | 16p | BCY72  | 14p | ZTX300 | 16p  |
| AC176  | 18p | BD131  | 35p | 2N697  | 12p  |
| AD161  | 38p | BD132  | 35p | 3N1302 | 38p  |
| AD162  | 38p | BD135  | 38p | 2N2905 | 22p  |
| BC107  | 8p  | BD139  | 35p | 2N2907 | 22p  |
| BC108  | 8p  | BD140  | 35p | 2N3053 | 18p  |
| BC109  | 8p  | BF244B | 36p | 2N3055 | 50p  |
| BC147  | 7p  | BFY50  | 15p | 2N3442 | 135p |
| BC148  | 7p  | BFY51  | 15p | 2N3702 | 8p   |
| BC149  | 8p  | BFY52  | 15p | 2N3704 | 8p   |
| BC158  | 9p  | MJ2955 | 98p | 2N3706 | 9p   |
| BC177  | 14p | MPSA06 | 20p | 2N3707 | 9p   |
| BC178  | 14p | MPSA56 | 20p | 2N3708 | 8p   |
| BC179  | 14p | TIP29C | 60p | 2N3819 | 22p  |
| BC182  | 10p | TIP30C | 70p | 2N3904 | 8p   |
| BC182L | 10p | TIP31C | 65p | 2N3905 | 8p   |
| BC184  | 10p | TIP32C | 80p | 2N3906 | 8p   |
| BC184L | 10p | ZTX107 | 14p | 2N4058 | 12p  |
| BC212  | 10p | ZTX108 | 14p | 2N5457 | 32p  |
| BC212L | 10p |        |     | 2N5458 | 30p  |
| BC214  | 10p |        |     | 2N5459 | 32p  |
| BC214  | 10p | 1N914  | 4p  | 2N5777 | 50p  |
| BC477  | 19p | 1N4001 | 4p  |        |      |
| BC478  | 19p | 1N4002 | 4p  |        |      |
| BC479  | 19p | 1N4004 | 5p  |        |      |
| BC548  | 10p | 1N4006 | 6p  |        |      |
| BCY70  | 14p |        |     |        |      |

### DIODES

|        |    |        |     |
|--------|----|--------|-----|
| 1N914  | 4p | 1N4148 | 3p  |
| 1N4001 | 4p | 1N5401 | 13p |
| 1N4002 | 4p | 1N5402 | 15p |
| 1N4004 | 5p | 1N5404 | 16p |
| 1N4006 | 6p | 1N5406 | 18p |

A SELECTION ONLY!  
DETAILS IN CATALOGUE.

|         |      |        |      |         |      |
|---------|------|--------|------|---------|------|
| 709     | 25p  | LM324  | 50p  | NE556   | 60p  |
| 741     | 22p  | LM339  | 50p  | NE565   | 120p |
| 747     | 50p  | LM380  | 75p  | NE567   | 170p |
| 748     | 30p  | LM382  | 120p | SN76003 | 200p |
| CA3046  | 55p  | LM1830 | 150p | SN76013 | 140p |
| CA3080  | 70p  | LM3900 | 50p  | SN76023 | 140p |
| CA3130  | 90p  | LM3909 | 60p  | SN76033 | 200p |
| CA3140  | 70p  | MC1496 | 60p  | TBA800  | 70p  |
| LM301AN | 28p  | MC1458 | 35p  | TDAl022 | 650p |
| LM318N  | 125p | NE555  | 25p  | ZN414   | 75p  |

### OPTO

| LEDs   | 0.125in. | 0.2in. |     |
|--------|----------|--------|-----|
| Red    | TIL209   | TIL220 | 9p  |
| Green  | TIL211   | TIL221 | 13p |
| Yellow | TIL213   | TIL223 | 13p |
| Clips  | 3p       | 3p     |     |

| DISPLAYS |           |      |  |
|----------|-----------|------|--|
| DL704    | 0.3 in CC | 130p |  |
| DL707    | 0.3 in CA | 130p |  |
| FND500   | 0.5 in CC | 100p |  |



### RESISTORS

Carbon film resistors.  
High stability, low noise 5%.

| E12 series. 4.7ohms to 10M. Any mix: |      |       |      |
|--------------------------------------|------|-------|------|
| each                                 | 100+ | 1000+ |      |
| 0.25W                                | 1p   | 0.9p  | 0.8p |
| 0.5W                                 | 1.5p | 1.2p  | 1p   |

Special development packs consisting of 10 of each value from 4.7 ohms to 1 Megohm (650 res.)  
0.5W £7.50. 0.25W £5.70

### CAPACITORS

HERE ARE JUST  
A FEW OF THE  
CAPACITORS STOCKED

| TANTALUM BEAD                                      |      |     |     |     |    | each |
|--|------|-----|-----|-----|----|------|
| 0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1 & 2.2uF @ 35V |      |     |     |     |    | 9p   |
| 4.7, 6.8, 10uF @ 25V                               |      |     |     |     |    | 13p  |
| 22 @ 16V, 47 @ 6V, 100 @ 3V                        |      |     |     |     |    | 16p  |
| MYLAR FILM   |      |     |     |     |    |      |
| 0.001, 0.01, 0.022, 0.033, 0.047                   |      |     |     |     |    | 3p   |
| 0.068, 0.1   |      |     |     |     |    | 4p   |
| RADIAL LEAD ELECTROLYTIC                           |      |     |     |     |    |      |
| 63V  | 0.47 | 1.0 | 2.2 | 4.7 | 10 | 5p   |
|  |      |     | 22  | 33  | 47 | 7p   |
|  | 100  |     |     |     |    | 13p  |
|  |      |     | 220 |     |    | 20p  |
| 25V  | 10   | 22  | 33  | 47  |    | 5p   |
|  | 100  |     |     |     |    | 8p   |
|  |      |     | 220 |     |    | 10p  |
|  |      |     |     | 470 |    | 15p  |
|  |      |     |     |     |    | 23p  |
| 10V  |      | 220 |     |     |    | 5p   |
|  |      |     |     | 470 |    | 9p   |
|  |      |     |     |     |    | 13p  |
|  |      |     |     |     |    | 23p  |

### 74LS

|      |     |       |      |
|------|-----|-------|------|
| LS00 | 16p | LS95  | 65p  |
| LS01 | 16p | LS123 | 56p  |
| LS02 | 16p | LS125 | 40p  |
| LS03 | 16p | LS126 | 40p  |
| LS04 | 16p | LS132 | 60p  |
| LS08 | 16p | LS136 | 36p  |
| LS10 | 16p | LS138 | 54p  |
| LS13 | 30p | LS139 | 50p  |
| LS14 | 70p | LS151 | 50p  |
| LS20 | 16p | LS153 | 50p  |
| LS30 | 16p | LS155 | 80p  |
| LS32 | 24p | LS156 | 80p  |
| LS37 | 26p | LS157 | 45p  |
| LS40 | 22p | LS164 | 90p  |
| LS42 | 53p | LS174 | 60p  |
| LS47 | 70p | LS175 | 60p  |
| LS48 | 48p | LS190 | 80p  |
| LS54 | 16p | LS192 | 70p  |
| LS57 | 29p | LS193 | 70p  |
| LS74 | 29p | LS196 | 80p  |
| LS75 | 44p | LS251 | 60p  |
| LS76 | 35p | LS257 | 55p  |
| LS78 | 35p | LS258 | 55p  |
| LS83 | 60p | LS266 | 40p  |
| LS85 | 70p | LS283 | 60p  |
| LS86 | 33p | LS290 | 55p  |
| LS90 | 45p | LS365 | 45p  |
| LS93 | 45p | LS366 | 45p  |
|      |     | LS367 | 45p  |
|      |     | LS368 | 45p  |
|      |     | LS386 | 35p  |
|      |     | LS670 | 180p |

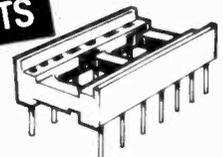
### TTL

|      |      |       |      |
|------|------|-------|------|
| 7400 | 12p  | 7493  | 34p  |
| 7401 | 12p  | 7494  | 52p  |
| 7402 | 12p  | 7495  | 52p  |
| 7404 | 12p  | 7496  | 50p  |
| 7408 | 14p  | 74121 | 25p  |
| 7410 | 12p  | 74122 | 33p  |
| 7413 | 25p  | 74123 | 40p  |
| 7414 | 48p  | 74125 | 35p  |
| 7420 | 12p  | 74126 | 35p  |
| 7422 | 24p  | 74132 | 50p  |
| 7427 | 24p  | 74141 | 56p  |
| 7430 | 12p  | 74148 | 90p  |
| 7442 | 43p  | 74150 | 70p  |
| 7447 | 55p  | 74151 | 50p  |
| 7448 | 58p  | 74156 | 52p  |
| 7454 | 14p  | 74157 | 52p  |
| 7473 | 25p  | 74164 | 70p  |
| 7474 | 25p  | 74165 | 70p  |
| 7475 | 32p  | 74170 | 125p |
| 7476 | 28p  | 74174 | 68p  |
| 7485 | 70p  | 74177 | 58p  |
| 7489 | 145p | 74190 | 72p  |
| 7490 | 32p  | 74191 | 72p  |
| 7492 | 35p  | 74192 | 64p  |
|      |      | 74193 | 64p  |
|      |      | 74196 | 55p  |
|      |      | 74197 | 55p  |

### CMOS FULL DETAILS IN CATALOGUE

|      |     |      |      |
|------|-----|------|------|
| 4001 | 15p | 4029 | 60p  |
| 4002 | 15p | 4040 | 68p  |
| 4007 | 15p | 4046 | 100p |
| 4011 | 15p | 4049 | 28p  |
| 4013 | 35p | 4050 | 28p  |
| 4015 | 60p | 4066 | 40p  |
| 4016 | 35p | 4068 | 20p  |
| 4017 | 55p | 4069 | 16p  |
| 4018 | 65p | 4071 | 16p  |
| 4023 | 15p | 4075 | 16p  |
| 4024 | 45p | 4930 | 48p  |
| 4026 | 95p | 4511 | 70p  |
| 4027 | 35p | 4518 | 70p  |
| 4028 | 52p | 4520 | 65p  |

### SKTS



| Low profile by Texas |       |        |     |
|----------------------|-------|--------|-----|
| 8 pin                | 10p   | 24 pin | 24p |
| 14 pin               | 12p   | 28 pin | 28p |
| 16 pin               | 13p   | 40 pin | 40p |
| Soldercon pins:      | 100:  | 50p    |     |
|                      | 1000: | 370p   |     |

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£14.95 Per stereo pair + £3.40 p&p.

★ As above but complete with all woodwork in kit form, finished in simulated teak veneer, with instructions. Size approx 20" x 11" x 9 1/2" **£28.00** Per stereo pair + £5.00 p&p

## EASY BUILD RECORD PLAYER KIT



for the D-I-Y man who requires a stereo unit at a budget price, comprising ready assembled stereo amp module, Garrard auto/manual deck with cueing device, pre-cut and finished cabinet work. Output 4 watts per channel, phones socket and record/replay socket including 2 SPHERICAL HI-FI speakers. **£19.95** p&p £4.05

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BSR Record auto deck on plinth with stereo cartridge ready wired.

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LED 5 function men's digital watch stainless steel finish

**£5.95**

LCD 5 function men's digital watch stainless steel finish

**£6.95**

LCD 8 Function CHRONOGRAPH men's digital watch, stainless steel finish.

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POCKET CALCULATOR. With LED display, memory and percentage key.

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### AM/FM DIGITAL CLOCK RADIO

Accurate 4 Digit Electronic Clock with 1/2" LED display. Buzzer and snooze timer.

**£11.95**

125 Watt Power Amp Module

**£13.95**

Mains power supply for above unit.

**£3.50**

MUSIC CENTRE CABINET with hinged smoke acrylic top, finished in natural teak veneers. Size 30 1/2" x 14 1/2" x 7 1/4" approx.

**£5.95**

MULLARD Built power supply

**£1.50**

DECCA DC 1000 Stereo Cassette P.C.B. complete with switch oscillator coils and tape-heads.

**£2.95**

DECCA 20w Stereo speaker kit comprising 2 8" approx. bass units + 2 3 1/2" approx. tweeter inc. crossovers

**£20.00**

VIDEOMASTER Super Score TV Game with pistol mains operation

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PORTABLE RADIO/CASSETTE RECORDER, AM/FM with clock.

**£41.95**

LW, MW, SW, VHF mains/battery operation.

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7" TAPE TRANSPORT Mechanism—a selection of models from

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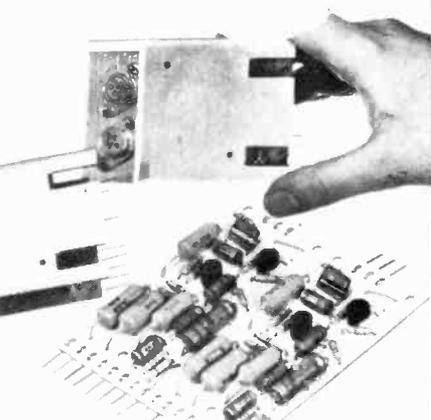
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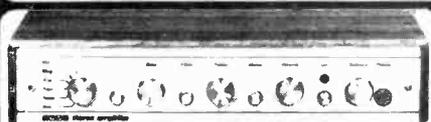


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**No 3**

**January  
79**

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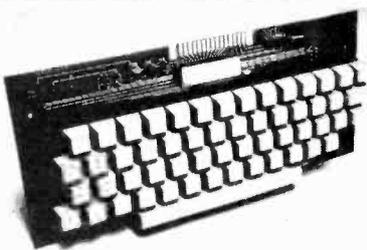
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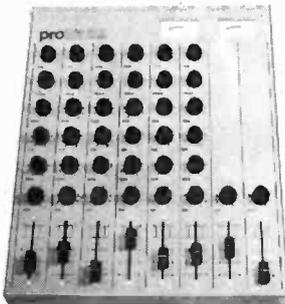
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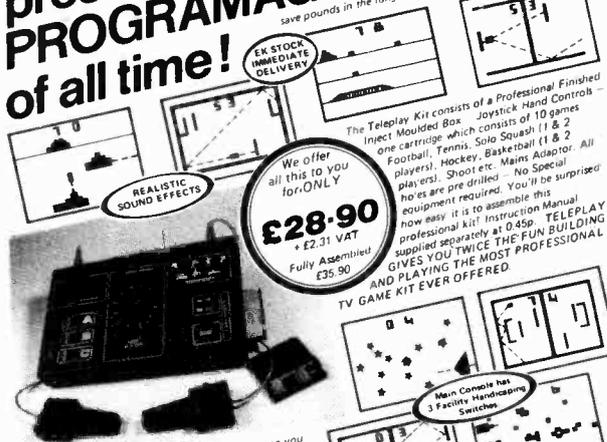
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# computing today

## No.3 January 1979

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Editor: Gary Evans

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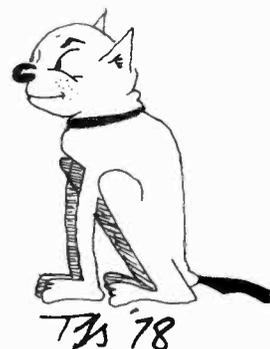
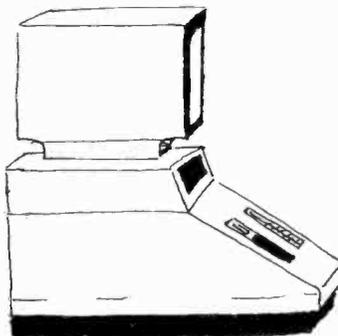
A number of errors that crept into last month's issue have been brought to our attention. Once again Phil Cornes was not credited in connection with the BASIC explained Series. Q1 in the EPROM Programmer should be shown as a 2N3638 and not PN3638 as in both Parts list and Circuit Diagram. The opto isolator is not a critical component and could be substituted by a more readily available device.

The missile program appearing in Softspot also contained a number of errors. Lines 90, 110 and 170 should be altered as follows

90 Y = (RND(16)-1)\* 64;Z = 1

110 VDU Z,32

170 VDU @(I+2),32



Man's best friends

# Letters

We would like to hear your views on computers and computing, we'll publish the best views in this, our new letters' page. This month, Mike Hughes — designer of the TRITON — answers a letter drawing attention to certain aspects of the computer design.

Dear Sir,

I am writing to request you to urgently consider the redesign of the Triton Computer, as it suffers from a serious design fault which will make it unreliable as it stands, and which will cause difficulties for expansion. As you may be now be aware I am referring to the data bus buffering. While the 8080a chip set has been buffered by a high drive (and unnecessary) 74LS245, the memory chips must also drive the data bus, and these have a single TTL drive capability. Bits 7 and 8 of the data bus are the most heavily loaded, with 5 LSTTL loads (= 1 TTL load), plus the UART, which presents 1 TTL load (at least this is what Texas say for the TMS 6011). Hence the memory chips are having to drive twice their rated load. Specifications being what they are this will usually be OK, especially when running so slowly. However usually is just not good enough in this situation, and several constructors are bound to get chips which are close to specification, and will be intermittent errors. The problem will become significantly worse when the bus expansion connector is used, as this will add an extra load, together with a lot of added cross-talk and bus noise.

As many of the people who may be considering the construction of this unit will not have the knowledge or equipment to detect this problem, I must, on their behalf, urge you modify this design as soon as possible.

A second, though less important, potential problem is in the -5V power supply, which is not a minor bias supply for 2708s (at least not according to Texas and Intel specifications). The specification is 30mA typical, 45mA max. Hence the power supply should be able to supply 180mA, which implies a series resistor of about 39-. This will dissipate a lot of power, and an IC regulator would be better.

Yours faithfully,

R. A. Cottis,

Corrosion and Protection Centre  
UMIST

I cannot disagree with anything in Mr Cottis' letter. I am, in particular, grateful to him for identifying the -5V rail problem which was an oversight on my part.

Unfortunately, the values given for R1 and ZD1 were a "hangover" from an early prototype which operated with a single EROM. These should have been changed to accommodate the higher current consumption of the completed system. Mr Cottis is quite correct in saying that R1 should be 39 ohm with a power rating of 1.5W. At the same time, ZD1 should be upgraded to have a power dissipation of 1W. The latter is necessary in the event of the system being operated with only one EROM in position.

Fortunately (or unfortunately as the case may be) this error will not show itself in cases which operate with 3 EROMS whose current consumption averages just below the "typical" value. Not many people will,

therefore, have experienced any problem. If they had the error would have been discovered earlier. Readers who have their system up and running with 3 EROMs in position need not react to the problem urgently — nevertheless, they should upgrade these components in due course prior to inserting a 4th EROM. Constructors just about to start are strongly advised to use the higher rated components from the word go.

The driving capabilities of the 2111 memories on the data bus is a much more difficult question to answer. Mr Cottis is quite correct in every thing he says by taking worst case input loads and output drive capabilities. The worst case conditions he mentions are, however, stated with a 0.4 or 0.45V maximum "O" level — allowing a 400mV low level noise margin.

Stretching the loading in the worst case condition will certainly encroach on the noise margin but as  $V_{OL}$  rises, as a result, so the input current will decrease. From figures available it would appear that in the worst case condition (including an extra LS load for an external bus driver), the noise margin could reduce to about 200 mV, and this would not be acceptable for stringent applications or in extremely high noise conditions.

As Mr Cottis implies, it is very unlikely that one will be so unlucky as to have all the worst case conditions stacked against him and this is what I was relying on to provide a reasonable noise margin for domestic/office noise environments. The "Bête Noire" is clearly the UART but I was reluctant to provide extra on board buffering for this for two reasons:-

1. It would have given rise to difficulties in layout — involving more board area.
2. This would have increased the board cost as well as possibly requiring extra components.

If one accepts that an extreme worst case conditions is unlikely there will be negligible problem at normal ambient temperatures. Even under a worse case situation at temperatures up to 60°C the system will still operate — but with impaired noise margin. It is in the latter situation that one might have problems with busbar noise etc.

I am indebted to Mr Cottis for drawing attention to this potential problem and in view of his comments, would suggest that readers planning expansions should keep their first umbilical cable from the main board to the peripheral mother board (soon to be published) as short as possible. They should also introduce a further bi-directional buffer on the data bus at the earliest position possible. This, incidentally, is already planned on the extension mother board.

To assure readers of the minimal chance of problems arising, we should point out that of the dozens of Tritons already built and working, there has not been one instance of bus noise problems. This includes one system which, already, has been externally expanded for a further 4k of RAM with no extra buffering.

M. J. Hughes

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# TRS-80: A Small Business Application

TERRY JOHNSON owns, with a partner, an insurance brokerage firm with twelve branches spread across the country. The firm also has interests in various property. Having used a computer bureau to process various accounting information, the firm are at present installing a TRS-80 to provide all the bureau facilities plus additional services.

**How did you start in business?** About 20 years ago, after coming out of the RAF, where I was a night fighter pilot, I needed a job. I had no business background but managed to get a job with an insurance company. There I found out there were such things as insurance brokers and after a bit of a late night study, I set myself up as a broker. Things, like topsy, grew from there, at our peak in 1974 we had 18 branches, but have now cut back to 12 — We employ 10 managers and about 40 other staff.

**Your first involvement with computers was via a computer bureau?** That's right, about five years ago we decided that the volume of accounting work generated by the various branches was getting to a level where some form of automation was necessary. We approached a number of the recognised agencies to see if they could offer us the type of package we wanted, without exception the products they offered would have meant considerable changes to our systems — not at all what we wanted.

At this point we decided on a different approach, we found — through the yellow pages I think — a specialist computer firm which undertook to design programs to customers' requirements. The firm had a scientific background and had never tackled anything along the lines we were asking. They accepted the challenge and a short time later we had a FORTRAN program that did all we wanted — simply keeping track of money in and money out and of our commodity — insurance policies in our case — but it might just as easily have been nuts and bolts or oranges.

**Did you encounter any problems with the system?** No, everything went very smoothly, we prepared our own program cards on a second hand flexowriter we picked up for £1000 and 48 hours later we had our batch back. During that first year about the only thing that happened was that the system was improved to provide a profit/loss statement and balance sheet.

**When did the Tandy TRS-80 come onto the scene?** About the middle of the year but the first time I realised that an "in house" system might be within our reach was at the DIY computer show at the beginning of this year.

**Why even consider a new system when your existing one was working so well?** To save money. We calculated that a system costing around £2500/£3000 could save us money over a period of 5 years with, of course, all the benefits of in house computing.

**Back to the Tandy then?** — Yes, in April of this year I went to the States on holiday and after looking around at what was available off the shelf over there at that time I decided to buy a Tandy TRS-80. The machine I bought was a Level 1 16K machine.

**Any problems getting it through customs?** Not after it had been classified as a data recording machine by binary system — no I paid my 7% duty on hardware and 8% VAT and I was through. I'd saved myself a lot of money. The cost in pounds was about £520, compared to the £700 odd that Tandy UK wanted assuming there was such a machine in this country.

**What about servicing if the machine goes wrong?** Tandy have a 90 day warranty on their equipment, which is available to first and subsequent owners in any country where Tandy have outlets — I wasn't worried about servicing.

**Have you had any trouble with your machine?** Yes, soon after I began using it, the keyboard suffered from an excessive amount of contact bounce. I took it to my local Tandy dealer, and it was back within a week — repaired at no charge under the warranty.

**How did you get on with the machine in those early days?** I had no experience of programming but found the Tandy manual soon had me familiar with BASIC and frustrated at the limitations of the level 1 machine.

I sent my TRS-80 to Tandy together with £79 for it to be upgraded to a Level 2 unit.

**What was your next step?** Well now came the most frustrating time for me, Level 2 BASIC was just what I wanted, but without a printer, floppy and more

memory the system just could not cope with the work I wanted it to do. Tandy had plans for expansion but no hardware available. I started looking around at other machines. The PET would never be acceptable to any typist with its present keyboard but the APPLE looked promising. I bought an apple this July but returned it about a week later, the reasons were that my machine kept crashing and as the BASIC I was using, Applesoft II was on tape, a five minute restart each time became trying. Add to this the fact that I was promised a number of hardware items that just didn't turn up and the Apple was not working out.

**Back to Tandy?** Yes. August was a dull month but I'd been promised the first expansion interface to arrive in this country and that arrived in September. The expansion interface contains space for an additional 16K or 32K RAM, a dick-controller for up to four disks, dual cassette decks as well as a Centronics parallel port.

After a bit of persuasion Sintrom at Reading — having sold me their ex-demonstration printer — hooked the printer up to the TRS-80, as the lead supplied did not produce any results this was a great leap forward — hard copy.

Things were moving fast now, as soon after this I discovered that a Micropolis disc drive would plug directly into the Tandy interface. I now had a system that could do all that I demanded of it.

**Does this bring us up to date?** No, a couple of weeks ago I went to the States again and picked up a couple of Tandy disks, a screen printer, a back up CPU and some extra memory. About \$3000 worth, again a

considerable saving on buying over here.

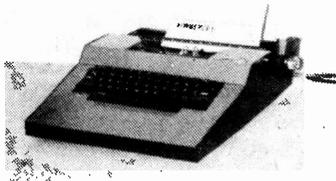
**What about the software development?** Of course that's been going on all the time, I've had no real difficulties with the task. The bulk of the work is done now, it's just a matter of getting the time to sort out the rest of the system for our target start date of January 1st.

**Why should a small business man consider using one of these small computer systems?** Three main reasons I think. Staff time and skill levels can be cut if a sensible system is devised. Accounting information that is good enough for our auditors to accept can be produced. Thirdly a vast flow of statistical information can be generated that gives the business man a far better idea of the performance of his operation at any point in time. What most people do by feel now can be done far more accurately by the computer. These three things together all add up to cutting costs.

**Do you think small business men could cope with setting up a system such as yours without outside help?** Most small businessmen are of above average intelligence — they have to be to survive. They also, in general have the drive and energy to get things done. I hadn't any knowledge of computers at the start of this year and reckon that now I have put together a system that will save me time and money. If I can do it I'm sure many other people in my position could. With the various software packages coming on the market at low cost, the business man may only be involved in a very small amount of work to get a low cost system to do exactly what he wants of it.

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# TRITON Software

## —MONITOR

Mike Hughes takes a detailed look at the Tritons monitor and describes some machine code programs that can be run on the computer

If you have built the TRITON computer you will want to get the best out of it and there are several modes in which it can be used. You can write and run programs in BASIC but you may wish to record and recall these to and from tape. To do this you need to know something about the MONITOR. You may wish to use the computer for control purposes for which you need to write machine language instructions. To do this it is essential to go through the Monitor — possibly making use of some of its in-built sub routines.

For those learning about computers it is a very good idea to get a grasp of MACHINE CODE. It is not difficult to learn and can make life much more exciting as you will be able to get the computer to respond much more quickly than it will through a BASIC Interpreter. Sometimes you can get several thousand times the speed for certain operations. To do this on the TRITON you must operate through the MONITOR.

TRITON's standard MONITOR is a program written in machine code which is held in ROM starting at address location 0000H. Its purpose is primarily to initialise the machine and to give it an elementary intelligence so that you can communicate with it. For this reason the machine must start off at the beginning of the monitor program every time it is switched on otherwise it becomes a worthless heap of rather expensive electronic components — unable to do anything. The first machine code instruction that the computer sees in the Monitor sets the STACK without which it would be impossible to do much in the way of decision making via nested sub-routines. It then proceeds to look at the next instruction which, in the case of TRITON, enables the interrupt operation if ever it is needed to be used. The following instruction is a JUMP which leads on to the first of the main routines called SCANMEM. This routine points to address 1600H and writes FFH into it. It then reads back the value from that address and checks that the FFH was actually stored. Furthermore it writes OOH into the same location and checks that too. This is a check that the memory is there and working which, at the same time leaves the memory location clear (i.e. containing OOH). The monitor routine then steps up one memory byte — to 1601H and does the same. This process is carried out on every successive location from 1600H upwards until the computer finds an error. The address of the location where the error occurred is most likely to be the top of the RAM work area but could be the address of a faulty IC. In either event this top address is written into a pair of RAM bytes used by BASIC 14.1 to tell BASIC how much work space is available. The two bytes of memory used for this are 1481H and 1482H. As a general rule

whenever two byte instructions or data are written into memory the 8080 microprocessor expects to see the least significant byte in the lower value of the two addresses. Thus if 2000H was the location where memory ended — as found by SCANMEM, location 1481H would contain OOH while 1482H would contain 20H.

After checking the memory the monitor initialises the computer which acknowledges this on the screen with its standard message:

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

The Monitor then goes into a keyboard loop and the computer effectively waits for you to tell it what to do. This will depend on which key you depress. The letters it expects you to type are those shown in its acknowledgement and are abbreviations for seven different primary operations you can do with the monitor. These are:

- P = Inspect any memory location and, if necessary change, or insert a byte of data. When the data is entered the computer automatically steps to the next address showing what is currently there and waits to see if you wish to change it.
- G = Start running a program from any specified starting address location. The computer asks you, within this routine, what start location you want.
- I = Input from tape recorder. The computer asks you for the header code of the file and then searches for it. When it has been found the data is written into the computer's memory starting at location 1600H. When the flag marking the end of the record has been found the computer re-initialises with an abbreviated form of its initial "switch on" message.
- O = Output a program to the tape recorder. This, again asks you to give your recording a header code. The routine automatically outputs programs written in BASIC and stops when it gets to the end of file address (the address written into bytes 1600H and 1601H by BASIC). For user written machine code programs you have to manually enter the address immediately following your last instruction into these two bytes. Tapes are ALWAYS loaded and dumped with 1600H being the start location! When dumping has finished the computer re-initialises.
- L = List the machine code content of all locations starting from any specified address. The

computer asks for the first address then prints out the contents of this and the next 14. It then asks MORE? and expects you to type Y otherwise it re-initialises.

W = Typewriter mode. The computer behaves just as if it was a keyboard and VDU. Anything you type is displayed on the screen including graphics. Cursor control and special VDU functions — e.g. Clear Screen, Reset Cursor etc all operate but the computer responds to nothing except CONTROL C which makes it re-initialise.

T = Jump to BASIC L4.1. This command causes the computer to jump out of the control of the Monitor into the control of BASIC. CONTROL C will jump back out of BASIC into the initialisation condition of the Monitor.

Note that CONTROL C will, in nearly all cases, get you out of an operation and back to the initialisation condition. The only times when it fails to do this are when you are locked in a user written machine code program loop; are searching tape for a non-existent header or are outputting to the tape recorder. In these three cases you will have to use Interrupt 2 (which re-initialises without clearing memory) or RESET which goes through the SCANMEM routine and erases any data in memory.

When the computer asks for its initial instruction via one of the above letters you simply have to type the letter. No carriage return is needed. If you type the wrong letter the computer replies "INVALID" and waits for you to try again.

Here are some examples to try with the above functions:

#### LED PORT TEST ROUTINE

|      |      |          |    |   |
|------|------|----------|----|---|
| 1600 | CALL | INCH     | CD | Input data from keyboard to accumulator             |
| 1601 | —    | —        | 0B |   |
| 1602 | —    | —        | 00 |   |
| 1603 | CMA  | —        | 2F | Complement contents of accumulator.                 |
| 1604 | OUT  | PORT 03H | D3 | Output contents of accumulator to PORT 3 (LED port) |
| 1605 | —    | —        | 03 |   |
| 1606 | JMP  | 1600H    | C3 | Jump back to 1600H for next input from keyboard.    |
| 1607 | —    | —        | 00 |   |
| 1608 | —    | —        | 16 |   |

This program enables you to test out both the LED port and the keyboard by outputting the binary code from the keyboard to the LEDs. The program complements the accumulator to compensate for the fact that on TRITON the LEDs go on for level "0." In this program they will go on if a bit from the keyboard is "1." Because we are going through the monitor's INCH routine you will find that a shift inversion takes place. You get upper case alpha codes when unshifted and lower case alpha codes when shifted. This is designed in to make the keyboard more convenient to use. Numerical keys are not affected by the shift inversion. Again, because we are using INCH you can escape from this program loop with CONTROL C. You will notice that the most significant LED (bit 8) is permanently off; this is because bit 8 is used for the input strobe and this bit is masked off by the monitor as data is entered. Notice also that the data is latched on to the LEDs after the key has been released.

#### INTERRUPT DEMONSTRATION PROGRAM

|      |      |        |       |    |                                |
|------|------|--------|-------|----|--------------------------------|
| 1618 | LXI  | D      | 161FH | 11 | Load start of string saying    |
| 1619 | —    | —      | —     | 1F | IAM INTERRUPT 3                |
| 161A | —    | —      | —     | 16 |                                |
| 161B | CALL | PSTRNG | CD    |    | Print carriage return followed |
| 161C | —    | —      | 2B    |    | by string.                     |
| 161D | —    | —      | 00    |    |                                |
| 161E | RET  | —      | —     | C9 | Return to main program.        |
| 161F | DATA | I      | —     | 49 | String data starts here and    |
| 1620 | —    | SPACE  | —     | 20 | terminates with end of text    |
| 1621 | —    | A      | —     | 41 | marker 04.                     |
| 1622 | —    | M      | —     | 4D |                                |
| 1623 | —    | SPACE  | —     | 20 |                                |
| 1624 | —    | I      | —     | 49 |                                |
| 1625 | —    | N      | —     | 4E |                                |
| 1626 | —    | T      | —     | 54 |                                |
| 1627 | —    | E      | —     | 45 |                                |
| 1628 | —    | R      | —     | 52 |                                |
| 1629 | —    | R      | —     | 52 |                                |
| 162A | —    | U      | —     | 55 |                                |
| 162B | —    | P      | —     | 50 |                                |
| 162C | —    | T      | —     | 54 |                                |
| 162D | —    | SPACE  | —     | 20 |                                |
| 162E | —    | 3      | —     | 33 |                                |
| 162F | —    | EOT    | —     | 04 |                                |

An example of a user written interrupt routine using INT3 push button. Note that it starts at the re-vectored start address 1618:

Load this program then reinitialise and press INT3 button. Next press W and do a bit of screen typing and press INT3 from time to time. The interrupt should announce its presence. We hope that this simple example will show you that, contrary to popular belief, interrupts are quite easy to write programs for.

#### VIDEO TYPEWRITER PROGRAM

|      |      |        |       |    |   |
|------|------|--------|-------|----|---|
| 1600 | LXI  | D      | 1612H | 11 | Load start address of message string          |
| 1601 | —    | —      | —     | 12 | in DE register pair. This is                  |
| 1602 | —    | —      | —     | 16 | required by PSTRNG sub-routine.               |
| 1603 | CALL | PSTRNG | CD    |    | Call sub-routine which                        |
| 1604 | —    | —      | 2B    |    | prints string starting at address held in DE  |
| 1605 | —    | —      | 00    |    | register pair.                                |
| 1606 | CALL | PCRLF  | CD    |    | Call sub-routine which                        |
| 1607 | —    | —      | 33    |    | prints out carriage return and line feed.     |
| 1608 | —    | —      | 00    |    |   |
| 1609 | CALL | INCH   | CD    |    | Call sub-routine which                        |
| 160A | —    | —      | 0B    |    | inputs data from keyboard and                 |
| 160B | —    | —      | 00    |    | holds this in accumulator.                    |
| 160C | CALL | OUTCH  | CD    |    | Call sub-routine which prints                 |
| 160D | —    | —      | 13    |    | out ASCII character from data in accumulator. |
| 160E | —    | —      | 00    |    |   |
| 160F | JMP  | 1609H  | C3    |    | Jump back to address 1609H                    |
| 1610 | —    | —      | 09    |    | and wait for next character from              |
| 1611 | —    | —      | 16    |    | keyboard                                      |
| 1612 | DATA | 0      | 4F    |    | Start address of message string               |
| 1613 | —    | /      | 2F    |    |   |
| 1614 | —    | K      | 4B    |    |   |
| 1615 | —    | SPACE  | 20    |    |   |
| 1616 | —    | T      | 54    |    |   |
| 1617 | —    | Y      | 59    |    |   |
| 1618 | —    | P      | 50    |    |   |
| 1619 | —    | E      | 45    |    |   |
| 161A | —    | !      | 21    |    |   |
| 161B | —    | EOT    | 04    |    | End of text terminator code.                  |

When you run this program it acknowledges with the message O/K TYPE! and you can then use the TRITON as if it were in the W function operating mode (i.e. it becomes nothing more than a video typewriter). You can escape from the program by depressing CONTROL C (this applies to any program which repeatedly goes through the INCH routine).

#### ALPHABET TWELVE TIMES OVER USING I/O

|      |       |        |    |   |
|------|-------|--------|----|---|
| 1600 | RST1  |        | CF | Clear screen via special re-start instruction                                   |
| 1601 | MVI B | 0CH    | 06 | Set decimal value 12 (oCH) in B to specify                                      |
| 1602 | —     |        | 0C | number of alphabets required.   |
| 1603 | MVI A | 41H    | 3E | Set ASCII code for "A" in accumulator.  |
| 1604 | —     |        | 41 |   |
| 1605 | CALL  | OUTCH  | CD | Print contents of accumulator.  |
| 1606 | —     |        | 13 |   |
| 1607 | —     |        | 00 |   |
| 1608 | INR A |        | 3C | Increment ASCII code in accumulator by one.                                     |
| 1609 | CPI   | 5BH    | FE | Compare it with ASCII code which is   |
| 160A | —     |        | 5B | one greater than Z.   |
| 160B | JNZ   | 1605H  | C2 | If not greater than Z jump back to 1605H  |
| 160C | —     |        | 05 | and repeat until complete   |
| 160D | —     |        | 16 | alphabet is   |
| 160E | CALL  | PCRLF  | CD | printed. If alphabet is completed output carriage return and line feed.         |
| 160F | —     |        | 33 |   |
| 1610 | —     |        | 00 |   |
| 1611 | DCR B |        | 05 | Decrement value in B register by one.   |
| 1612 | JNZ   | 1603H  | C2 | If it is not zero we do not have 12 alphabets so jump back to 1603H and repeat. |
| 1613 | —     |        | 03 |   |
| 1614 | —     |        | 16 |   |
| 1615 | JMP   | REINIT | C3 | If it is zero re-initialise.  |
| 1616 | —     |        | B9 |   |
| 1617 | —     |        | 02 |   |

This program should be compared with the one following as they both do the same thing — print the alphabet twelve times and then re-initialise. This, first, program uses conventional I/O techniques whereas the second makes use of the powerful memory mapped option to the TRITON's VDU. We hope you will recognise the tremendous difference in speed of operation between the two methods. Note that in both programs we make use of the RST1 instruction at the beginning. This is one of 8 special re-start instructions which are fixed destination CALL instructions. Using RST1 will call the sub routine at location 0008H which, in the case of TRITON's MONITOR is then re- vectored with a jump to 0134H. The routine in question is the one which clears the VDU screen and resets the cursor. The advantage of using an RST instruction is that you do not have to specify the address of the sub routine hence saving two bytes in your program. You should only use RST instructions if the sub routine being called terminates in a RETURN command.

When you run the program try and judge the time it takes to display the 12 alphabets and then go on to the next example.

#### ALPHABET TWELVE TIMES OVER USING MEMORY MAPPING

|      |       |     |    |  |
|------|-------|-----|----|--|
| 1600 | RST1  |     | CF | Clear screen with special re-start instruction                     |
| 1601 | LXI H |     | 21 | Load HL register pair with address one less than start of VDU RAM. |
| 1602 | —     |     | FF |  |
| 1603 | —     |     | 0F |  |
| 1604 | MVI B | 0CH | 06 | Set number of alphabets required in register B.                    |

|                  |         |        |    |  |
|------------------|---------|--------|----|--|
| 1605             | —       |        | 0C |  |
| 1606             | MVI A   | 41H    | 3E | Set ASCII code for "A" in accumulator.   |
| 1607             | —       |        | 41 |  |
| 1608             | INX H   |        | 23 | Increment HL register pair by one.   |
| 1609             | MOV M,A |        | 77 | Copy contents of accumulator to memory.  |
| 160A             | INR A   |        | 3C | Increment contents of accumulator.   |
| 160B             | CPI     | 5BH    | FE | Compare contents of accumulator with code  |
| 160C             | —       |        | 5B | one greater than Z.  |
| 160D             | JNZ     | 1608H  | C2 | If it isn't greater than Z jump back to 1608H and repeat.                                      |
| 160E             | —       |        | 08 |  |
| 160F             | —       |        | 16 |  |
| 1610             | MOV A,L |        | 7D | If it is: copy contents of L to accumulator  |
| 1611             | ADI     | 26H    | C6 | Add 26H to this value.   |
| 1612             | —       |        | 26 |  |
| 1613             | CC      | 1629H  | DC | If addition causes a carry; call sub routine which increments H register by one                |
| 1614             | —       |        | 29 |  |
| 1615             | —       |        | 16 |  |
| 1616             | MOV L,A |        | 6F | Replace new low byte address in register L.  |
| 1617             | DCR B   |        | 05 | Decrement register B by one.   |
| 1618             | JNZ     | 1606H  | C2 | If it's not zero we do not have 12 alphabets so jump back to 1606H and repeat.                 |
| 1619             | —       |        | 06 |  |
| 161A             | —       |        | 16 |  |
| 161B             | MVI B   | 0CH    | 06 | Set decimal value 12 into B register.  |
| 161C             | —       |        | 0C |  |
| 161D             | MVI A   | 0AH    | 3E | Set accumulator to ASCII code for line   |
| 161E             | —       |        | 0A | feed.  |
| 161F             | CALL    | OUTCH  | CD | Output line feed to VDU to step cursor down. (to get it clear of last alphabet).               |
| 1620             | —       |        | 13 |  |
| 1621             | —       |        | 00 |  |
| 1622             | DCR B   |        | 05 | Decrement register B by one.   |
| 1623             | JNZ     | 161FH  | C2 | If it's not zero we have not stepped cursor to below the last line of alphabet so jump back to |
| 1624             | —       |        | 1F |  |
| 1625             | —       |        | 16 |  |
| 161FH and repeat |         |        |    |  |
| 1626             | JMP     | REINIT | C3 | If it is; re-initialise.   |
| 1627             | —       |        | B9 |  |
| 1628             | —       |        | 02 |  |
| 1629             | INR H   |        | 24 | Sub-routine to increment register H in event of a carry.                                       |
| 162A             | RET     |        | C9 |  |

Although this program is longer than the one just described you will see an element of similarity in the way the alphabet is formed (by incrementing the accumulator) and we keep track of the number of alphabets in the B register. Instead of using the I/O OUTCH routine we use the HL register pair to point to memory locations which are within the block of the VDU's RAM. This starts at 1000H and finishes at 13FFH. We then use the MOV M, A instruction which copies whatever is in the accumulator to the memory location being addressed by the HL register pair. By using the INX H instruction we can increment the latter to display the next character etc. Notice that carriage returns and line feeds are not needed in the main body of the program because we are using addressing to tell the computer exactly where to place each character. When one alphabet is finished we have to compute the address of the start of the next by adding the hex number 26 to the address currently in the HL register pair (this is done at instruction 1611H). Notice that after this operation we have to make allowances for a carry by calling an INR H sub routine.

When memory mapping the VDU you must remember that the clear screen/reset cursor operations does more than is immediately apparent to the eye. The addresses of different

positions on the VDU screen must correspond to specific places on the screen (1000H is the top left hand corner and 13FFH is the bottom right corner). If, as a result of previous activity, the VDU screen has been scrolling these absolute address values do not correspond to positions in an absolute manner you must carry out a cursor reset operation. This can be on its own or combined with the screen clear operation. A similar operation must be carried out if you use the VDU function when under the control of BASIC L4.1. Note that it takes the VDU 132mS to carry out a home cursor operation so if every you output the raw instruction in your own software you must introduce a time delay greater than this before outputting anything else to the VDU. The Clear Screen/Reset Cursor utility in the monitor has a delay of about 200mS built into it so you can call it without introducing any further delay.

Note that when this program runs the cursor stays stationary in its reset position (top left corner of screen). If we allowed it to stay there the re-initialisation message would overprint our alphabets so we have included some extra instructions (starting

at 161BH) which step the cursor down twelve positions immediately prior to re-initialisation.

To further demonstrate the flexibility of memory mapping you can alter the layout on the screen by altering the value added to the address to get the next line. Alter the data at location 1612H to 29 and re-run the program. The lines should have start points staggered by 3 character positions. Similarly you can alter the start location for the display as a whole by altering the data in locations 1602H and 1603H. Try making these 20 and 10 respectively and alter the data at 1612H to 25. When you run the program the rows should slant the other way.

When memory mapping the VDU you must always be careful to ensure that your memory pointer (HL register pair) cannot exceed the highest address of VDU (13FFH) otherwise you will start over-writing the input buffer and stack area of the monitor. If this happens all sorts of strange things will begin to take place and you will probably find you completely lose control through the keyboard. If this should happen you must resort to the RESET button and end up with a cleared memory!

## MEMORY MAP AND MONITOR UTILITIES

To help those who wish to get involved in machine code programming at an early stage here are the addresses of memory blocks and ports. It is assumed that you will be operating under the control of the standard Monitor program so we also list the addresses of its main Utilities.

### MEMORY START ADDRESSES

|                       |   |
|-----------------------|---|
| 0000H - 03FFH 1K EROM | (Holds standard MONITOR)  |
| 0400H - 07FFH 1K EROM | (Holds BASIC L4.1 "A")  |
| 0800H - 0BFFH 1K EROM | (Holds BASIC L4.1 "B")  |
| 0C00H - 0FFFH 1K EROM | (Spare location)  |
| 1000H - 13FFH 1K RAM  | (VDU memory — can only be written into by computer)   |
| 1400H - 14FFH ¼K RAM  | (Holds stack and tables for Monitor from 1400H to 147FH; 1480H upwards through this block will be used by BASIC L4.1 tables otherwise is free as M/C code work area)  |
| 1500H - 15FFH ¼K RAM  | (Completely reserved for BASIC L4.1 stack otherwise is free for the user)   |
| 1600H - 1FFFH 2½K RAM | (Work area for BASIC L4.1 or user programs. NOTE that locations 1600H and 1601H are made use of by tape I/O routines to store End of File address — hence user programs for saving/loading to and from tape should always start at 1602H) |

2000H - FFFFH 56K.

Available for "Off Board" extensions

### PORT DESIGNATIONS

|           |   |
|-----------|---|
| 00H       | Keyboard INPUT (NOTE special routine is necessary)  |
| 01H       | Tape I/O UART Status INPUT  |
| 02H       | Tape I/O UART Data Strobe (start transmission) OUTPUT   |
| 03H       | LEDs OUTPUT (NOTE LEDs are on for "O")  |
| 04H       | Tape I/O UART Receive Data Enable (receive data) INPUT  |
| 05H       | VDU OUTPUT (NOTE strobe — bit 8 — has to be specially formatted by software)                      |
| 06H       | Spare OUTPUT (NOTE only bits 7 and 8 are output)  |
| 07H       | Relay OUTPUT (NOTE bit 8 is used to drive tape control relay out bit 7 is output as a spare line) |
| 08H - FFH | Available for "Off Board" extensions  |

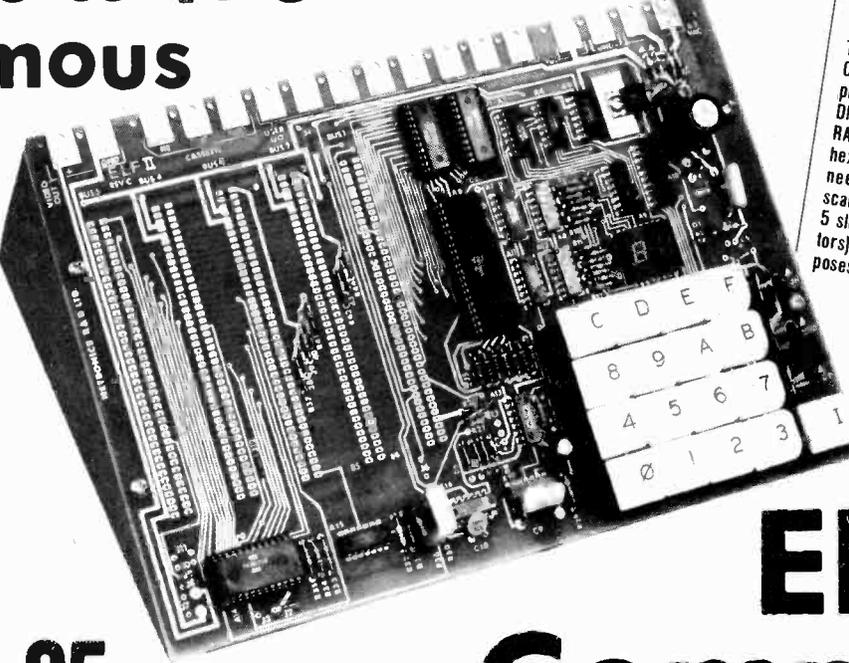
### MONITOR UTILITIES ETC

|            |   |
|------------|---|
| 0000H RST0 | Reset address. Enables Interrupt and checks and clears memory writing number of bytes available into locations 1481H (low order byte) and 1482 (high order byte). With full main board memory in place this should read 2000H. Then goes on to Initialise computer. |
|------------|---|

|       |        |  |  |
|-------|--------|--|--|
| 0008H | RST1   | Reacts to Interrupt 1 clearing VDU and resetting cursor.   | useful and can save a lot of redundant instructions elsewhere. NOTE you can only guarantee using these if you have MONITOR V4.1 on board!  |
| 000BH | INCH   | A CALL routine which inputs character from keyboard. Stays in keyboard loop until key is depressed.  |  |
| 0010H | RST2   | Reacts to Interrupt 2 clearing VDU and initialising computer without clearing memory. Used for normal reset operation.   | 0053H INIT Destination of Interrupt 2. Clears screen and initialises computer. Also resets stack so should only be used as destination of a JUMP instruction.  |
| 0013H | OUTCH  | A CALL routine which outputs character to VDU.   | 02B9H REINIT This should only be used as a JUMP destination. It resets the stack and re-initialises the computer WITHOUT clearing the screen. A useful instruction at the end of user programs to avoid having to use the HLT instruction. |
| 0018H | RST3   | Reacts to Interrupt 3 and re-vector to 1618H for user routine.   |  |
| 001BH | INDATA | A CALL routine which allows string of characters to be entered to any place in memory. Start location of string pointed to by DE register pair which must be pre-loaded before calling INDATA. Returns on Carriage Return.   | 0327H TPEON When called switches the tape control relay on (relay contacts could be used for other control purposes by the user). NOTE that routine returns with 80H in accumulator.   |
| 0020H | RST4   | Reacts to Interrupt 4 and re-vector to 1620H for user routine.   | 032CH TPEOFF When called switches the tape control relay off. Routine returns with 00H in accumulator.   |
| 0023H | PDATA  | A CALL routine which allows string of characters to be printed from any place in memory. DE register pair must be pre-loaded with start address before calling. Routine returns when it sees EOT terminator (04H) but DE steps to one address beyond terminator allowing immediate re-call for further string to be printed. | 03A1H ACKA Start address of string which prints INVALID. Use should be made of PSTRNG utility to insert Carriage Return and Line Feed.   |
| 0028H | RST5   | Reacts to Interrupt 5 and re-vector to 1628H for user routine.   | 03B5H ACKB Start address of string which prints START=. (Use via PSTRNG).  |
| 002BH | PSTRNG | A CALL routine identical to PDATA except that it outputs Carriage Return/Line Feed prior to printing string.   | 03C4H ACKC Start address of string which prints HEADER=. (Use via PSTRNG)  |
| 0030H | RST6   | Reacts to Interrupt 6 and re-vector to 1630H for user routine.   | 03CFH ACKD Start address of string which prints END. (Use via PSTRNG)  |
| 0033H | PCRLF  | A CALL routine which prints Carriage Return followed by Line Feed and then returns with the original contents of accumulator intact.   | 00AAH BASICIN Checks to see if a key has been depressed on keyboard. If it has it returns with the data otherwise returns immediately with the accumulator cleared and flags set accordingly. Useful for real time interactive programs.   |
| 0038H | RST7   | Reacts to Interrupt 7 and re-vector to 1638H for user routine.   | 010DH DLY When called introduces approximately 3mS time delay and returns with all registers (except flags) intact.  |
|       |        |  | 0116H FIVSEC When called introduces a delay of between 5 and 6 seconds. Returns with registers and flags intact.   |
|       |        |  | 0134H CLRSCN Clears screen and resets cursor. Approximately 200mS time delay is built into this routine. Returns with registers and flags intact.  |

The above are fixed location utilities whereas the following are within the main body of the MONITOR which are liable to be re-located if new generation monitors are written. They are, nonetheless, very

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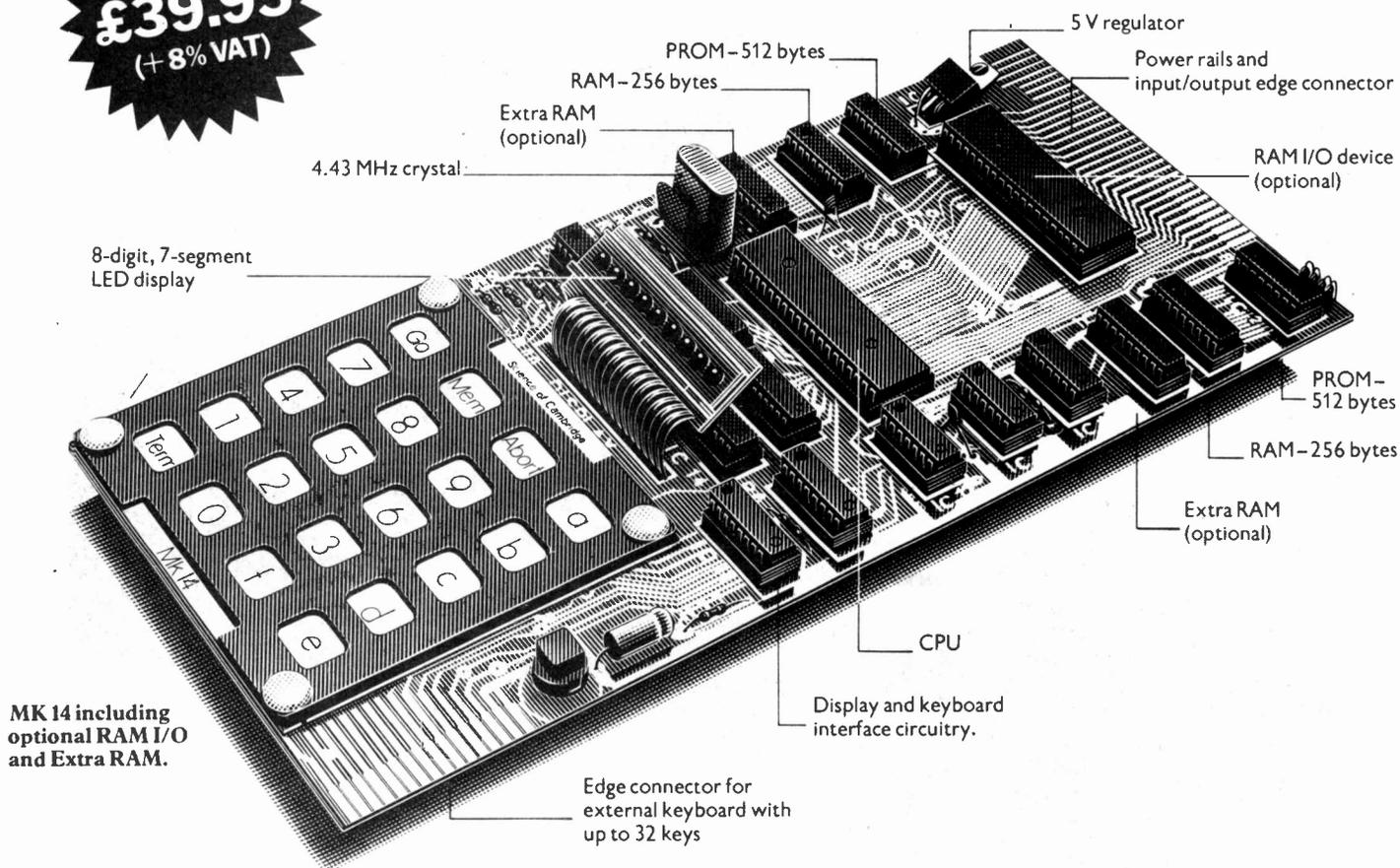
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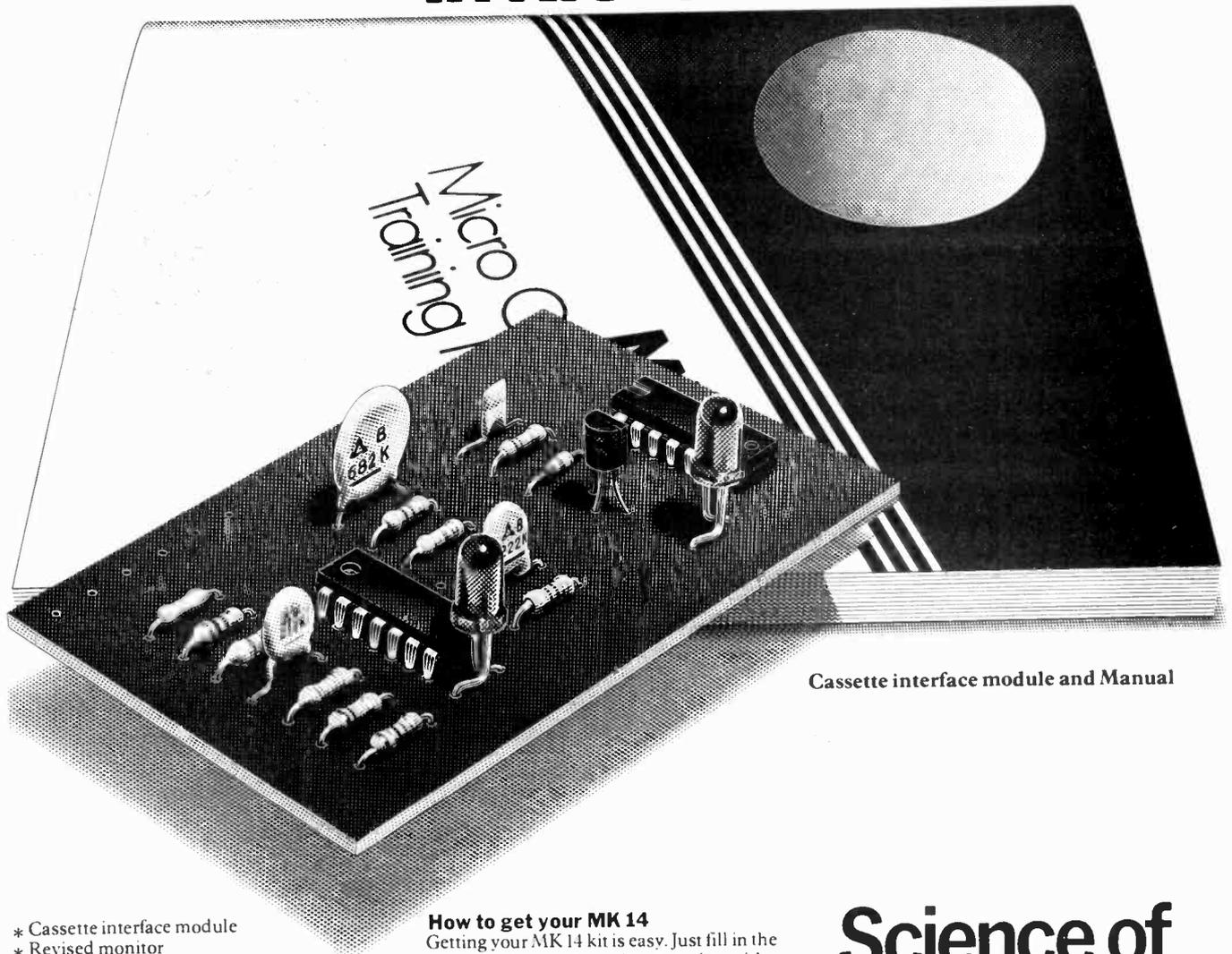
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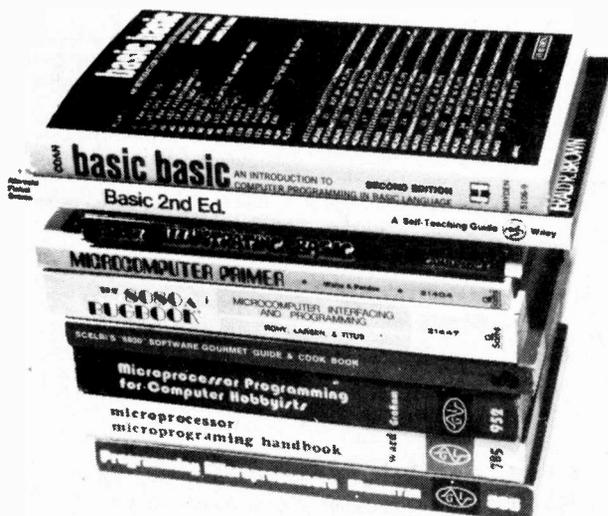
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# Softspot

Don Scales has written another game for the TRITON. We would like to expand Softspot over the next few months so please send us any software (machine code, BASIC etc.) which you feel would be of interest to others.

## REVERSAL (1K) DESCRIPTION

The REVERSAL GAME is a game of skill played with the computer. The computer will arrange the numbers 1 to 9 in a random sequence and your job is to arrange them into ascending order in the minimum number of moves.

For example

The machine might print the following sequence –  
8 3 7 9 1 4 2 6 5

You now have to get these arranged in ascending order. To do this, you are allowed to reverse the order of any number of digits starting at the left hand side. The machine will ask

### NUMBER TO REVERSE

If you enter 4 the result will be

9 7 3 8 1 4 2 6 5

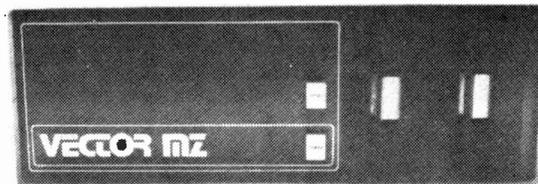
If you now enter 9 you will get

5 6 2 4 1 8 3 7 9

You now have 9 in the correct place and can set about getting 8 7 6 etc. in their correct positions.

```

10 PRINT 'THE REVERSAL GAME'
20 FOR I=1 TO 9
30 LET A=RND(9)
40 IF I=1 GOTO 80
50 FOR J=1 TO I-1
60 IF @(J)=A GOTO 30
70 NEXT J
80 LET @(I)=A
90 NEXT I
95 LET B=0
200 PRINT #2, @(1), @(2), @(3), @(4), @(5), @(6), @(7), @(8), @(9)
210 INPUT 'NUMBER TO REVERSE' J
220 IF J<1 GOTO 240
230 IF J<10 GOTO 260
240 PRINT 'INVALID - TRY AGAIN'
250 GOTO 210
260 LET K=(J+1)/2
270 FOR I=1 TO K
280 LET A=@(I), @(I)=@(J+1-I), @(J+1-I)=A
290 NEXT I
295 LET B=B+1
300 FOR I=1 TO 9
310 IF @(I) # I GOTO 200
320 NEXT I
330 PRINT 'TOTAL', #3,B
340 GOTO 10
    
```



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## In The Beginning

It all started back in 1974 when Intel introduced the 4004, the first true microprocessor. It developed almost by accident, as a result of Intel's efforts to produce a calculator of unprecedented flexibility. The shock waves of the hand-held calculator revolution were still being felt by every section of society and the back-room boys' eyes lit up with that "You ain't seen nothing yet" look as they drew up the chip-masks for their next product, the 8-bit 8008.

Assisted by the lessons learned from the cut-throat calculator business the microprocessor developed with frightening speed and predictability. Frightening not only because of the vast amount of high-technology and high finance poured into the field, but also because of the dramatic effect extrapolations of such technology can have on a broad spectrum of society. Predictable because everyone knew what was going to develop. The shrinking of calculators from giant cabinets to flip-top packs in the space of just a few years created an extraordinary blase attitude towards electronics. It was a spectacular demonstration of the omnipotence of the new technology of micro-electronics. It was proof that now nothing is impossible — just draw up the specifications, expend x thousand man-hours and y million dollars, and there you have it. So the microprocessor has been born at a time when nothing comes as a surprise any more. But maybe the real surprise is yet to come.

## The New "Hams"

Of all the sub-sets of electronics hobbyists the most clearly defined to date has been the radio amateur. Members of this particular sect follow a technological faith which started with the first wireless communication and has since flourished, gaining millions of followers in a relatively short time.

For many hams their hobby almost becomes a life-style within itself, always striving for that rare DX the eternal pursuit of that elusive one-to-one SWR. Is it possible that we are now witnessing the founding of a new faith, one whose god speaks in 1s and 0s rather than 5s and 9s?

By making a few comparisons between amateur radio and amateur computing certain patterns can be seen emerging which may be an indication of what course the future of personal computing might take.

## Power To The People

Like amateur radio, amateur computing is a high-technology which makes the latest developments in the science of electronics available to anyone at all who has the time and money to pursue them. The money factor is all important — the lower the cost of the hardware, the more people can afford to pursue the hobby. A reasonably useful microcomputer system might cost in the order of \$1,000. Hams might spend this sort of money on radio gear, for that matter a radio-controlled aircraft enthusiast, amateur photographer or stamp-collector could easily spend that much on his hobby. So thanks to the microprocessor the cost of your own personal computer is no longer a barrier to most people.

This new accessibility and the free interchange of ideas and information between hobbyists has the effect of distributing "computer power" over a broad spectrum of people. This leads to a breaking down of much of the mystique which has traditionally surrounded the world of computers; they are being de-mystified as the magic is systematically exposed as little more than sleight of hand. As large number of amateurs invade a hitherto sacred field which was once the sole province of a privileged few the elite will inevitably grow in number until it finally becomes plebian.

## "Homebrew" vs "Appliance"

As with amateur radio there are two factions within the computer cult, the "homebrewer" who builds his own equipment for the sake of the experience gained, and the "appliance operator" who buys a ready-built, going unit and gets what he wants from operating his instrument, writing programs and experimenting with the performance of the hardware as bought. His investment in the computer itself is more financial and less emotional than in the case of the homebrewer.

There is always some overlap between the two factions, but they can usually be classified by comparing the time spent building, testing and modifying the hardware to the time spent actually using it once it's working.

### The Sky's The Limit

Radio equipment has rather unique and interesting characteristics. It can never really be declared "finished". There is always more to add to the station, improvements to be made, better antennas, higher power, lower noise. Computers share this trait which makes them too the ideal subject for a hobby. Today's mass storage is tomorrow's scratch-pad. There is unlimited scope for improvement and expansion of the hardware.

If ever the computer itself should look like having its full complement of RAM, ROM, AND I/O parts, the hobbyist can turn his attention to the vast range of peripherals that are available to him. A radio transmitter can be hooked up to an antenna and a microphone and that's about it, but nothing can be so insular as to resist interfacing to a computer if the intrepid hobbyist uses a little imagination.

More importantly, once the computer is operative a literally infinite amount of software development waits to be done. Like radio operating, this phase of the hobby is particularly attractive because the operating cost is nothing more than the electricity bill.

### The Junk Box

Ever since the tradition of stripping a discarded radio chassis was established by the pioneers of amateur radio, the humble junk box has been the hallmark of the truly worthy hobbyist. In much the same way as one may judge someone's social standing by the way he dresses, how neatly his garden is kept, radio amateurs assess each other's status by the quality and quantity of a bits and pieces which lurk for years in the dark recesses of their junk box until their true worth is finally recognised and they are discarded. Because the microcomputer hobby is so new, junk box computer parts of good vintage are rarer, but there is always the stimulating challenge of pushing a seemingly irredeemable piece of obsolete equipment into service. Radio ham and computer hobbyist alike share the unique pride and joy of operating equipment which the professionals have officially declared worthless.

### Doing The Impossible

Besides the resurrection of dead equipment, hams are keen on performing another type of miracle. This involves proving by practical demonstration that something which should by rights not be possible does, in fact, work. With amateur radio this usually entails forging forth into extremes of technology (or bad practice, depending on how you look at it), generally revolving around a successful communication in spite of a red-hot "final", vast distances or an antenna made of wet string.

To the computer ham comparable feats entail successful execution of programs which are either

exceptionally short or unbelievably long or so cunningly convoluted that not even the person who wrote it knows how it works. Thanks to the new technology involved there is also a whole new set of miracles which rely on getting a phenomenal number of logic functions into an incredible small space.

Amateurs are in a rather unique position in that they are permitted to exceed manufacturers' ratings to see to what limits they can push a particular component or piece of equipment. This practice gave rise to many novel techniques in the field of radio and a similar thing is bound to happen in computing.



The software bugs seem to come out just before sunrise.

### Time Is Not Money

Amateurs make many other contributions to the science to which they are devoted as a result of the enormous amount of time they spend on their hobby. Because of the non-commercial nature of their pursuits, computer hobbyists can afford to undertake time-consuming projects which would not be economical as a professional enterprise.

Like the radio amateur who stays awake all night tuning across the bands looking for a rare contact, the computer ham often burns the midnight oil chasing an elusive bug in his software. Radio propagation never seems to be optimum at a civilized hour; similarly the software bugs only seem to come out just before sunrise.

With both amateur radio and amateur computing the real fun of the hobby lies in setting a goal and then achieving it no matter how long it takes or how inefficient the techniques used may be. The computer ham may devote hundreds of hours to developing a program that does nothing more than play a seemingly useless game. But, as with any technical hobby, a lot of valuable techniques are learned in the process.

### Spreading The Word

A natural development from any widely followed hobby is the formation of clubs where people with similar interests can meet and exchange ideas. Major amateur radio clubs like the Radio Society of Great Britain, the Amateur Radio Relay League and the Wireless Institute of Australia have been established for many years and cater for hundreds of thousands of enthusiasts.

Even though the do-it-yourself computer hobby is

# - The Early Years

so young there are already hundreds of computer hobby clubs. The biggest of these are found on the west coast of America which is where most of the world's microprocessor products originate. The Southern California Computing Society has about 5,000 members. At the moment there are nearly 200 smaller computer clubs in the USA and an estimated 20,000 people have their own personal computer.

Magazines devoted entirely to the computer hobbyist have been established with great success. The most widely read glossy is *byte* which now circulates over 60,000 copies.

The radio amateurs' "field day" has always provided a means of information exchange between individuals. As communication is the basis of ham radio, publicising such events poses no problems, but computer hams have only their specialist magazines for such promotion. A few conventions have been held by computer hobbyists where the main purpose has been to establish standards so that hobbyists can easily share the software they have developed. Manufacturers of personal computing hardware also take an interest in these gatherings because it is an excellent opportunity to find out what the hobbyist is interested in and therefore which products will sell.

## Speaking of Computers

Due to the unusually verbal nature of the hobby itself, radio amateurs have developed a unique vocabulary. The language which results has such a high jargon content and is spoken so fluently that it is quite unintelligible to the outsider. This serves to give the group its own identity and binds its members together.

Although amateur computing is still in its infancy its followers found that the computer industry had already provided them with a highly developed jargon, complete with an impressive range of off-the-shelf, buzzwords which have been nurtured to perfection by 20 years of professional verbal dazzling. This they have eagerly seized and followers now have a language of their own.

The most telling sign of both radio and computer hams is their often amusing ability to construct seemingly meaningful sentences using all the rules of English grammar except that the keywords are replaced with strings of number of initials. The radio amateur might say, "QRX, I've got to check my SWR", while the computer amateur could hit you with, "I've put a PIA on my 6800 for I/O."

To the uninitiated talking in code like this seems like an awfully anti-social way of passing secret messages between club members — it serves to keep the in-group "in" by providing a feeling of comradeship for members and it keeps out all but the most determined newcomers.

## Future Shock (Electric)

Although personal computing is already well established as a hobby, the real impact of its advent is yet to come.

It is a characteristic of any hobby that those who pursue it develop great expertise in the field. A keen 10 year old stamp collector may know as much about stamps as a professional stamp dealer. Having spent his youth building radio transmitters a ham of 20 might know as much about radio as a University-qualified electronic engineer.

We are now finding a new breed of hobbyist/expert, a hobbyist who has spent thousands of hours of leisure time building computers and programming them. He could well know more about computers than many professionals in the field. As the hobby grows there will be more and more people to whom computers are second nature, people who are fully conversant with a broad range of computer concepts and totally up-to-date with the state of the art.

Traditional training and qualifications are already being seriously challenged by these hobbyists who might enroll in a University computer science course already knowing more than they will be taught.

As this flood of expertise hits the workforce we are bound to see dramatic changes in the status of the computer professional. Will there be a sudden surplus of computer engineers and programmers, or will the wave of new technology bring with it expansion of the industry to absorb it?

The remarkable advances in solid state technology which led to the development of microprocessors have made their mark on the electronics industry, but it's the "expertise explosion" which will follow that will have the real impact on society.



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# TRS-80 Update

The August issue of ETI carried a review of the Tandy's TRS-80. The machine, made available for review, was equipped with the Tandy Level 1 floating point 'Tiny BASIC' ROM and 4K of dynamic RAM.

Since then Tandy have introduced a number of developments on the BASIC TRS-80 machine — The Level 1 system was made available with 16K of memory and the more powerful Tandy Level 2 BASIC was introduced into this country supported by both 4K and, top of the range, 16K of dynamic RAM. Any machine from the range can be upgraded in performance by returning it to Tandy for internal mods.

This update to the original review deals with the major differences between machines equipped with the Level 1 and Level 2 BASICs. For a general description of the TRS-80 machine, the comments of the original review are still valid.

## Key Improvement

The level 2 BASIC is a 12K version of the microsoft BASIC used by many machines in the TRS-80's price bracket. Before going on to describe the Level 2 BASIC, which is considerably more powerful than Level 1, in detail, it may be as well to mention two hardware orientated improvements implemented on this upgraded machine.

The TRS-80's keyboard is decoded by the resident software and in the Level 1 machine the decoding system used meant that one had to release one key before the computer would allow the entry of another. This led to such messages as "Plase tye in yor name" — Even those of us who are not touch typists could get up enough speed to defeat the Level 1 keyboard. Level 2 lets you hit the second key before you have released the first key. Even level 2 does not let you get away with too much, however, and if you hold down three or four keys at a time, some keys will then generate several characters as they are pressed.

The other major area of improvement on the hardware/software border is the speed at which programs are dumped to and loaded from the TRS-80's cassette recorder.

Level 1 used a data transfer rate of 250 baud — the level 2 rate is twice this at 500 baud. Because of this faster transfer rate it may be found that the volume setting on the recorder that was suitable for use with a Level 1 machine will have to be altered for satisfactory performance with Level 2, in general a lower volume control setting will be needed.

## Editing

One of the major differences between Level 1 and Level 2 is the provision of a powerful editing facility in the latter. We do not have enough space to go into a detailed description of the editor but a few examples of what can be accomplished should give an idea of its power.

One can list any line of a program individually, insert material anywhere in a line, delete material anywhere in a line, delete the remainder of a line beyond the cursor and insert new material in its place. Any desired number of characters to the right of the cursor may be deleted or a change may be made to a

specified number of characters. The editor provides a search facility, so that (for example) a line may be searched for the second occurrence of the letter G and move the cursor to that position or tell the computer to delete all characters to that point and leave the cursor there.

Other editing features allow you to quit the edit saving all changes, to quit deleting all changes or the cancel all changes made and restart.

All in all a very powerful editor.

Level two basic allows variables to be stored in different forms — single or double precision. A # (hash) after a calculation will cause the result to be output as a 16 place decimal (print 1/3 #), an ! (exclamation mark) will keep a variable at single precision (G!) and a % (percent) symbol will keep the number as an interger.

The system of representation can be selected for the type of work required — Tip, if you can work with whole numbers, store them as integers, your program will run twice as fast and occupy half the memory space as programs without these restrictions.

## Print Format

Level 2 BASIC allows some fairly sophisticated formatting of output. It can be used in many applications such as printing report headings, accounting reports etc. Using nine "Field Separators," one can specify digit positions, cause automatic rounding off, concatenate (join together) multiple strings or string variables, align columns — a comprehensive system that allows any output to be presented in an easily readable form.

## Strings

The Level 2 manual states that "Without string handling capabilities, a computer is just a superpowered calculator." What this makes the level 1 machine with its "String Things" — strings which one was not able to handle — is a question we leave open: Needless to say the Level 2 machine provides a wide range of string handling commands.

The DEFSTR statement allows any valid variable name to contain a string, adding a type declaration character (\$) has the same effect.

Each string can contain up to 255 characters and strings can be compared as well as concatenated.

Strings can be compared with the same symbols used for comparing numbers — The ASCII codes for the characters being the values compared.

Level 2 features ASC and CHR\$ commands. ASC gives the ASCII numerical code for a string character while CHR\$ performs the reverse operation.

The INKEY\$ function will allow an entry from the keyboard while a program is running — without the use of the return key, useful for "Real Time" games if nothing else. INKEY\$ will strobe the keyboard and return with a one character string — This being a null string if no key is pressed.

Manipulation of strings can be carried out with the following commands, LEFT\$, MID\$, RIGHT\$, LEN and string\$.

LEFT\$ (A\$, 3) will print the first three characters from the left of A\$ — Thus if A\$ were TANDY the command would select TAN — MID\$ will select characters from the middle of the string and RIGHT\$, not surprisingly, from the right. The formats are the same for LEFT\$.

STRING\$ provides a string of a specified character for a specified character for a specified length. For example STRING\$ (25, ?) would output 25 question marks.

### Trace

Level 2 BASIC provides a trace facility that is very useful for the debugging of programs. The command TRON followed by RUN will output to the screen the exact sequence in which the program lines are executed. To turn off the trace function the command TROFF is used.

### Functions

Level 2 adds considerably to the four in-built arithmetic features of level 1.

To MEM (size of used memory), INT (Convert variable to integer), ABS (absolute value of variable) and RND (Random number generator) are added 12 more.

These are the trig functions SIN, COS, TAN and ATAN — The maths functions EXP, LOG, SGN and SQR.

The command RANDOM at the beginning of a

program will ensure a different series of random numbers each time program is run. CDBL and CSNG concern themselves with the format in which a numerical variable is stored. CDBL provides a double-precision value of the expression following CDBL in brackets, even if the operands are single — precision or integers, CSNG does the opposite by providing a single precision value of the expression.

Many other functions may be created using the 16 Level 2 functions and Appendix E of the level two manual provides a guide to these.

### Error messages

Whereas level 1 BASIC provides three (WHAT? HOW: and SORRY) error messages, Level 2 has 23 two-letter codes providing a far more specific indication of the error. Level 1's feature of printing the error code at the exact point at which the error occurs is however lost — The message being printed on the following line.

Another facility present in Level 1 but lost in the more powerful version is that of abbreviated statements and commands.

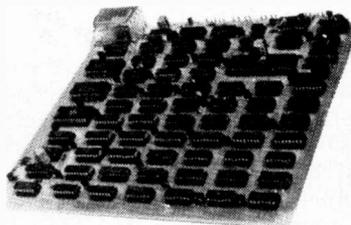
Tandy, however, produce a conversion-tape which will allow software written for a Level 1 machine to be converted to run a Level 2 machine.

### Arrays

Arrays are permitted to Level 2, the number of dimensions being limited by the size of the available memory-string arrays are also allowed.

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# TRS-80 Update

Level 2 BASIC provides the PEEK and POKE commands. Poke allows a specified value to be written into a specific RAM location PEEK allows the value stored at any RAM location to be retrieved.

POKE is particularly useful when producing graphics displays on the screen. Level 1's SET statements for handling screen graphics were rather slow — Level 2 provides 63 special graphics characters that can be speedily manipulated by the POKE command.

The display can also produce double width (same height) characters. By hitting shift key and right arrow the format is changed. Note however that anything on screen at the time only has every other letter enlarged. The clear key will return the display to the normal format.

## User Subroutines

Level 2 features the BASIC USR statement that permits the calling of user written subroutines.

## File Search

Level 2 allows the user to label files and to search for a the named file. CLOAD "TEST" will ignore all files on tape until the one called "TEST" is found. A useful feature is that as the machine searches for a file, the names of all those on the tape before the specific file is found will be displayed in the upper right hand corner of the display.

A file can be verified after being dumped by entering CLOAD? The machine will then load the program from tape and compare it with that stored in memory. A handy feature that allows one to ensure a program has been faithfully recorded.

## Manual

Unlike the level 1 manual, which makes an excellent job of teaching BASIC, the level 2 manual — As the forward says — Is not for the total beginner.

The manual does not go into the detail of the 233 page Level 1 manual. The Level 2 manual for example presents nine subroutines for array/matrix manipulation with very little explanation. 31 function codes are mentioned in one of appendices with little indication of how they are used in a program.

## Computer Conclusion

The Level 2 package certainly provides a significant improvement over the Level 1 version of this machine and, in our opinion takes the TRS-80 from the realms of the "Superpowered Calculator" — Tandy's words — into the area of real computing.

The number of add-ons available now — floppies, memory, printers etc means that the TRS-80 can form the heart of a flexible system suitable for a wide range of applications.

**See the article on a small business application of a TRS-80 system elsewhere in this issue.**

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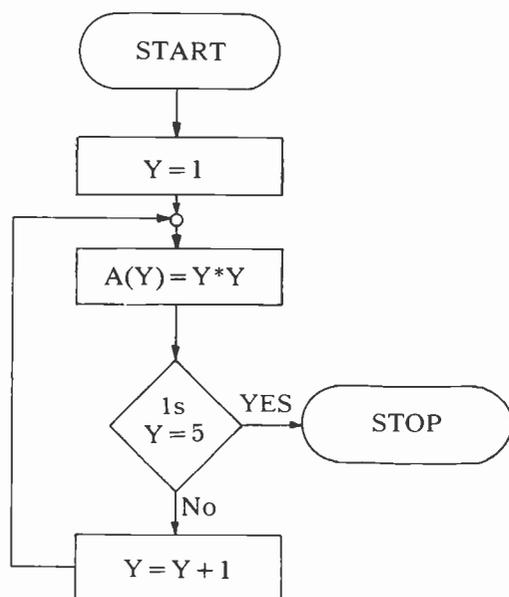
# Beginning BASIC

Phil Cornes resumes his description of BASIC with a look at some of the conditional branching instructions featured in this language

## IF THEN

THIS IS THE first of BASIC's really powerful conditional branching statements (we look at the others below) that go into the make-up of BASIC and we will add an IF THEN statement to the previous program segments (last month) to see what it can do.

Consider the following—



This is the same flow chart that we saw earlier except that now there is a two-way branch added which is made dependent upon the answer to the question 'IS Y = 5'.

Before we go on to look at the program derived from this flow chart, there is one other thing we need to consider. You will notice from the flowchart that IF Y is 5 when the decision box asks the question THEN we branch to a stop box. The statement in BASIC which causes the execution of a program to terminate is the END statement and you will find one of these in the program.

There is no statement in BASIC which corresponds to the start box on the flow chart (that is just presented for our information) and so the first box we consider contains  $Y = 1$ . The statement needed to

convey this to the computer is—

```
LET Y = 1
```

but remember that every statement in a program must have a line number, and so we have—

```
10 LET Y = 1
```

We now move on to the next box

$A(Y) = Y * Y$  and produce the statement—

```
20 LET A(Y) = Y * Y
```

The third box is the new one and we write—

```
30 IF Y = 5 THEN
```

THEN what? Well, we have to branch to the line number which contains the END statement, but we don't yet know which one this will be. So we can either sit and wait until we have written the END statement, or we can say always let the END statement exist on some high numbered line (say 9999) so if we ever need an END statement, we know what line it will appear on. We will do it this way so line 30 will read—

```
30 IF Y = 5 THEN 9999
```

and so if Y does equal 5, then we branch to the END statement that we will put in line 9999.

If the test (IS Y = 5) fails (answer is NO) then line 30 will be ignored and the computer will carry on executing the statements in the normal line number order.

The next box down contains  $Y = Y + 1$ , and so line 40 reads—

```
40 LET Y = Y + 1
```

From this we now branch back to the statement  $A(Y) = Y * Y$  which is on line 20 and we get—

```
50 GOTO 20
```

and lastly

```
9999 END
```

If we write this out in line number order, we get—

```

10 LET Y = 1
20 LET A(Y) = Y*Y
30 IF Y = 5 THEN 9999
40 Y = Y + 1
50 GOTO 20
9999 END

```

and this is our first complete program.

It does not matter that the line numbers do not follow on in multiples of 10, they don't have to, but what is more important is the fact that we do leave some numbers spare between our statements so that if we find we have missed out a line, or think of something else that we would like to add, then we have plenty of space to do so.

Consider the following—

```

5 REM INITIALIZE Y
10 LET Y = 1
15 REM PUT Y*Y IN A(Y)
20 LET A(Y) = Y*Y
25 REM TEST FOR Y = 5
30 IF Y = 5 THEN 9999
40 LET Y = Y + 1
50 GOTO 20
9999 END

```

REM (I thought REM was an android or something to do with sleep) in BASIC is short for REMark and tells the computer that whatever follows on this line is to be ignored because they are only notes for the programmer as a reminder of what is happening.

REMark statements in a program of this length are unnecessary, but we will soon be writing programs of sufficient length and complexity to justify their use as memory aids.

Returning now to our IF-THEN statement (IF Y=5 THEN 9999) the equals sign used here is not an arithmetic operator, but the first of the comparison operators. Any of the other comparison operators (<, >, <=, >=, <>) could also be used in an IF THEN statement, so that—

```

30 IF Y > 4 THEN 9999
130 IF Q < 19.2 THEN 55
902 IF A(17) >= 14.9 THEN LET P = P + 1

```

are all valid statements.

Notice here the twist in the tail of line 902. This is also a valid statement on most machines. This is easier to understand if we consider the IF-THEN statement as two separate statements. The first part (the IF part) asks a question (in line 902 — IS A(17) >= 14.9) to which the computer can answer either YES or NO. If the answer is NO then this statement is finished with and control passes on to the next higher numbered line. If the answer is YES then the computer passes on to the second statement on the line, the THEN part. THEN what? THEN LET P = P + 1 or THEN END or THEN 900 (this is really an abbreviation of THEN GOTO 900) or THEN any other statement. We can even put another IF THEN statement in.

Consider the following—

```
200 IF (A = 1)*(B = 1) THEN 900
```

The computer encountering this would first ask the question IS A = 1. If the answer is NO control passes to the next higher numbered line. If, on the other hand, A is equal to 1, we move on to the statement following the THEN and encounter another IF THEN statement which is treated in exactly the same way as the first. IS B = 1. If NO then carry on with the next line, if YES THEN GOTO 900. You will see that using this logic we will only pass control to line 900 if both A = 1 AND B = 1. At about this point your memory should be stirring to the fact that you have read something about logical operators earlier and indeed this is the place where they fit in. Depending on which machine you are considering, there are two ways of re-writing line 200 above to achieve the same result.

You could use—

```
200 IF A = 1 AND B = 1 THEN 900
```

which will normally be the format for machines with standard or extended BASIC, or—

```
200 IF (A = 1)*(B = 1) THEN 900
```

for the tiny BASIC machines

Notice the brackets in the second example. These tell the computer where one comparison ends and the other starts, otherwise the computer would attempt the following—

```
200 IF A = 1*B
```

(multiplication sign!) and then bomb out on the second equals sign.

The other common logical operator (OR) can also be used in a similar manner—

```
300 IF Q > 3*H OR S < 9 THEN R = R - 2
```

or

```
300 IF (Q > 3*H) + (S < 9) THEN R = R - 2
```

Notice the brackets again in the second example for similar reasons, and notice also the omission of the optional LET keyword before the R = R - 2. We will continue to omit the LET from now on.

Finally for this month, we will go on to consider one of the pre-defined functions of BASIC (somewhat out of turn, but we'll see why in a moment) the random number generator.

## RND(X)

We will start off by saying that the X within the brackets (the brackets are necessary and must be used whatever we replace X by) may be replaced by



# BASIC

any constant, variable name or expression with the proviso that when the computer evaluates the contents of the brackets they must not be negative or the computer will bomb out. When the computer has evaluated the brackets and checked that the answer is not negative, anything after the decimal point is chopped off (so that 0.238 would be truncated to 0, similarly 8.9 would become 8 and so on) if the result of this operation is zero, then the computer will generate a random decimal number (up to 6 digits) in the range zero to one, so that when—

20 R = RND(0)

is executed, R will take a random value between zero and one. If the result after truncating the contents of the brackets is not zero (it must by now be a positive integer) then the computer will generate a random integer between one and the number in the brackets inclusive, so that, for example—

50 R = RND(6.8)

Would assign a random integer to R with a value between 1 and 6 inclusive (6.8 would be truncated to 6). This is a very useful function for any statistical or games applications and has been included at this time so that we can set you some homework (you need the practice). You will find that you now know enough about BASIC to convert the three card shuffling routines presented in the first part into programs and we would suggest that if you are following this series seriously, you should attempt to do just this. Sample answers will be presented next month.

The answers to the questions posed last month are

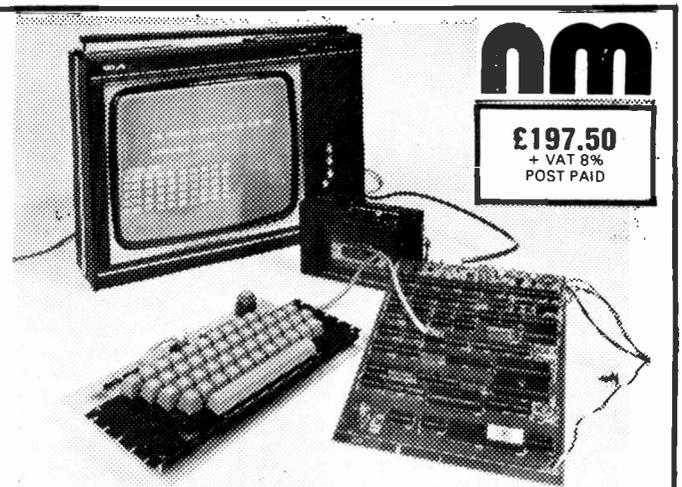
- 1 The expression has a value of 21, and
- 2 the expression could be simplified to  $7 + 7 * 8 / 2 / ((12 + 8) * 2 / 20)$

You cannot remove the brackets round  $(12 + 8) * 2 / 20$  (if you made this mistake, think about why not).

Next month we go on to look at how we get the computer to print some answers, subroutines and some more conditional branching.

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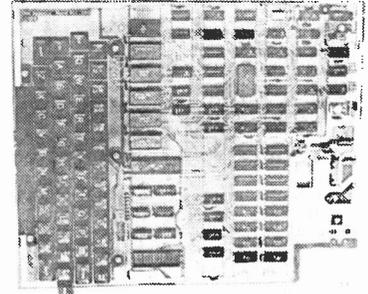
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SPC(I) SQR(X) TAB(I) TAN(X) USR(I)

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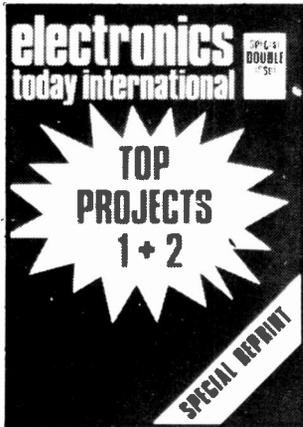
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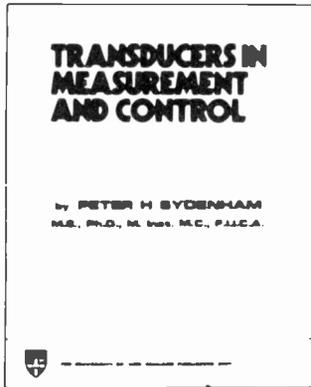
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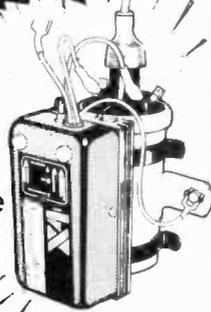
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# DATA SHEETS EXPLAINED

The data sheets which we publish regularly are very popular, but from time to time we receive requests for a fairly simple explanation of the terms and abbreviations which one finds in semiconductor device data sheets, and so here it is!

THE INFORMATION contained in semiconductor device data sheets is often grossly misunderstood. Great care must be taken to ensure that the exact meaning of a term or abbreviation is clear. As an example, we can quote the following conversation which actually occurred between two people who should both have known better.

A representative of a semiconductor distributor was showing data on a new power device to a lecturer. The lecturer said that the device data was wrong, since the maximum collector current was quoted as 12A and the maximum collector-emitter voltage ( $V_{CEO}$ ) as 80V; this is a power level of  $12 \times 80 = 960W$ , but the maximum permissible dissipation quoted in the data sheet is only 90W. The representative could provide no answer!

The data was, of course, perfectly correct. The problem arose because neither of the people concerned had appreciated the exact meaning of  $V_{CEO}$  which signifies the collector-emitter voltage *with the base open circuited*. Under these conditions (with zero base current) the collector current will be very small and the power dissipation in the transistor will also be quite small. Thus there is a great deal of difference between  $V_{CE}$  (the collector-emitter voltage under any conditions) and  $V_{CEO}$  (the collector-emitter voltage with the base open circuited). If still more information is required, one must look into the SOAR (Safe Operating ARea) graph to ascertain the regions of the collector voltage/collector current curve where the device can be safely operated for limited or unlimited times.

This is a very simple example of the pitfalls one can encounter if one does not really understand the *exact* meanings of the terms and abbreviations used in data sheets. Such misunderstandings are very common, but not (we hope!) amongst the devices covered in our data sheets, since it is equally important that our readers understand the exact meanings of abbreviations used in data sheets on relatively simple devices such as ordinary diodes and transistors.

## Letter Symbols

Three of the most important symbols used in semi-conductor device data sheets are V, I and P for voltage, current and power respectively. Various subscripts are added to these three letters to indicate the electrode(s) to which the symbol is being applied and possibly certain circuit conditions. Some of the most commonly used subscripts are listed below.

|    |                          |
|----|--------------------------|
| A  | anode                    |
| AV | average                  |
| B  | base                     |
| BO | breakover                |
| BR | breakdown                |
| C  | collector                |
| D  | drain or delay           |
| E  | emitter                  |
| F  | forward                  |
| G  | gate                     |
| H  | holding                  |
| I  | input                    |
| J  | junction                 |
| K  | cathode                  |
| M  | peak value of a quantity |
| O  | open circuit or output   |

|   |   |
|---|---|
| R | reverse or repetitive                   |
| S | source, short circuit, series or shield |
| T | in the on state (that is, triggered)    |
| W | working                                 |
| X | specified circuit                       |
| Z | impedance                               |

## Order of subscripts

In most cases more than one subscript is needed; the subscripts are usually placed in a definite order governed by the following rules:

The first subscript indicates the electrode at which the current or voltage is measured.

The second subscript denotes the reference terminal or circuit mode. (This subscript is often omitted if it is felt no ambiguity will arise.)

The letter O may be used as a third subscript to show that the electrode not indicated by any previous subscript is open circuited. Similarly the letter S can be used as a third subscript to show the third electrode is shorted to the reference electrode of the second subscript, whilst the letter R as a third subscript indicates that a specified resistance is connected between the third electrode and the reference electrode.

The supply voltage to a collector is indicated as  $V_{CC}$ , the second suffix being a repetition of the first in the case of supply voltages. Similarly, one often meets the symbol  $V_{DD}$  for the positive supply to a CMOS (or COS/MOS) device, this being the supply to the drain. The negative supply to CMOS devices is normally represented by the symbol  $V_{SS}$ .

It should now be clear why  $V_{CEO}$  is the steady collector emitter voltage with the base open circuited. Similarly  $I_{CER}$  is the collector cut off current with a specified resistance between the base and emitter. It is current with the base and emitter joined, since either the base or emitter can be used as the reference electrode without any change when they are joined.

The parameters of individual devices vary from one device to another of the same type number. The typical value of a parameter such as transistor current gain is often quoted in data sheets by the abbreviation 'typ' after the quantity, but minimum and maximum values are also often quoted. In economical devices no maximum and minimum values may be quoted. In the case of breakdown voltages the minimum value applicable to any device of that type number is usually quoted so that the circuit designer knows that he can apply that value of voltage without danger of the device junction breaking down.

The above discussion gives the general principles of the way in which the symbols for various parameters are chosen. It is not complete, since we have not yet covered such items as current gain of a transistor or thermal characteristics of a device. However, these and other quantities will be covered in the following tables.

## Thermal characteristics

The symbols used for the following thermal quantities apply to all types of semiconductor device.

|           |   |
|-----------|---|
| $P_{tot}$ | total power dissipated within the device                  |
| $T_{amb}$ | ambient temperature                                       |
| $T_c$     | temperature of the case of the device                     |
| $T_j$     | temperature of the junction in the semiconductor material |
| $T_{mb}$  | temperature of the mounting base of the device (= $T_c$ ) |

|                         |   |
|-------------------------|---|
| $T_{\text{stg}}$        | storage temperature   |
| $\theta_h$              | thermal resistance of heat sink. (Units: °C/W)                              |
| $\theta_i$              | contact thermal resistance between the case of the device and the heat sink |
| $\theta_{j\text{-amb}}$ | junction to ambient thermal resistance                                      |
| $\theta_{j\text{-c}}$   | junction to case thermal resistance   |

## Symbols used mainly with diodes

|                  |  |
|------------------|--|
| $C_d$            | diode capacitance with reverse bias                                  |
| $C_f$            | diode capacitance with forward bias                                  |
| $C_j$            | capacitance of the junction itself                                   |
| $C_{\text{min}}$ | minimum capacitance (which occurs at the rated breakdown voltage)    |
| $C_o$            | diode capacitance at zero bias                                       |
| $f_{\text{co}}$  | cut off frequency of a varactor diode                                |
| $I_F$            | total dc forward current   |
| $i_F$            | instantaneous forward current  |
| $I_{F(AV)}$      | average forward current  |
| $I_{FM}$         | peak forward current   |
| $I_{FRM}$        | repetitive peak forward current                                      |
| $I_{FSM}$        | non-repetitive peak forward current occurring under surge conditions |
| $I_R$            | continuous reverse leakage current                                   |
| $i_R$            | instantaneous reverse leakage current                                |
| $I_{RRM}$        | repetitive peak reverse current                                      |
| $I_{RSM}$        | non-repetitive peak reverse current                                  |
| $I_Z$            | zener diode continuous operating current                             |
| $I_{ZM}$         | zener diode peak current   |
| $t_{\text{on}}$  | turn on time   |
| $t_{\text{off}}$ | turn off time  |
| $t_r$            | rise time  |
| $t_{rr}$         | reverse recovery time  |
| $t_s$            | storage time   |
| $V_F$            | steady forward voltage   |
| $v_F$            | instantaneous forward voltage  |
| $V_R$            | steady reverse voltage   |
| $v_R$            | instantaneous value of the reverse voltage                           |
| $V_{RM}$         | peak reverse voltage   |
| $V_{RRM}$        | repetitive peak reverse voltage                                      |
| $V_{RSM}$        | non-repetitive peak reverse voltage (on surges)                      |
| $V_Z$            | zener diode working voltage  |

## Symbols used mainly with transistors

|   |   |
|---|---|
| $C_{ob}$                                      | transistor output capacitance in the grounded base circuit  |
| $C_{oe}$                                      | transistor output capacitance in the grounded emitter circuit   |
| $f_T$   | transition frequency or gain-bandwidth product in common emitter circuit  |
| $h_{FE}$                                      | current gain in the grounded emitter circuit (or in the grounded base or grounded collector circuit).                               |
| $(h_{FB}, h_{FC})$                            |   |
| $h_{fe}$                                      | the increase in collector current divided by the small increase in the base current which produces it. (Small signal current gain.) |
| $I_B, I_C$<br>or $I_E$                        | the steady base, collector or emitter current.  |
| $I_{B(AV)}, I_{C(AV)}$<br>or $I_{E(AV)}$      | the average value of the base, collector or emitter current.  |
| $I_{CEX}, I_{CM}, I_{EM}$<br>or $I_{EM}$      | collector cut-off current in a specified circuit<br>peak value of collector, base or emitter current                                |
| $i_b, i_c$<br>or $i_e$                        | rms value of the alternating component of the current   |
| $I_{b(m)}, I_{c(m)}, I_{e(m)}$<br>or $I_{om}$ | peak value of the alternating component of the current  |
| $i_c, i_b$<br>or $i_e$                        | instantaneous value of the total current  |
| $i_c, i_b$<br>or $i_e$                        | instantaneous value of the alternating component of the current   |
| $I_{CBO}$                                     | collector cut off current with the emitter open circuited   |

|                           |   |
|---------------------------|---|
| $I_{CBS}$<br>or $I_{CES}$ | collector cut off current with emitter shorted to the base                                      |
| $I_{CEO}$                 | collector cut off current with the base open circuited  |
| $I_{CER}$                 | collector cut off current with a specified value of resistance between the base and the emitter |
| $I_{EBO}$                 | emitter cut off current with the collector open circuited                                       |
| $V_{BE(SAT)}$             | base-emitter saturation voltage   |
| $V_{(BR)}$                | breakdown voltage   |
| $V_{(BR)CBO}$             | collector to base breakdown voltage with emitter open circuited                                 |
| $V_{(BR)CEO}$             | collector to emitter breakdown voltage with base open circuited                                 |
| $V_{CB}$                  | collector-base voltage  |
| $V_{CBO}$                 | collector to base voltage with emitter open circuited   |
| $V_{CC}$                  | collector supply voltage  |
| $V_{CE}$                  | collector to emitter voltage  |
| $V_{CEO}$                 | collector to emitter voltage with base open circuited   |
| $V_{ce}$                  | collector to emitter rms voltage  |
| $V_{CE(SAT)}$             | collector to emitter saturation voltage   |
| $V_{EB}$                  | emitter-base voltage  |
| $V_{EBO}$                 | emitter-base voltage with collector open circuited  |
| $V_{eb}$                  | emitter-base rms voltage  |

## Symbols used mainly with FETS

|           |   |
|-----------|---|
| $I_D$     | steady value of the drain current                                       |
| $I_{DSS}$ | steady value of the drain current with the gate connected to the source |
| $I_m$     | peak drain current  |
| $I_G$     | steady gate current   |
| $I_S$     | steady source current   |
| $r_{DS}$  | drain to source (or channel) resistance                                 |
| $V_{DS}$  | steady drain to source voltage  |
| $V_{GS}$  | steady gate to source voltage   |

## Symbols used mainly with thyristors

|            |   |
|------------|---|
| $I_{FRM}$  | repetitive peak forward current.                          |
| $I_{FSM}$  | non-repetitive peak (surge) current                       |
| $I_{GD}$   | gate current which does not trigger the device            |
| $I_{GT}$   | gate trigger current                                      |
| $I_{GO}$   | gate turn off current                                     |
| $I_H$      | holding current required to maintain conduction           |
| $I_R$      | steady reverse leakage current                            |
| $I_{RG}$   | reverse gate current                                      |
| $I_{RRM}$  | repetitive peak reverse current                           |
| $I_{RSM}$  | non-repetitive peak reverse current (in surge conditions) |
| $I_T$      | steady anode-cathode 'ON' state current                   |
| $P_G$      | gate power  |
| $t_{gt}$   | gate controlled turn-on time                              |
| $t_{gt}$   | gate controlled turn-off time                             |
| $V_{(BO)}$ | breakover voltage   |
| $V_D$      | continuous off state voltage                              |
| $V_{FG}$   | forward gate voltage                                      |
| $V_{GT}$   | gate trigger voltage                                      |
| $V_R$      | steady reverse voltage                                    |

## Operational amplifier terms

**Bandwidth,  $\Delta f$ .** The frequency at which the gain falls by a factor of 0.7 relative to the gain at low frequencies.

**Common mode rejection ratio, CMMR.** The gain when a signal is applied to one of the inputs of the amplifier divided by the gain when the signal is applied to both the inverting and non-inverting inputs. It is usually expressed in dB.

**Frequency compensation.** An operational amplifier requires a capacitor to enable it to be used in circuits which are stable over a wide frequency range. Internally compensated operational amplifiers have this capacitor fabricated on the silicon chip, but an external capacitor must be used with other types of operational amplifier which do not contain an internal capacitor.

**Input bias current,  $I_{BIAS}$ .** The mean value of the currents at the two inputs of an operational amplifier.

**Input offset current,  $I_{OS}$ .** The difference in the two currents to the inputs of an operational amplifier. Normally much smaller than the input bias current.

**Input offset voltage,  $V_{OS}$ .** The voltage which must be applied between the two input terminals to obtain zero voltage at the output.

**Open loop voltage gain,  $A_{VOL}$ .** The amplifier gain with no feedback applied.

**Output resistance,  $R_O$ .** The small signal resistance seen at the output when the output voltage is near zero.

## Voltage regulator terms

**Dropout voltage,  $V_{DO}$ .** When the difference between the input and output voltages falls down below the dropout voltage, the device ceases to provide regulation.

**Foldback current limiting.** In regulators with foldback current limiting, the current will 'fold back' to a fairly small value when the output is shorted.

**Line regulation.** The change in the output voltage for a specified change in the input voltage.

**Load regulation.** The change in output voltage for a change in the load current at a constant chip temperature.

**Quiescent current,  $I_Q$ .** The current taken by the regulator device when it is not delivering any output current.

**Ripple rejection.** The ratio of the peak-to-peak ripple at the input of the regulator to that at the output. Normally expressed in dB.

## Monolithic timer terms

**Comparator input current.** The mean current flowing in the comparator input connection during a timing cycle.

**Timing capacitor,  $C_T$ .** This capacitor is normally connected between the comparator input and ground. The time taken for it to charge controls the delay time.

**Timing resistor,  $R_T$ .** This is the resistor through which the timing capacitor charges.

**Trigger current.** The current flowing in the trigger input connection, at the specified trigger voltage.

**Trigger voltage.** The voltage required at the trigger pin to initiate a timing cycle.

## Conclusions

Data sheets must be used intelligently and with much thought. Information on the conditions under which an entry in the data sheet is applicable is often stated in small print, but is of great importance. Data should always be thoroughly studied before a device is used for the first time, only then will you be able to fully understand the potential applications of the device.

Thus  $i_E$  is the instantaneous value of the total emitter current,  $i_{E(av)}$  the instantaneous value of the alternating component of the emitter current, and  $I_{E(AV)}$  the average (DC) value of the total emitter current. Other subscripts can be used in a similar way,  $I_F$  being the forward DC current with no signal,  $I_F$  the instantaneous forward current and  $I_{FM}$  the peak forward current.

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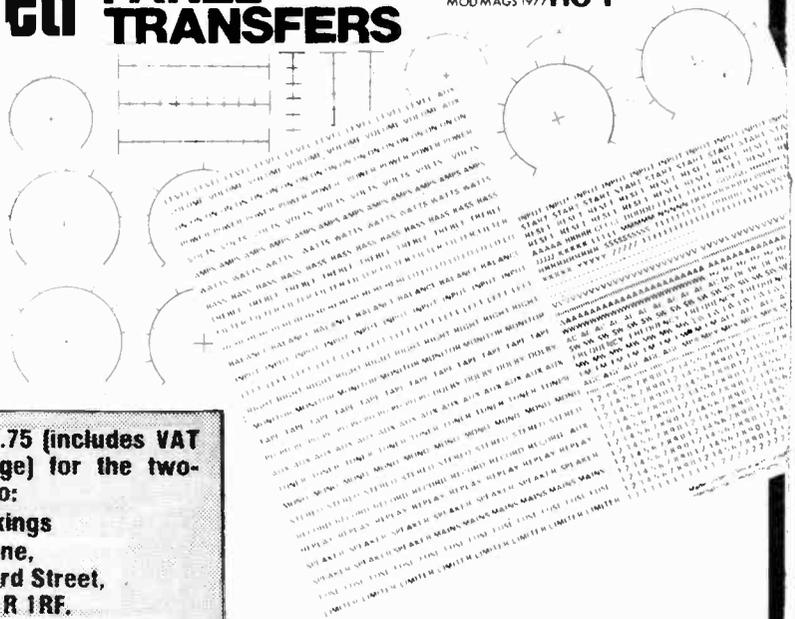
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# Understanding Digital Electronics

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- Book 3** Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.
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- Book 5** Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.
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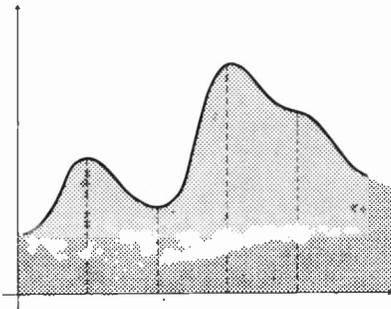
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# Hobby Electronics

Next  
Month

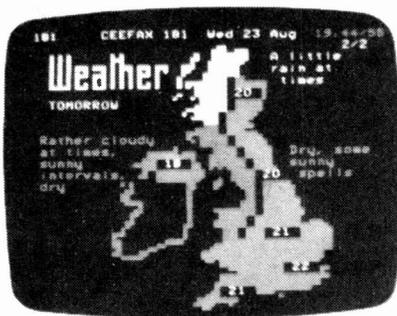
## 4-Channel Equaliser



A fully-fledged graphic equaliser with four bands, allowing you to adjust the response of your Hi-Fi to suit the room it's in! Alternatively, this unit can be used as a really sophisticated tone control. This project was designed by a professional audio consultant especially for HE. We think it'll be a winner!

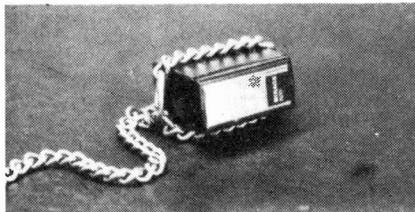


## Viewdata



One of the most exciting developments in modern TV technology is the advent of data transmission and display. Viewdata is Britain's answer to advances which could mean shopping from the home, a computer terminal in every room or even the abolition of commuting!

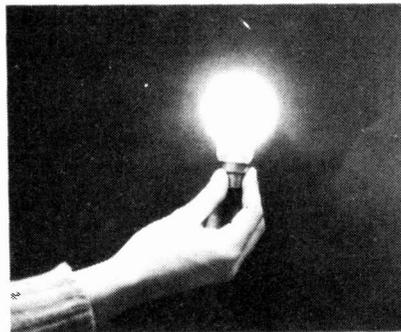
## Slave Flash



Using one flash gun is fairly straightforward — but how do you use two or more simultaneously?



## Touch Switch



A switch with no moving parts! Just touch it and turn on the lights, motors or whatever turns you on. By the way, the above photo is not an illustration of the switch in action, but one of our staff having a bright idea.



## Holograms

Following on from the LASER article in this issue, we look into (!) holograms — what are they, how are they made and what use are they. This is a fascinating topic and one which is sure to make a big impact on all our lives in the future.

## Project Daedalus

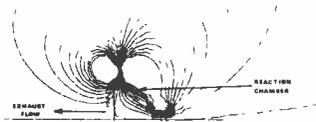


Fig. 9 Magnetic field created in the region of the vehicle

The British Interplanetary Society has just published a report which shows that interstellar flight by an un-manned vehicle is possible with modern technology. The report is nearly 200 pages of detailed drawings, calculations and specifications. We examine it clearly in detail.

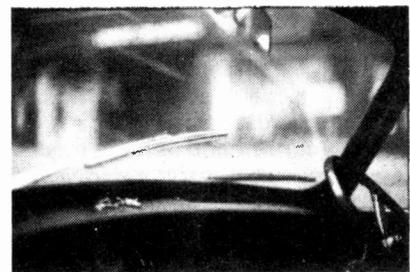


## BASIC Programming

If you've ever wondered exactly what's involved in programming a computer, then this is for you. We look at BASIC — one of the most popular computer languages — and see what it's all about. This article will require no previous knowledge and will be much more than an introduction to the subject.



## Variwiper



Ever been driving in one of those horrible drizzles which is too fine for the wipers to work properly? This circuit makes them repeat one sweep at pre-set time intervals — ideal for those conditions.

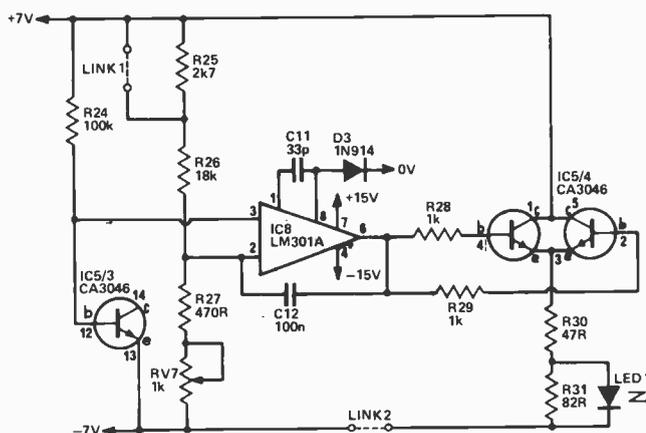
January issue will be on sale on December 8th

The items mentioned here are those planned for the next issue but circumstances may affect the actual content.

# TEMP STABILISED LOG CONVERTER

This design can be set up for either logarithmic or exponential operation and incorporates a neat heater circuit for temperature stability.

IN THE CONVENTIONAL musical scale, consecutive notes are not separated by the same frequency, but by the same ratio — the twelfth root of two. This is quite acceptable for most musical instrument manufacturers, except that in electronic music equipment it is easier to make oscillators which have an accurately linear frequency/control voltage characteristic. The keyboards of most music synthesizers give an output voltage of 1 V for each octave on the keyboard. This can easily be generated by a set of equal resistors between the contacts on each key and a voltage applied to each end (normally 5 V). However this means the oscillator is required to have an exponential frequency/control voltage response.



Below: the circuit diagram of the converter section. One channel only is shown here, the second — identical — uses the even components numbers. Above: the oven circuitry.

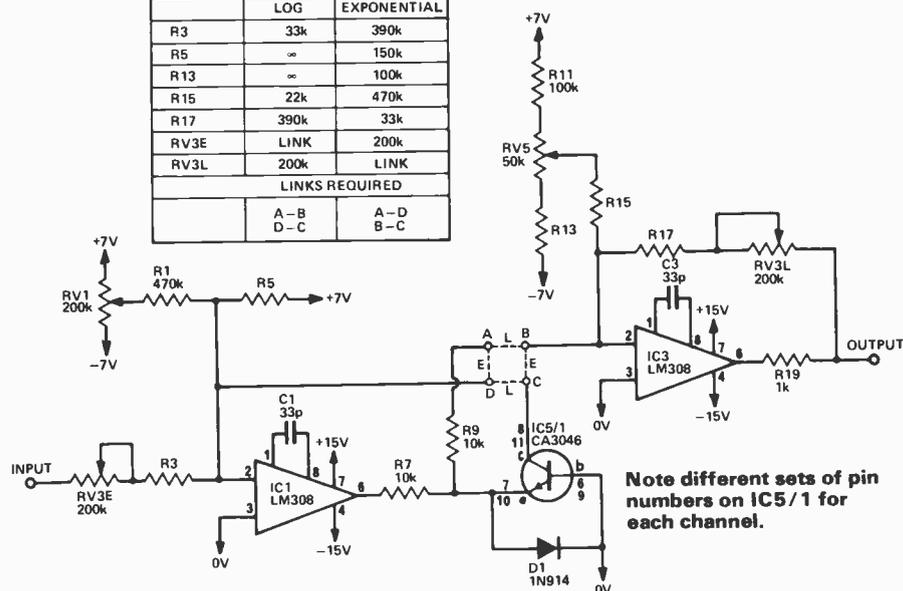
## Trouble

This is where the trouble usually starts. An exponential converter is normally used which relies for its operation on the relationship between current and voltage in a silicon diode or transistor. However, unless temperature stabilisation is used the oscillator will not stay in tune for very long. With this unit the transistor used is heated to around 55°C and stabilised at this temperature, eliminating the problem of thermal drift.

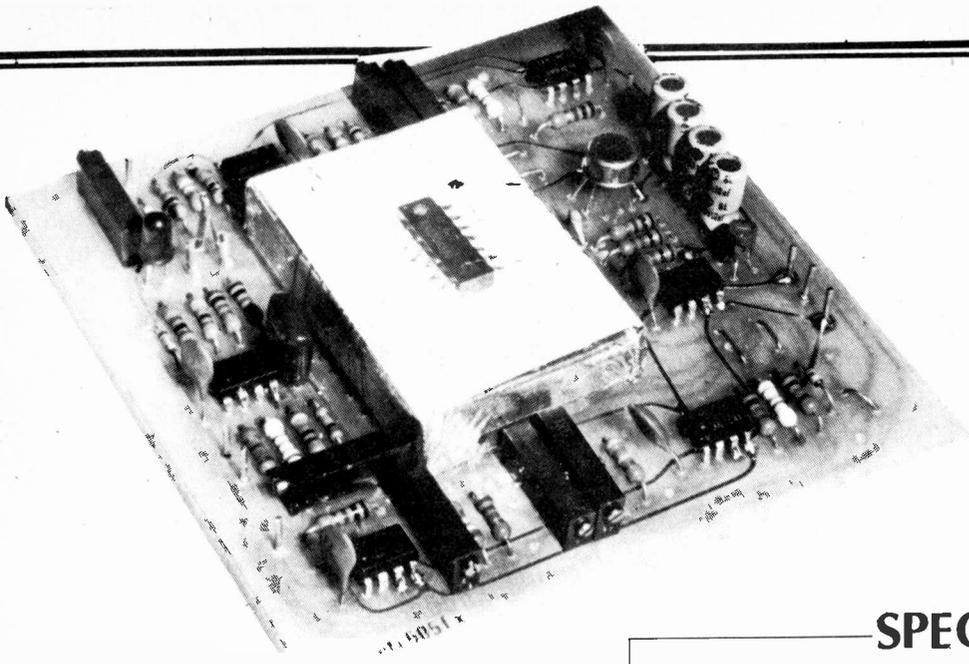
In the instrumentation field a lot of functions are displayed in dBs which are a logarithmic measurement. As this unit can be connected in either exp or log modes it is useful for this purpose also.

As the unit will normally be used with some other equipment, we have not described any mechanical housing.

| VALUES OF UNMARKED COMPONENTS |            |             |
|-------------------------------|------------|-------------|
|                               | LOG        | EXPONENTIAL |
| R3                            | 33k        | 390k        |
| R5                            | ∞          | 150k        |
| R13                           | ∞          | 100k        |
| R15                           | 22k        | 470k        |
| R17                           | 390k       | 33k         |
| RV3E                          | LINK       | 200k        |
| RV3L                          | 200k       | LINK        |
| LINKS REQUIRED                |            |             |
|                               | A-B<br>D-C | A-D<br>B-C  |



Note different sets of pin numbers on IC5/1 for each channel.



The photo on the left shows the complete unit with the oven top removed to show IC5. Link 1 is made from a couple of valve socket pins in this prototype.

## SPECIFICATION

|  |  |
|--|--|
| <b>Transfer functions</b><br>exponential<br>log. | $V_{out} = 0.15625 \times 2V_{in}$<br>$V_{out} = \text{Ln}(V_{in}/0.15625)/\text{Ln}2$ |
| <b>Useful dynamic range</b>                      | 50dB or 8 octaves  |
| <b>Oven temperature</b>                          | approx. 55°C   |
| <b>Warm up time</b>                              | about 2 minutes  |
| <b>Power supply</b>                              | ± 10 to ± 15 volts   |

## HOW IT WORKS

This unit relies on the fact that the collector current of a transistor is exponentially related to the base voltage.

In the log mode the collector of the transistor is linked back to the input of IC1. In this way the collector current is proportional to the input voltage and therefore the voltage on its emitter is logarithmically related to the input voltage. This voltage is then amplified and level shifted by IC3 to give the desired output.

In the exponential mode the 10k resistor R9 is linked back to the input of IC1 and the voltage on the emitter of the transistor is proportional to the input voltage; the collector current is exponentially related to the input voltage. This current is converted to a voltage by IC3.

All this works well provided the transistor is at a constant temperature. Compensation can be made by using other junctions and thermistors, however even the self-heating effect of the transistors can affect linearity. The transistors we have used are part of a transistor array IC which has three individual NPN transistors and a differential pair. We heat the chip up by dissipating heat in the differential pair while measuring the base-emitter voltage of one of the individual transistors. IC8 is used to compare this voltage to one set by the divider R25, 26, 27 and RV7. The base-emitter voltage is normally about 0.67 V at 20°C and drops about 2.2 mV per degree above this temperature. IC8 then stabilises the chip temperature to about 35°C above the temperature at which it was initially calibrated. As it warms up the current in the transistors will fall and when hot the voltage drop across R31 will be low enough that the LED will extinguish. The transistor array is housed in a polystyrene housing to conserve heat.

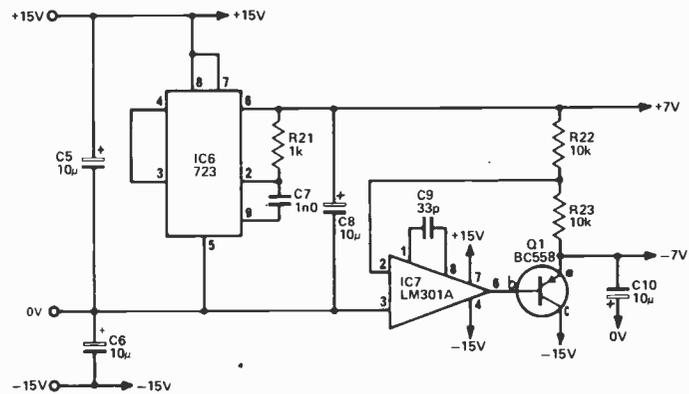


Fig. 1b. The power supply section which supplies the stable ± 7 V needed for the bias and adjustment controls.

The only difference between the assembly of this board and any other is the oven and the connections to the transistor array package. The oven is made out of two pieces of polystyrene about 55 x 35 x 12mm. The outside of the oven should be covered with aluminium foil to help reduce heat loss. The aluminium itself should be covered with a layer of adhesive tape where the leads can touch. A piece of thick paper should be used between the oven and the pcb to insulate the tracks.

## Half Baked

The centre of the oven should be hollowed slightly to hold the IC (bend the leads out straight as shown in the photo; a hot soldering iron is the easiest method. Do not remove more than necessary. Now solder a 40 mm length of thin copper wire (a single strand of multistrand cable is best) to each pin, then with the base of the oven in position, sit the IC in the oven and connect the leads to the appropriate holes. If a small amount

## PARTS LIST

RESISTORS all 2%, 5W  
 R1, 2 470k  
 R3-R6 see table 1  
 R7-R10, 22, 23 10k  
 R11, 12, 24 100k  
 R13-R18 see text  
 R19-R21, 28, 29 1k  
 R25 2k7  
 R26 18k  
 R27 470R  
 R30 47R  
 R31 82R

POTENTIOMETERS  
 RV1-RV4 200k multitrn trimmer  
 RV5, 6 50k multitrn trimmer  
 RV7 1k multitrn trimmer

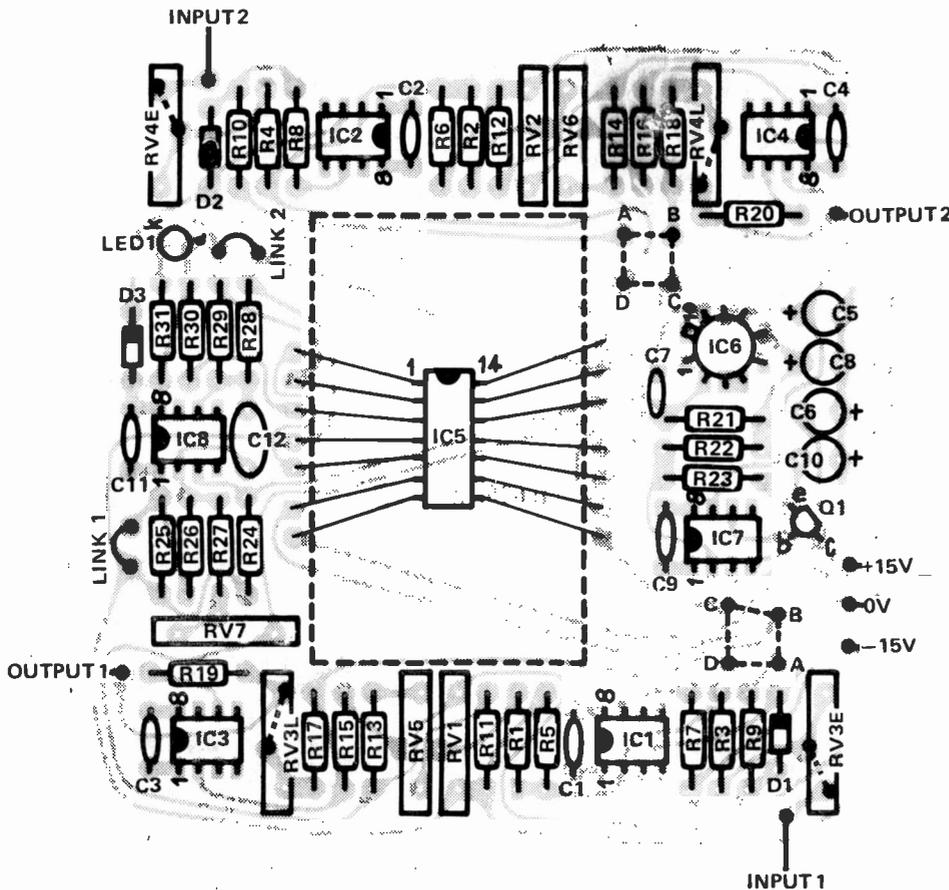
CAPACITORS  
 C1-C4 33p ceramic  
 C5, 6 10u 25 V electrolytic  
 C7 1n0 polyester  
 C8 10u 25 V electrolytic  
 C9 33p ceramic  
 C10 10u 25 V electrolytic  
 C11 33p ceramic  
 C12 100n polyester

SEMICONDUCTORS  
 IC1-IC4 LM308  
 IC5 CA3046  
 IC6 723  
 IC7, 8 LM301A

Q1 BC558

D1-D3 1N914  
 LED T1L 209

MISCELLANEOUS  
 PCB  
 Polystyrene foam for oven



Component overlay for the complete log converter project.

## BUYLINES

The project depends upon the CA 3046 device — near equivalents will probably **not** function. The CA 3046 itself is readily available — we

found it in both the Marshalls and Stevenson catalogues when we looked for it! Initial reaction here had been that it would be difficult to obtain.

of epoxy cement is placed under the oven it will stay in position. Now fit the top of the oven and secure with a piece of adhesive tape until it has been checked out. It finally can be cemented with epoxy adhesive.

The potentiometer values chosen are a compromise between ease of adjustment and the ability to compensate different transistors. If the potentiometer does not have enough range then the series resistor will have to be varied. We have

specified 2% resistors throughout to obtain a better temperature coefficient than is possible with conventional 5% resistors. It will not help to select out of normal 5% types.

### Calibration

The equipment needed comprises an accurate digital voltmeter and a variable power supply with a fine voltage control. The + 7 V rail can be used for this with a multi-turn potentiometer.

## CALIBRATION TABLE

| A       | B       |
|---------|---------|
| -3.00 V | 19.5 mV |
| -2.00 V | 39 mV   |
| -1.00 V | 78 mV   |
| 0.00 V  | 156 mV  |
| +1.00 V | 312 mV  |
| +2.00 V | 625 mV  |
| +3.00 V | 1.25 V  |
| +4.00 V | 2.50 V  |
| +5.00 V | 5.00 V  |
| +6.00 V | 10.00 V |

This table shows the relationship between the input and output. In the exponential model A is the input with B the output while in the log mode B is the input and A the output.

## Oven Control

1. Before switching on, remove link 2 and fit link 1.
2. Switch on and monitor the voltage on the output of IC8 (pin 6).
3. Adjust RV7 until the voltage is about  $-5$  V. The potentiometer is sensitive in this area but the actual voltage is not critical.
4. Remove link 1 and fit link 2. The LED should now come on for about two minutes before slowly going out. This indicates that the oven is stable.

## Calibration of Log Mode

1. Set 0 V on the input.
2. Monitor the voltage on the junction of R7 and R9.
3. Adjust RV1 to give a negative voltage on this point. Now adjust RV1 slowly until the voltage just switches positive.
4. Set 0.15625 V in the input.
5. Adjust RV5 to give 0 V output.
6. Set 5.00 V on the input.
7. Adjust RV3 to give 5.00 V output.
8. Set 1.25 V on the input and check the output voltage. It should be 3.00 V. If it is higher go back to step 4 except adjust RV5 to give  $-0.010$  V and use RV1 to bring it back to zero. Continue with step 6, 7 and 8. If the output voltage at 1.25 V input is less than 3.00 V adjust RV5 to give  $+0.010$  V instead of  $-0.010$  V.

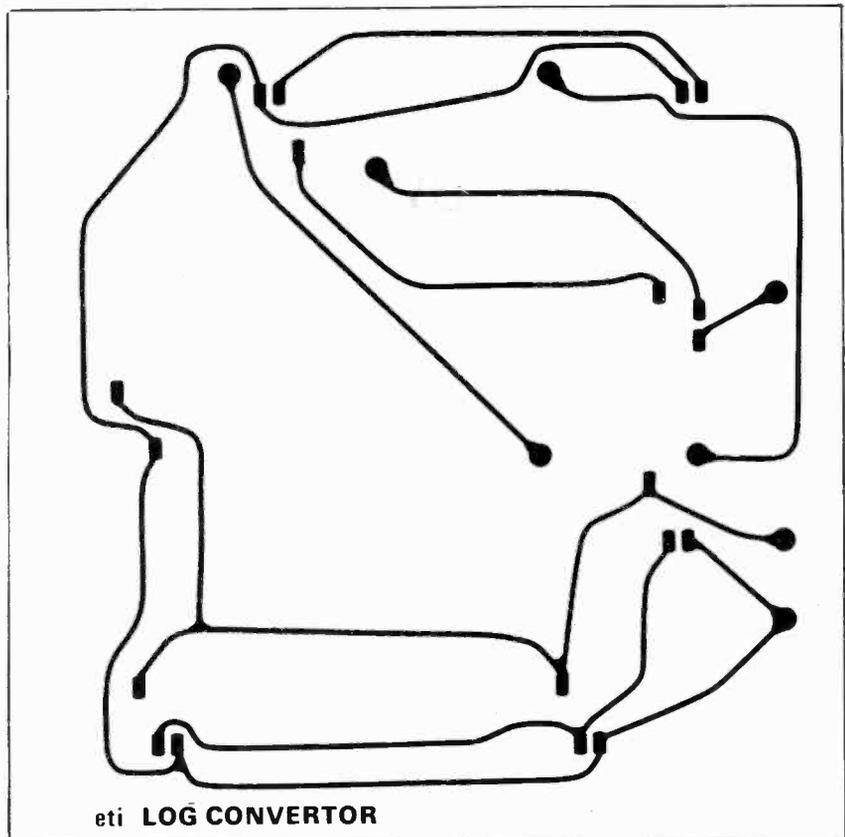
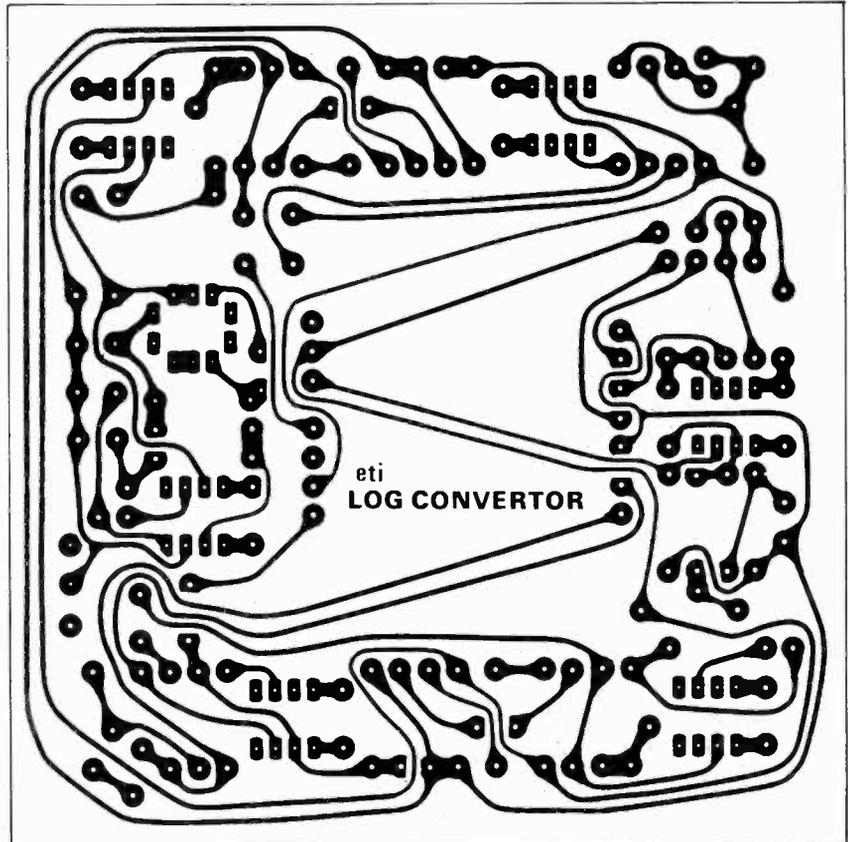
Continue until all three points are correct.

## Calibration of Exponential Mode

1. Place a link between the junction of R7 and R9, and 0V.
2. Adjust RV5 to give 0.00 V output. Remove the link.
3. With 0.00 V input, adjust RV1 to give 0.15625 V output.
4. With 5.00 V input, adjust RV3E to give +5.00 volts output.
5. Check output voltage with 3.00 V input. It should be 1.25 V.
6. If high repeat steps 1-5 except output. If low, repeat steps 1-5 except adjust RV5 to give about 10mV output.

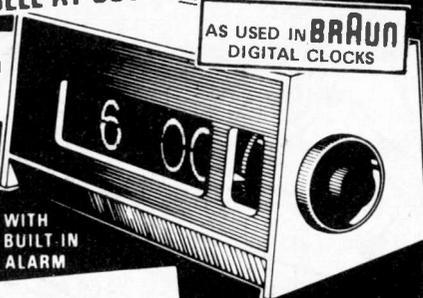
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Both sides of the PCB shown full size. On the top is the underside and the pattern beneath that is for the topside of the board.



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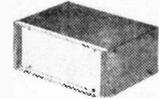
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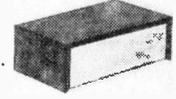
Aluminium box with lid and screws.

| L             | W | H |      |
|---------------|---|---|------|
| 3 x 2 x 1     |   |   | 44p  |
| 4 x 3 x 1 1/2 |   |   | 52p  |
| 4 x 3 x 2     |   |   | 60p  |
| 6 x 4 x 2     |   |   | 67p  |
| 6 x 4 x 3     |   |   | 78p  |
| 8 x 6 x 2     |   |   | 105p |
| 8 x 6 x 3     |   |   | 118p |



Professional black P.V.C. coated case with satin anodised front panel and trim.

| W              | D | H |      |
|----------------|---|---|------|
| 9 x 6 x 3      |   |   | 443p |
| 9 x 6 x 4 1/2  |   |   | 479p |
| 9 x 6 x 6      |   |   | 512p |
| 12 x 8 x 3     |   |   | 544p |
| 12 x 8 x 4 1/2 |   |   | 618p |
| 12 x 8 x 6     |   |   | 660p |



Black P.V.C. top with U-shaped aluminium chassis.

| L                 | W | H |      |
|-------------------|---|---|------|
| 6 x 4 1/2 x 2     |   |   | 134p |
| 6 x 4 x 3 1/2     |   |   | 145p |
| 8 x 5 1/2 x 2 1/2 |   |   | 165p |
| 10 x 6 1/2 x 3    |   |   | 215p |

|            |     |           |     |          |      |
|------------|-----|-----------|-----|----------|------|
| AD161/2 MP | 83p | BC347A    | 14p | BF274    | 24p  |
| OC36       | 60p | BD183     | 80p | BF394    | 30p  |
| BC108A     | 9p  | BD263A    | 42p | BF422    | 20p  |
| BC148      | 8p  | BF137     | 24p | LM741C   | 17p  |
| BC149C     | 9p  | BF194     | 10p | TBA120A  | 75p  |
| BC154      | 9p  | BF195     | 10p | SN76013N | 120p |
| BC171B     | 9p  | BF198     | 21p | SN76033N | 120p |
| BC172B     | 9p  | BF200     | 21p | SN76110N | 75p  |
| BC183A     | 10p | BF255     | 23p | SN76131N | 150p |
| BC30B      | 15p | BF256 FET | 33p | SN76660N | 75p  |

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| 330/25v            | 10p | 47/16v   | 7p  |
| 10/25v             | 5p  | 330/63v  | 16p |
| 15/16v             | 6p  | 470/16v  | 15p |
| 22/10v             | 5p  | 470/40v  | 15p |
| 22/16v             | 6p  | 1000/25v | 18p |
| 22/25v             | 7p  | 2000/30v | 20p |
| 33/35v             | 8p  |          |     |
| 33/50v             | 9p  |          |     |
| 47/40v             | 10p |          |     |
| 100/10v            | 8p  |          |     |
| 100/63v            | 10p |          |     |

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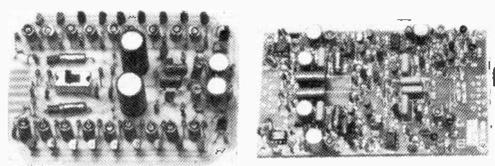
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**POWER AMPLIFIERS**

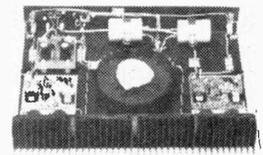
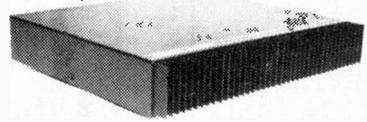
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| POWER AMP KIT   |        | £32.40 |        |
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| CPR1  | £29.49 | CPRIS  | £39.98 |
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| POWER SUPPLY:   |        |        |        |
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# microfile.....

**This month dynamic Gary (mines a pint) Evans goes random, ROMs the seas as a pirate and plays strange games with a T.V., but still finds time to visit North London.**

BEING CAUGHT PIRATING software could lead to all sorts of unpleasantness—boys in blue or more likely the boys in black (the legal eagles) looking for a large fee in some test case. At any rate copying, or rather being caught copying, software that someone, somewhere is willing to protect is something to avoid. It's for this reason that the guys at Transam — they who supply kits for the Triton — suffered a few nervous twitches when they heard that someone called Dobbs on the phone and he wanted to have a few words with them.

Now the BASIC that was used in the Triton has been around for some time. When development of the computer started we realised we could not undertake to write an 8080 interpreter from scratch and we looked around for something that was "in the public domain". The listing of an interpreter that appeared in Dr. Dobbs journal seemed to us to be just the thing we wanted — had we made a dreadful mistake.

Well gentle reader (I'm an Asimov fan) as it turned out we need not have worried at all. On picking up the phone, instead of some irate, distant American voice a softspoken northerner (north of England that is) greeted the ear.

This Dobbs had nothing to do with publishing a software journal working — as it turned out — for British Rail. He wanted to order a Triton.

Relief all round — is there a Mr. Byte in the house. What the manufacturers produce today, industry uses the next day and we, the amateurs, use the day after that and what the manufacturers are producing now are 16 bit MPUs. Intel, Motorola, Zilog Texas — everybody seems to have caught the 16 bit bug.

The first small system for the Home Office to use a 16 bit beast is almost certain to be the long awaited, and much talked about, Texas machine. Just what overnight "quantum jump" in performance these 16 bit based systems are going to provide, remains to be seen — but at least we should have something with a bit more to offer in terms of throughput and facilities than the current crop of 8 bitters. At what cost penalty will become evident over the next year or so.

Dynamic RAMs are very cheap, are they not? A couple of systems in use in this country feature such devices — the TRS-80, although here any cost savings do not seem to be passed on to the end user, and the NASCOM.

The more extensive use of dynamic RAM in small systems is probably a hang over from the days when it was all anybody could do to get a dynamic memory card up and running. There is no doubt that a dynamic card

can be a real pig to fault find. So many things have to happen at exactly the right time for the system to work at all. Unless some very sophisticated diagnostic equipment is available, it could prove almost impossible to decide what is wrong.

With the current crop of dynamic RAM controllers, however, hopefully there will be so little margin for error that we shall start to see nice cheap 4K and 16K memory expansion systems.

One example of a RAM controller that seems to do it all is the Intel 8202 — I have not yet managed to get a data sheet for this device but when I do I'll let you know just what it can do. In the meantime, if any of you have played around with dynamic devices, perhaps you'll let me know how you got on.

The North London Hobby Computer Club seems to be going from strength to strength. I was at their second meeting a while back and there was standing room only in the two rooms occupied by the club for demonstrating on the PET and the Triton. A continuing program of interesting talks and demonstrations is planned and if you live in North London, is recommended that you go along to the North London Poly in the Holloway Road and see what is going on for yourself.

Mine of Information Ltd is a company that is out to contest the high prices charged for many of the American microcomputer books brought over to this country. To quote from their literature "some worthwhile books are distributed by companies with exclusive European or British rights; there is a temptation to capitalize on the monopoly by increasing prices. In these circumstances Mol has to charge its customers more than is reasonable! Mol is taking action to contest the high prices. (When the choice of books is wider there will be no need to buy from such suppliers)."

A fresh attitude, as I can think of at least one outfit which must be making a mint from a number of exclusive titles sold at a high mark up. Some increase in cost from a straight \$70 £ conversion is acceptable — to quote Mol again — "It means extra hassle and expense to bring books to Britain" — but not as much expense and hassle as some would have us believe.

I wish Mol luck in their campaign and if you would like their lists send an SAE to

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By the way members of the North London Computer Club get 10% off the prices in the list — yet another reason to pay a visit to the club. ▶

# NEWS: Microfile

The trend in America at the moment, or at least one of the trends, is for the home computer and the TV games to meet in a sort of common ground. One example of such a product is the Bally Arcade "box". The machine features a calculator style keyboard with slot for a Bally cartridge as well as sockets into which a number of accessories can be plugged, these include the two hand controllers supplied with the basic machine.

The machine features a number of built in games including the excellent gunfight which many of you may have seen in the arcades over here. This game produces good high resolution graphics in colour as well as a repertoire of musical sounds.

By plugging a ROM cartridge into the front panel socket additional games can be played on the machine and if a BASIC cartridge is used the Arcade is converted to a computer running the familiar TINY BASIC as per the TRITON.

Z80 based, the Arcade is supported by 8k of ROM to store the resident games and 4K of RAM which acts mainly as a screen memory.

The Bally Arcade is not the only product to appear in this area. Magnavox has the "Dyssey 2" machine from Intertec and it's rumoured, Atari are ready to launch something into this market.

ETI

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**BURROUGHS 9 DIGIT** Panapac calculator display 7 segment 0.25 digits. Neon type with red bezel socket and data. £2.25 ea. 10 for £20.

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| BC109C       | 0.120 | 0.100 | 0.085 | 0.075 |
| BC114        | 0.080 | 0.065 | 0.050 | 0.040 |
| BC132        | 0.080 | 0.065 | 0.050 | 0.040 |
| BC153        | 0.085 | 0.070 | 0.055 | 0.045 |
| BC172        | 0.075 | 0.060 | 0.050 | 0.040 |
| BC173        | 0.075 | 0.060 | 0.050 | 0.040 |
| BC205        | 0.070 | 0.060 | 0.050 | 0.040 |
| BC208        | 0.075 | 0.060 | 0.050 | 0.040 |
| BC209        | 0.075 | 0.060 | 0.050 | 0.040 |
| BD181        | 0.600 | 0.500 | 0.440 | 0.400 |
| BD182        | 0.700 | 0.600 | 0.500 | 0.400 |
| BF181        | 0.240 | 0.16  | 0.140 | 0.125 |
| BF50         | 0.180 | 0.200 | 0.185 | 0.160 |
| BF51         | 0.180 | 0.160 | 0.140 | 0.125 |
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SET 8: 14x8x108 £1  
SET 9: 50x50 10v E1  
SET 10: 40x20 10v E1  
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SET 13: 40x20 10v E1  
SET 14: 40x20 10v E1  
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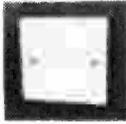
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| AC142 24p          | BC557 14p  | OC72 34p    | 7400 12p   | 7497 138p  |             | 4528 55p                  | 0A202 9p                 | 2.5" x 5"                                | 51p                       |    |
| AC151 42p          | BCY30 67p  | OC84 46p    | 7401 12p   | 74100 88p  |             | 4578 27p                  | IN4148 4p                | 3.75" x 5"                               | 60p                       |    |
| AC152 52p          | BCY34 74p  | IP29 40p    | 7402 12p   | 74104 50p  |             | 4583 82p                  | 1N916 5p                 |  |                           |    |
| AC153 53p          | BCY59 24p  | IP30 40p    | 7403 12p   | 74105 40p  | <b>CMOS</b> | 4585 105p                 | 1N4001 4p                |  |                           |    |
| AC176 18p          | BCY70 14p  | IP31 50p    | 7404 12p   | 74107 25p  | 4000 15p    |                           | 1N4002 4p                | <b>CERAMIC CAP 50V</b>                   | 2p                        |    |
| AC188 23p          | BCY71 14p  | IP32 55p    | 7405 13p   | 74109 30p  | 4001 15p    |                           | 1N4003 5p                | 22pF to 50,000pF                         |                           |    |
| AD149 65p          | BCY115 52p | IP33 75p    | 7406 24p   | 74110 46p  | 4002 15p    |                           | 1N4004 6p                |  |                           |    |
| AD161 35p          | BCY121 79p | IP34 98p    | 7407 24p   | 74116 160p | 4007 15p    | <b>VOLTAGE REGULATORS</b> | 1N4005 7p                | <b>POLYESTER CAP 250V</b>                | 5p                        |    |
| AD162 38p          | BCY123 79p | IP35A 253p  | 7408 14p   | 74118 82p  | 4008 64p    | 7805 60p                  | 1N4006 8p                | .01, .015, .022, .033, .047, .068, .1 uF | 5p                        |    |
| AF114 30p          | BCY124 97p | IP36A 389p  | 7409 14p   | 74120 125p | 4009 35p    | 7812 60p                  | 1N4007 9p                | .15, .22, .33 uF                         | 7p                        |    |
| AF118 30p          | BCY131 35p | IP41A 69p   | 7410 12p   | 74121 25p  | 4010 35p    | 7815 60p                  | 1N5400 13p               | .47, .68 uF                              | 13p                       |    |
| AF125 27p          | BCY132 35p | IP42A 69p   | 7411 19p   | 74122 33p  | 4011 15p    | 7818 60p                  | 1N5401 14p               | 1 uF                                     | 17p                       |    |
| AF126 27p          | BCY135 38p | IP2955 126p | 7412 17p   | 74123 40p  | 4012 15p    | 7824 60p                  | 1N5402 15p               | 2.2 uF                                   | 28p                       |    |
| AF127 27p          | BCY136 37p | IP3055 64p  | 7413 25p   | 74125 35p  | 4013 35p    | 7905 79p                  | 1N5403 20p               |  |                           |    |
| AF139 37p          | BCY137 38p | ZTX108 14p  | 7414 48p   | 74126 35p  | 4014 60p    | 7912 79p                  |                          |  |                           |    |
| AF186 54p          | BCY138 38p | ZTX109 14p  | 7416 24p   | 74132 50p  | 4015 60p    | 7915 79p                  | <b>BRIDGE RECTIFIERS</b> |  |                           |    |
| AF239 40p          | BCY140 35p | ZTX300 16p  | 7420 12p   | 74141 56p  | 4016 35p    | 7918 79p                  | 1A/50V 22p               | <b>ELECTROLYTIC CAP 25V</b>              | 7p                        |    |
| ASV53 81p          | BF115 25p  | 2N706 13p   | 7421 22p   | 74142 200p | 4017 55p    | 7924 79p                  | 1A/100V 24p              | 1 uF to 47 uF                            | 8p                        |    |
| ASV54 81p          | BF167 29p  | 2N1131 23p  | 7422 18p   | 74145 58p  | 4018 64p    |                           | 1A/200V 27p              | 68 uF, 100 uF                            | 8p                        |    |
| ASV55 69p          | BF173 27p  | 2N1132 23p  | 7427 24p   | 74147 110p | 4020 60p    |                           | 1A/400V 30p              | 150 uF                                   | 9p                        |    |
| BC107 8p           | BF178 34p  | 2N1302 38p  | 7428 28p   | 74148 90p  | 4021 60p    | <b>THYRISTORS</b>         | 2A/50V 34p               | 220 uF                                   | 12p                       |    |
| BC108 8p           | BF179 37p  | 2N1304 54p  | 7430 12p   | 74150 70p  | 4022 55p    | 1A/100V 28p               | 2A/100V 36p              | 330 uF                                   | 12p                       |    |
| BC109 8p           | BF180 37p  | 2N1305 25p  | 7432 23p   | 74151 50p  | 4023 15p    | 1A/200V 38p               | 2A/200V 38p              | 470 uF                                   | 15p                       |    |
| BC113 17p          | BF181 37p  | 2N1306 39p  | 7433 24p   | 74153 50p  | 4024 45p    | 1A/400V 40p               |                          |  |                           |    |
| BC117 20p          | BF182 37p  | 2N1308 40p  | 7437 22p   | 74154 85p  | 4025 15p    | 3A/100V 36p               | <b>OPTO/ DISPLAYS</b>    |  |                           |    |
| BC119 24p          | BF183 37p  | 2N1613 22p  | 7438 22p   | 74155 52p  | 4027 35p    | 3A/200V 38p               | 2N5777 50p               | 4.7 ohms to 1 Mohms                      | 1p                        |    |
| BC140 34p          | BF184 28p  | 2N1711 21p  | 7440 13p   | 74156 51p  | 4028 52p    | 3A/400V 51p               | OCF71 70p                |  |                           |    |
| BC142 27p          | BF185 30p  | 2N1893 44p  | 7441 51p   | 74157 51p  | 4029 60p    |                           | DRP12 70p                | <b>POTENTIOMETERS</b>                    | 25p                       |    |
| BC143 27p          | BF194 13p  | 2N2217 27p  | 7442 42p   | 74160 60p  | 4030 35p    | <b>LINEARS</b>            | DL704 115p               | 1 Kohm to 2 Mohms log/linear             | 58p                       |    |
| BC147 8p           | BF196 13p  | 2N2219 21p  | 7443 74p   | 74161 65p  | 4035 60p    | 710CN 40p                 | DL707 115p               | 5 Kohm to 1 Mohm log switch              |                           |    |
| BC149 8p           | BF197 13p  | 2N2369 16p  | 7444 74p   | 74162 65p  | 4041 57p    | 741-8 22p                 |                          | <b>PRESETS 0.1W horizontal</b>           | 5p.                       |    |
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| BC158 9p           | BF200 36p  | 2N2484 22p  | 7446 55p   | 74164 70p  | 4043 54p    | 748C-8 30p                | Red 9p                   | <b>TRANSFORMERS 240V primary</b>         | 95p                       |    |
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| BC166 8p           | BF257 37p  | 2N2906 22p  | 7448 57p   | 74166 80p  | 4047 95p    | CA301-8 80p               | Green 14p                | 9.0-9V 100mA                             | 250p                      |    |
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| BC186 23p          | BF300 38p  | 2N3704 8p   | 7472 24p   | 74180 80p  | 4071 16p    | CA314-0E 70p              | 16 pin 13p               |  |                           |    |
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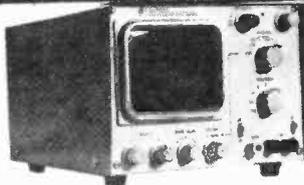
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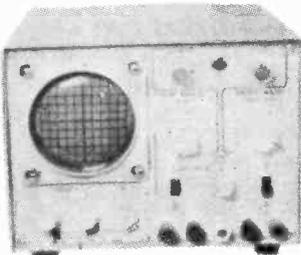
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# CLICK ELIMINATOR

**The Cat Sat On The Mat: or was there one of your favourite records on the mat? Never mind — ETI steps in to rescue your valuable vinyl from those evil clicks and pops.**

EVEN THE MOST fastidious of record collectors must have some records in his collection which during their career have picked up the odd scratch or two. Perhaps your record collection dates back to the time before you obtained that second mortgage, sold the wife or whatever, to get the latest in laser controlled fluid damped, tangential tracking phonograms, sorry record deck, and the previous system has left it's mark on these early platters.

## In The Click Of Time

However the scratches got there, they are bound to be obtrusive on any reasonably Hi-Fi set up and even if you do not qualify for the title Hi-Fi purist — someone who listens, not to the music, but to the defects, real or imagined, in the Hi-Fi chain — the clicks will detract from your enjoyment.

Enter ETI — we can help. The click suppressor described here will remove or greatly reduce the audible transient sounds — nice phrase — resulting from scratches on a record's surface.

## Design Decisions

When designing a click suppressor it is fairly obvious that we have to be able to tell the click from the cacophony as it were. Fortunately a click has several unique characteristics which set it apart from a music signal. For instance it will have very fast attack and delay times — even high frequency percussive sounds will delay slowly, although attack will be fast. A click will also be of a very short duration — again musical sounds are in general of a longer duration.

Once we have spotted our click, it is necessary to remove it. In our case we substitute a short period of silence

— subjectively unnoticeable — in place of the click.

As our click detection circuit requires a finite time in which to operate, we will also have to provide some sort of delay for the music signal within the system. Our circuit, and all the commercially available units, use a CCD delay line to provide this delay. It is the recent availability of this device that has made the click suppressor possible, or rather brought it within the financial reach of the constructor. ▶

**Next month we will be giving the full details for building and setting up the Click Eliminator**



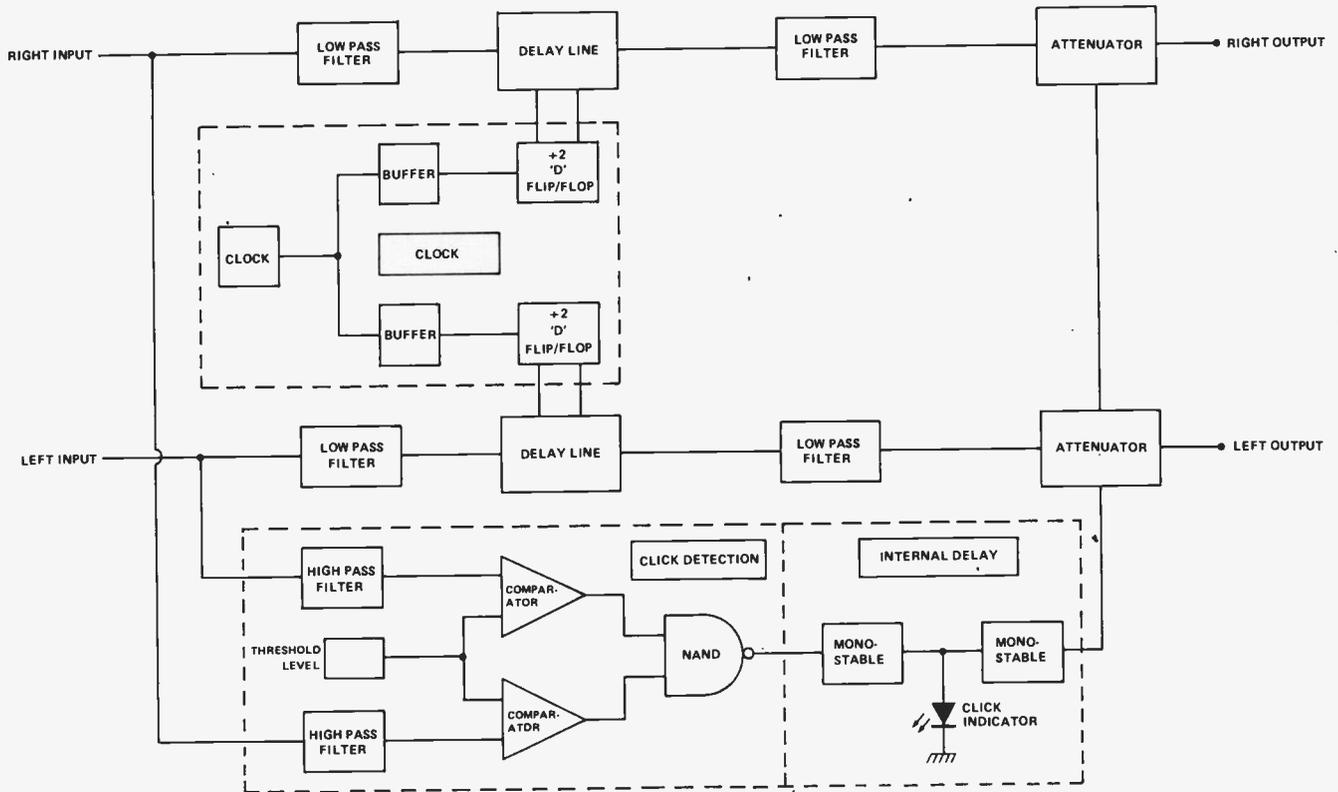


Fig. 1. Block diagram of the ETI click eliminator.

## HOW IT WORKS

Overall operation of the circuit can best be understood by reference to the block diagram shown in fig 1. The signal from each of the inputs is fed both to a delay line, with associated low pass filters, and to the "Click Detection" block. This provides a negative going signal at its output coincident with a click appearing on either input channel.

With the click identified, the next step is to remove it without affecting the subjective quality of the program material. The circuit operates by dramatically attenuating the signal passing through the unit for a brief period of time "Either Side" of the click.

If the attenuation is large enough and it's period accurately synchronised to the occurrence of the click, the effectiveness of the unit is dramatic. The loss of program material during this blanking period which might be thought to be as objectionable as the click itself, seems to produce little subjective disturbance.

It has been shown that periods of attenuation of this nature, up to 10ms, do not unduly disturb the signal, and the 2ms or so necessary to "straddle" a click goes entirely unnoticed.

It is necessary to incorporate a delay line within the circuit as a finite time is necessary for the click detection circuits to operate. The chain of events is shown in fig 2. The click is fed to the input of the delay line and at some time later will emerge from this device where it is passed to the attenuator. Meanwhile the click has been detected and activates two 555 timers acting as monostables. The first provides a click detection indicator for the front panel. As this returns to its stable state, it triggers the second 555. It is this IC that causes the 570 IC to suppress the signal.

By careful selection of the timing components associated with the 555's, the signal is blanked during the time when the click is emerging from the delay line.

A detailed description of the various circuit blocks now follows.

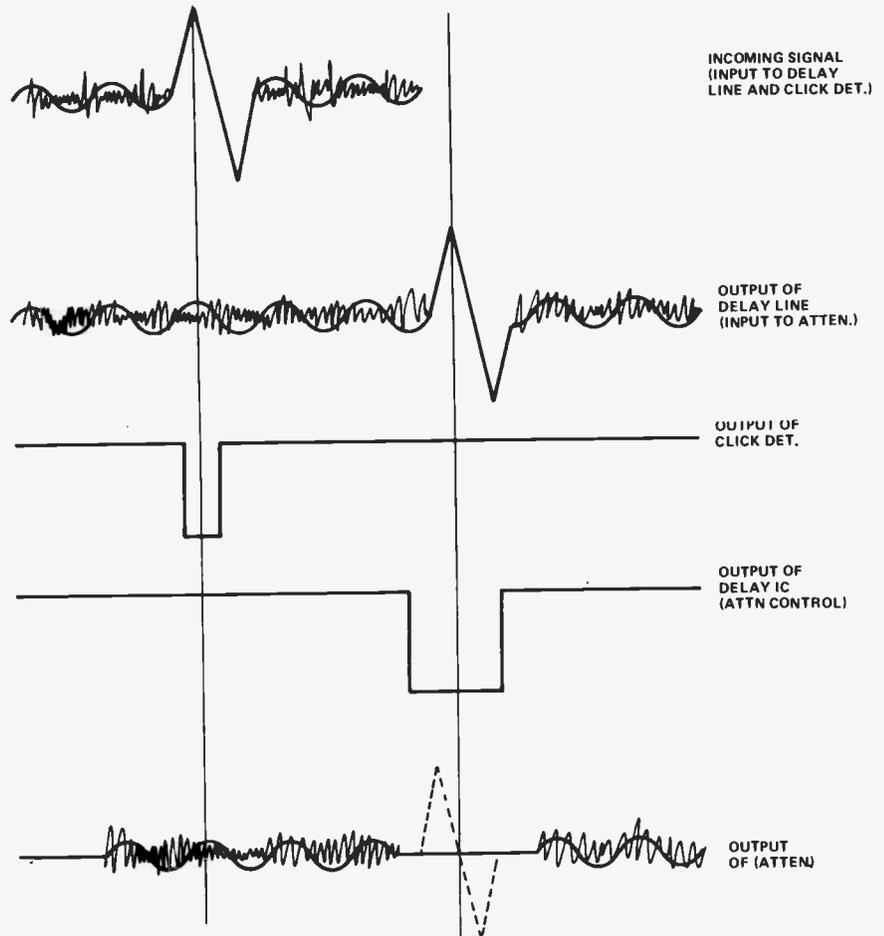
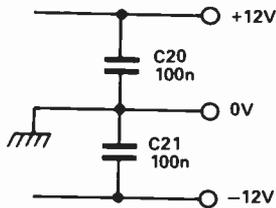
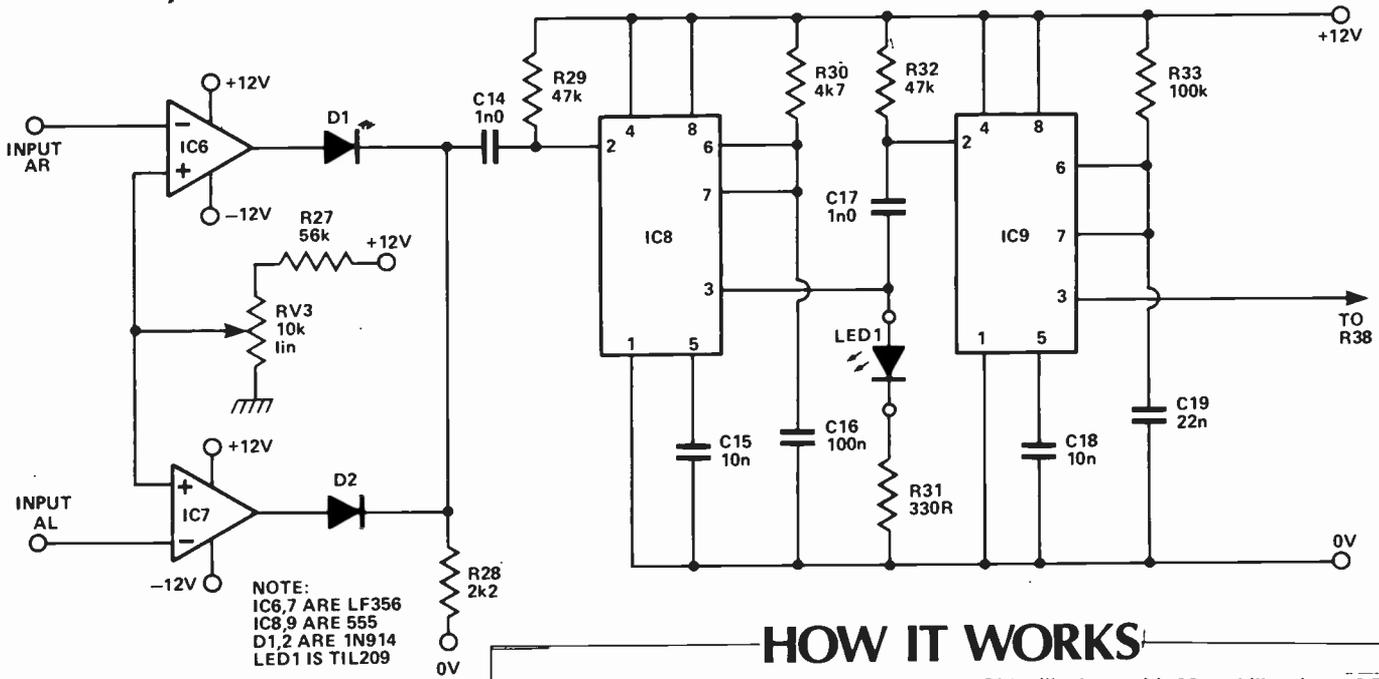


Fig. 2. Above are shown the waveforms that illustrate the action of the circuit when a click has been identified and is to be suppressed.

# PROJECT: Click Eliminator



Second stage of the "click detection" circuitry.

## HOW IT WORKS

### CLICK DETECTOR AND ATTENUATOR CONTROL

Outputs from the low pass filters described above are passed to comparators IC6 and 7. The outputs of these IC's are usually high, but if the level at their inputs exceeds a level (set by RV3) they will go low. This control is set such that the comparator will operate only when a high amplitude click is passed to IC6 and IC7, the click being of greater amplitude than the program material.

Another unique characteristic of a click is that it will appear on both channels simultaneously. We therefore pass the outputs of the comparator IC's to the NAND gate formed by D1, D2, and R28. The junction of these components and C14 will be high unless both the comparator outputs are low.

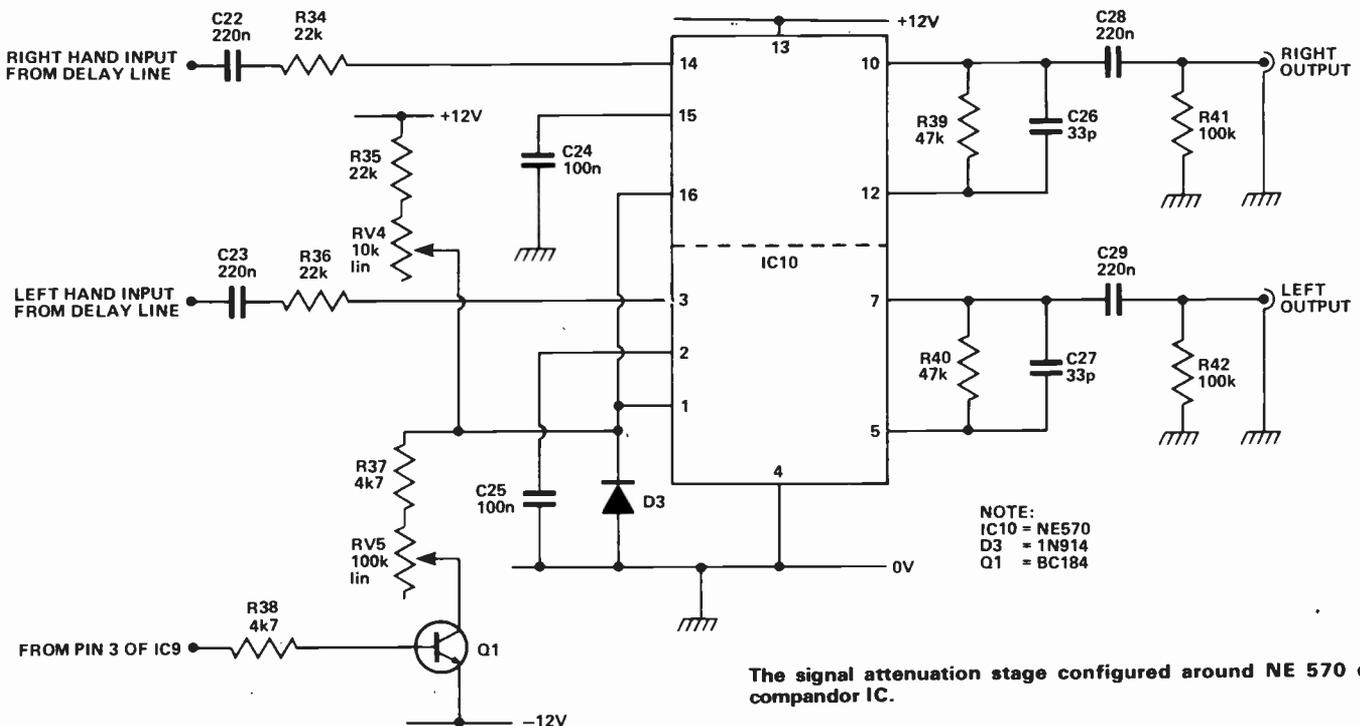
A negative going signal applied to IC8 via

C14 will trigger this IC and illuminate LED 1 the click indicator LED. After X ms the IC's output will return to its stable state and in so doing will trigger IC9. This IC controls the attenuator and will suppress the program material during its astable state.

### ATTENUATOR STAGE

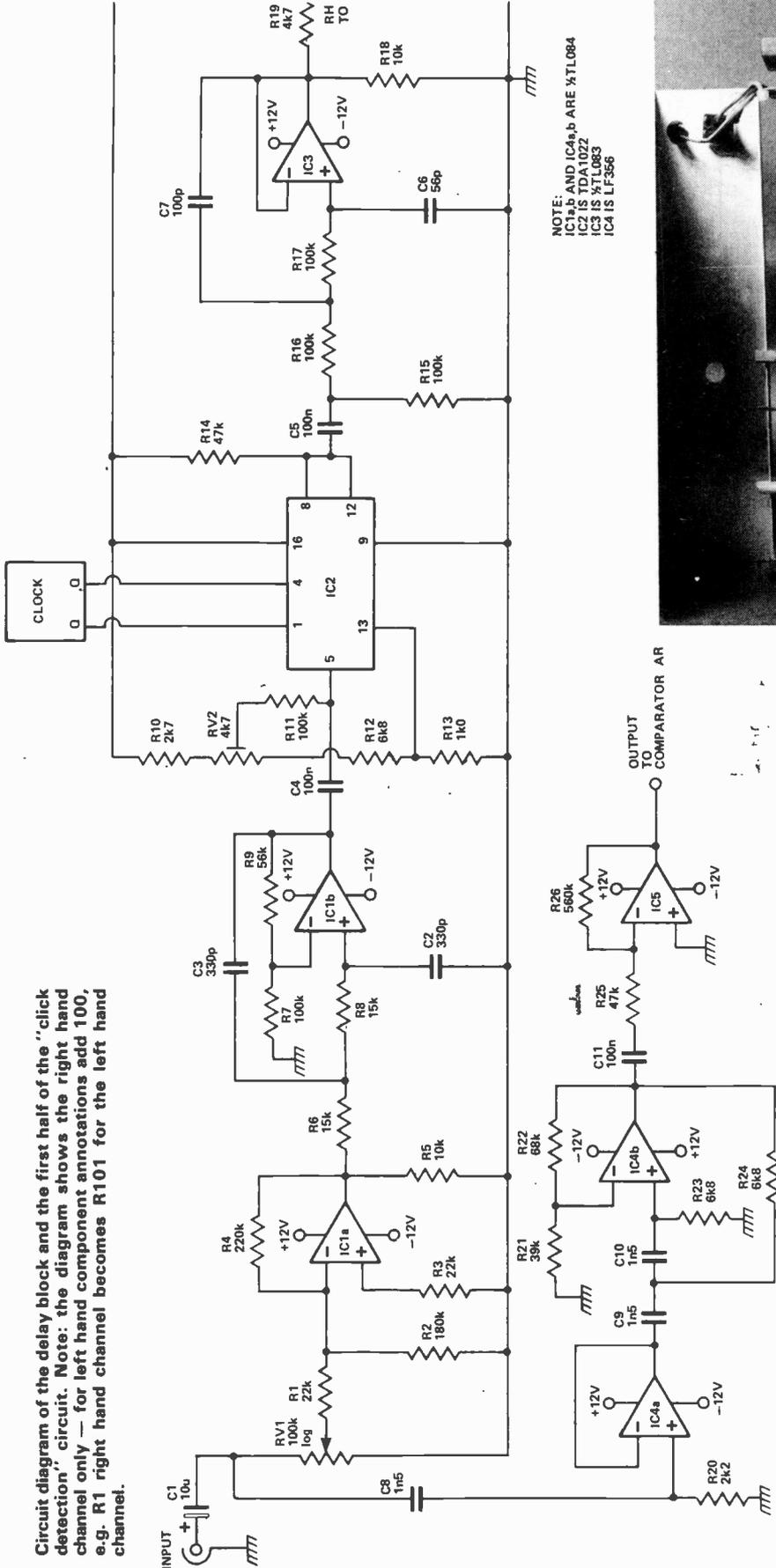
The attenuator is built around an NE570 dual compandor IC (see data sheet Oct 77 p.59). The inputs to the IC are at pins 14 and pin 3, the outputs — with suitable filters — are taken from pins 10 and 7. Gain control is achieved by robbing current from the NE570.

As the input to Q1 is taken high, the device will start to conduct and thus rob the NE570 of current, thus reducing the gain of the amplifier within the device. The control action is set up by RV4.



The signal attenuation stage configured around NE 570 dual compandor IC.

Circuit diagram of the delay block and the first half of the "click detection" circuit. Note: the diagram shows the right hand channel only — for left hand component annotations add 100, e.g. R1 right hand channel becomes R101 for the left hand channel.



## HOW IT WORKS

**DELAY LINE AND FIRST STAGE OF CLICK DETECTOR**

The circuit block shown above forms one channel of the delay line and click detector circuitry (the other channel is identical). The input signal is first passed to IC1a, which is configured as an inverting amplifier. The output from this stage is fed to IC1b and associated components. This stage forms a second order Butterworth filter with an upper 3dB point of about 18kHz. The stage also has a small amount of gain in its pass band.

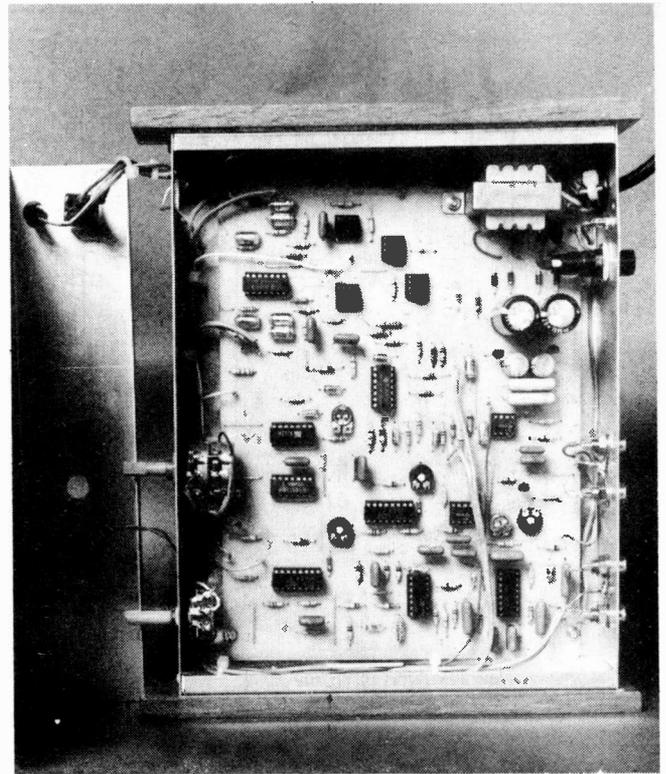
This configuration ideally meets the drive requirements of the delay line, which suffers from an insertion loss, made up for by the passband gain and must have the maximum frequency applied to it limited to, in this case, the audio spectrum of frequencies. The reason for the frequency limit is that the maximum frequency fed to a delay line must not be greater than half the frequency of the

clock signal superimposed on the output that might cause HF overload in subsequent stages.

The input of the delay line is pin 5, the filter section that forms the first stage of the click detector.

A click has a number of unique characteristics, one of which being that it is rich in HF energy — a result of its fast attack and delay time. The effect of passing the music signal through a low pass filter will be to highlight the high energy click amongst the generally low high frequency content of normal program material.

The low pass filter is once again built around a second order Butterworth stage. The signal is passed to this stage after a simple HF filter and buffer (IC4a). The output from the filter is amplified by inverting amplifier IC5 and fed to the second half of the



by B. J. R.

# PARTS LIST

## RESISTORS

R1, 3, 34, 35, 36, 101, 103 22k  
 R2, 102 180k  
 R4, 104 220k  
 R5, 18, 105, 118 10k  
 R6, 8, 106, 108 15k  
 R7, 11, 15, 16, 17 39k  
 R22, 122 68k  
 R26, 126 560k  
 R30, 37 4k7  
 R31 330R

R12, 23, 24, 112, 123, 124 6k8  
 R13, 44, 113 1k0  
 R14, 19, 25, 29, 32, 39, 40, 43, 114, 119, 125 47k  
 R20, 28, 120 2k2  
 R21, 121 39k  
 R22, 122 68k  
 R26, 126 560k  
 R30, 37 4k7  
 R31 330R

## POTENTIOMETERS

RV1 +101 100k log gang  
 RV2, 102 4k7 min. preset  
 RV3 10k  
 RV4, 6 10k min. preset  
 RV5 100k min. preset

## CAPACITORS

C1, 101 10u 16V tantalum  
 C2, 3, 37, 102, 103 330p polystyrene  
 C4, 5, 11, 16, 20 21, 24, 25, 30, 104, 105, 111 100n polyester  
 C6, 106 56p polystyrene  
 C7, 107 100p polystyrene  
 C8, 9, 10, 108, 109, 110 1n5 polystyrene  
 C12, 13, 35, 36 47u 16V electrolytic  
 C14, 17 1n0 polystyrene  
 C15, 18 10n polyester  
 C19 22n polyester  
 C22, 23, 28, 29 220n polyester  
 C26, 27 33p polystyrene  
 C31, 32 1000u .25V electrolytic  
 C33, 34 470n polyester

## SEMICONDUCTORS

IC1, 4 TL084  
 IC2 TDA1022  
 IC3 TL083  
 IC5, 6, 7, 105 LF356  
 IC8, 9 555  
 IC10 NE570  
 IC11 4001  
 IC12 4013  
 IC13 78L12  
 IC14 79L12  
 Q1 BC108  
 D1, 2, 3 1N914  
 D4, 5, 6, 7 1N4001  
 LED1, 2 TTL209

## MISCELLANEOUS

PCB as pattern, case (Maplin B3), phono sockets, fuse (500mA) plus holder, switch (DPDT), knobs to suit, cable etc.

click detector described below.

### CLOCK AND POWER SUPPLY

Pls 1 and 4 of the delay line must be presented with 180° out of phase wave forms. The clock signal is generated by the CMOS oscillator based around IC11a and b, which after buffering is fed to the two D type flip-flops contained within IC12. The Q and Q' outputs of this device provide the required 180° out of phase drive signals.

The power supply is a straightforward design based on two three-terminal regulators.

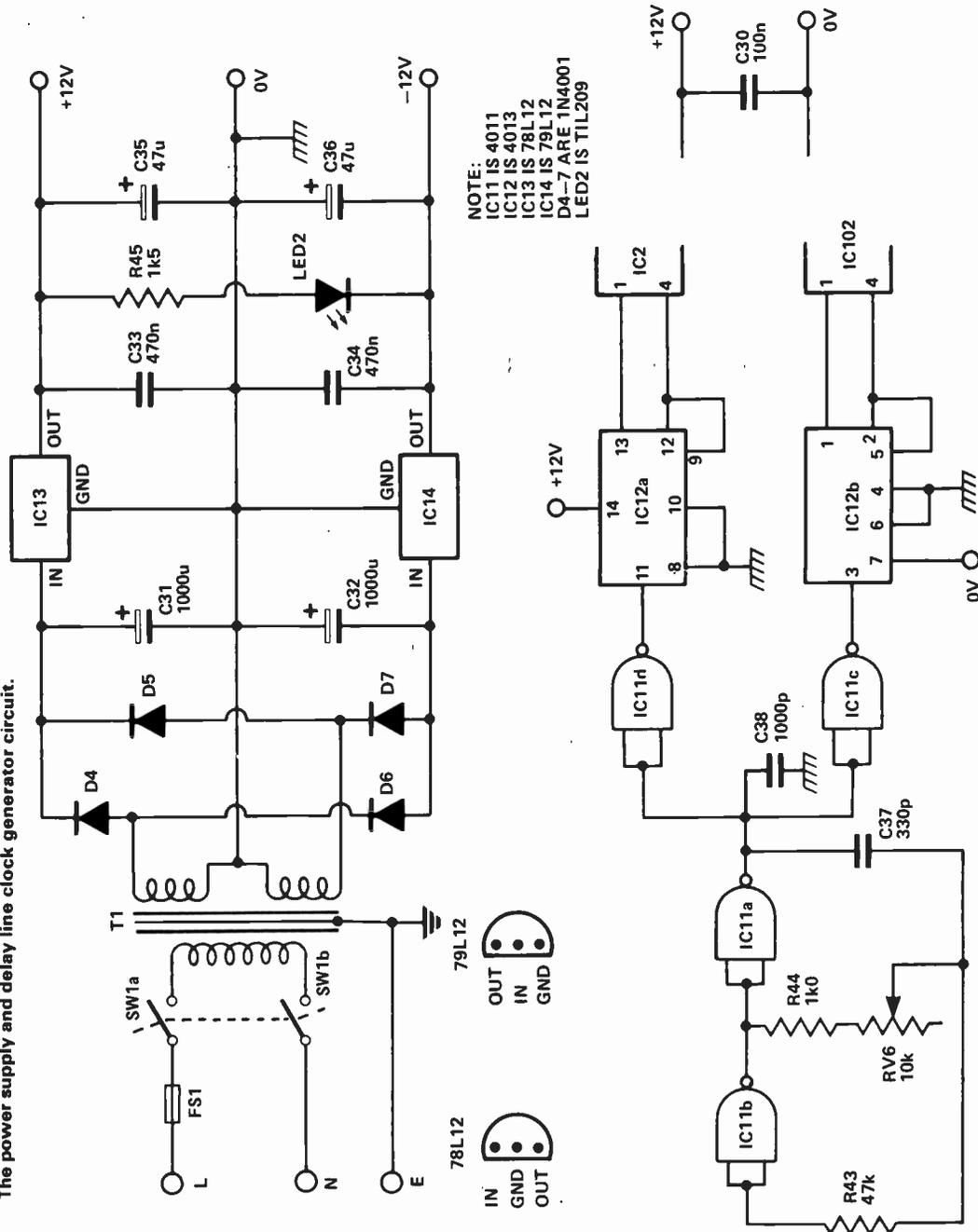
clock signal used in controlling the device. If this precaution is not observed, the result is severe distortion.

The clock drive circuitry is described below.

The input of the delay line is pin 5, the resistor chain R10, R11, R12, R13 and RV2 is to hold pin 13 at 1V0 above ground, this ensures maximum dynamic range in the delay line, and to bias pin 5 for class A operation which minimises distortion.

The output from the delay line is taken, via C5, to another Butterworth filter, this stage being used to remove any high frequency

The power supply and delay line clock generator circuit.



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## LEDs

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BC158 PNP SILICON, 4 for 50p.  
BAY31 Signal Diodes, 10 for 35p.  
741CG RCA OP Amps 4 for £1.00.  
SCRS400V at 3A, stud type, 2 for £1.00.  
TIP2955 Silicon PNP power transistor, 60V at 15A, 90 Watts. Flat pack type, 2 for £1.50.  
GERMANIUM DIODES, approx 30 for 30p.  
1N4148 (1N914) diodes 10 for 25p.

**VALVES**

QQV03/2DA (ex. equipment), £3.00.  
QQV03/10 (ex. equipment), 75p or 2 for £1.20.  
6B86 (ex. equipment), 2 for 50p.  
All the above valves are untested, except for heaters, and no guarantee of percentage of emission is given. Sorry - no returns.

**MULLARD BSA2 85V STABILISER VALVES** (brand new), 70p each or 2 for £1.20.

## ALL BELOW - ADD 8% VAT

**RED LEDs** (Min. type) 5 for 70p

**VIDICON SCAN COILS** (Transistor type, but no data), complete with vidicon base. £6.50 each. Brand new AEI CS108/R MICROWAVE DIODES, up to X-Band, max. noise figure 8.5dB at 9.375GHz. 80p each.

**DIE-CAST BOXES**  
SIZE APPROX.

|                                   |       |
|-----------------------------------|-------|
| 4.3 x 2.3 x 1.2 (111 x 60 x 30mm) | £1.25 |
| 4.8 x 2.3 x 1.5 (121 x 60 x 38mm) | £1.75 |
| 4.8 x 3.8 x 1 (121 x 95 x 25mm)   | £2.10 |
| 4.8 x 3.8 x 2 (121 x 95 x 51mm)   | £2.45 |
| 6.8 x 4.8 x 2 (171 x 121 x 51mm)  | £3.10 |
| 4.8 x 3.8 x 3 (121 x 95 x 76mm)   | £3.50 |
| 6.8 x 4.8 x 4 (171 x 121 x 101mm) | £4.47 |
| 8.8 x 5.8 x 2 (222 x 146 x 51mm)  | £4.25 |
| 10.6 x 6.8 x 2 (273 x 171 x 51mm) | £5.30 |

**SPIRALUX Tools** for Electronics enthusiast... SAE for list.

**4MHz XTAL PACKS** (10 assorted xtals between 4MHz and 5MHz). Our selection only £1.00 pack.

**SOLDER SUCKERS** (Plunger Type). Standard Model, £5.50.  
Skirted Model, £6.00.  
Spare Nozzles, 65p each.

**WELLER WP600** Mains operated temperature control, soldering iron. £15.00.

**SPARE TIPS** (for WP600). Two types available. TYPE C77 (W600) Standard. TYPE AA7 (W600). Finer tip. £1.60 each.

**WELLER TCP2** temperature controlled soldering iron, and PUZ20 power unit (replaces Weller TCP1). Iron + PSU £30.00. Spare tips C77 (standard), or K7 (finer tip) £1.50 each.

**Slider Switches,** 2 pole make and break (or can be used as 1 pole change-over by linking the two centre pins), 4 for 50p.

**PLASTIC PROJECT BOXES,** with screws on lids (in black ABS) with brass inserts.

Type NB1 approx 3 x 2 1/2 x 1 1/2 45p each.  
Type NB2 approx 3 1/2 x 2 1/2 x 1 1/2 55p each.  
Type NB3 approx 4 1/2 x 3 1/2 x 1 1/2 65p each.  
Type NB4 approx 8 1/2 x 5 1/2 x 3 1/2 £1.50 each.

**Slider Switches** 2 pole make and break (or can be used as 1 pole change-over by linking the two centre pins), 4 for 50p.

**OSMOR 10V REED RELAY COILS** (1k ohm coil) to fit 1/2 reeds (not supplied), 2 for 50p.

**HF CHOKES** wound on 1/4 x 1 long ferrites, 4 for 50p.

**VHF CHOKES** wound on 6-hole tubular ferrites, 5 for 40p.

## ALL BELOW - ADD 8% VAT

**DUAL TO18 HEATSINKS** 1 x 1/2 x 1/4 with screw-in clamps, 3 for 50p.

**GLASS BEAD FEEDTHROUGH INSULATORS,** solder-in type, overall dia. 5mm, pack of approx. 50 for 50p.

**LARGE GLASS BEAD FEEDTHROUGH INSULATORS,** as above but 8mm dia. pack of approx. 50 for 70p.

**20V RELAYS,** PCB mounting type, single pole change-over, 35p each.

**10.7MHz SSB XTAL FILTERS** (2.4kHz Bandwidth) Low imp. type, Carrier and unwanted sideband rejection min. -40dB (need 10 69835 & 10.70165 xtals for USB/LSB, NOT SUPPLIED). Size approx. 2 x 1 x 1. £10.00 each.

**LOW PASS FILTERS** (low imp. type), 2.9MHz, small metal encapsulation, size approx. 1 1/2 x 1/4 x 1/4 75p each.

## ALL BELOW - ADD 12 1/2% VAT

**CELESTION B x 5 ELLIPTICAL SPEAKERS** 20 ohm, 3 watts rated, £1.50 each + 12 1/2% VAT.

**VARICAP TUNERS** Mullard type. ELC1043/05. £5.00.

**BSR AUTOCHANGE RECORD PLAYER DECKS** with cue device. 33-45-78 rpm. for 7 10 12 records. Fitted with SC12M Stereo Ceramic cartridge and styl. Brand new, £14.00 + 12 1/2% VAT.

**GARRARD AUTOCHANGE RECORD PLAYER DECKS,** Model 6.300, with cue device. 33-45-78 rpm. for 7 10 12 records. Fitted with KS418 Stereo Ceramic cartridge and styl. Brand new, £16.00 + 12 1/2% VAT.

**TV LINE LINEARITY COILS.** Special offer 10 for £1.00.

**TV SCAN COILS, B/W,** to fit 110 degree tubes. £1.00.

**TV SCIN (pin type),** 4 for 50p.

**3-pin Din Plugs,** 4 for 50p.

**Din 3-pin metal sockets,** 15p each.

**Om Speaker Skts,** 2-pin, 4 for 30p.

**Dublier Electrolytics,** 50µF 450V, 2 for 50p.

**Dublier Electrolytics,** 100µF 275V, 2 for 50p.

**Plessey Electrolytics,** 470µF 63V, 3 for 50p.

**TCC Electrolytics,** 1000µF 30V, 3 for 50p.

**Dublier Electrolytics** 5000µF 35V, 50p each.

**Dublier Electrolytics,** 5000µF 50V, 60p each.

**ITT Electrolytics,** 6800µF 25V, high grade, screw terminals, with mounting clips. 50p each.

**Resistor PKs,** approx 300 pieces 1/2 to 2 watt types mixed values, our selection. £1.00 each.

**A RANGE OF CAPACITORS AVAILABLE AT BARGAIN PRICES. SAE FOR LIST.**

# electronics today

international

What to look for in the February issue: On sale Jan 5th

## TODAYS 100 WATT AMPLIFIER AT YESTERDAYS PRICES

ETI, Britain's most ingenious magazine has come up with a 100W mixer amplifier, with distortion below 0.1% at all signal levels, S/N ratio greater than 80dB, inputs for four sources, including one or two disc inputs as you wish. Somehow or other the design, by Richard Bekker, cost less than £50 to build

complete with metalwork.

A complete kit of parts will be made available and full constructional details will be given next month. The unit is finished to match the five channel light show presented in the December issue of ETI.

Crowds are expected to throng shops early next month — newsagents are preparing.

## BUILD YOUR OWN VCT AND FIND OUT WHAT VCT MEANS

The revolutionary device that will replace the op-amp.

We got fed up waiting for it to be released. We did something about it.

We show you how to construct your very own VCT next month!

Astound your friends!

Confuse your budgie!

Amuse your boss!

No home dare be without its VCT!

ETI brings home the bacon next month!

## VOICE SYNTHESIS CRISIS—

# MACHINES SPEAK OUT!

Panic in the streets! Women and children unsafe! Machines can speak! Prime Minister to go on steam radio tonight! From our undercover agent — Tim Orr — comes full details of the invention that could cause a bigger stir than the

double breasted jacket! Several methods are in use, and a new unit is soon to be available which promises to confound us all.

Speech synthesis is here to stay, and Special Agent Orr is right

there in the forefront reporting back for ETI readers exclusively next month. If you value your sanity you cannot afford to miss this! Thinking people everywhere will be talking about this — don't be left out at the dinner table!

## SLIDING INTO SYNCH?

OK you guys youse asked for this and now youse gonna get it, see? Youse bin ringing and hassle us boys down at ETI to do youse a slide synchroniser so long now dat the broad on de phone is going bananas see? So we gotta give it to youse see? Nuffin personal see? OK?

**NEXT MONTH: COMPUTING TODAY GOES TO 48 PAGES! CAN MANKIND SURVIVE? WILL YOU BYTE OFF MORE THAN WE CAN CHEW? FIND OUT IN COMPUTING TODAY NEXT MONTH!**

## SCILLY SCOPE

Make more use of your tele folks! Here is a unit to make the room pulsate with colour in time to your hi-fi! Hooks into music signals to give an oscilloscope type display on a television screen, in full glorious colour! What will they think of next? Pocket calculating machines?

Articles mentioned here are in an advanced state of preparation but circumstances may affect the final contents.

## Composer goes SCAMP

An amazing revelation came to the attention of the British electronics public today. ETI have plans for an MPU composer! Bach and Handel have been heard to revolve in their graves at 2000 RPM at this stunning news! This audacious machine employs a SC/MP processor and an amazingly low component count. All will be finally revealed in the next issue of ETI, and anyone remotely interested in music, synthesisers or electronics is urged not to miss it! A machine that thinks up and plays its own tunes has to be seen to be believed.

| 7400N AND 74LS00N SERIES TTL |      |     |       | Memory |      |      |      | Micro-PROCESSOR |      |         |     | ELECTROLYTICS |     |           |     |        |     |        |      |      |      |     |     |    |
|------------------------------|------|-----|-------|--------|------|------|------|-----------------|------|---------|-----|---------------|-----|-----------|-----|--------|-----|--------|------|------|------|-----|-----|----|
| 7400                         | .10  | .19 | 7400  | .34    | .60  | 2102 | 1.20 | 4012            | .14  | 4160    | .95 | 8C107         | .09 | BS125     | .25 | ZTX14  | .22 | 2N3709 | .08  | 1F   | 10   | 25  | 40V | 63 |
| 7401                         | .12  | .19 | 7491  | .65    |      | 4013 | .34  | 4161            | .95  | 8C107B  | .10 | 8C107H        | .10 | BY127     | .15 | ZTX31  | .20 | 2N3710 | .07  | 1    | .045 | 05  | 055 | 06 |
| 7402                         | .12  | .19 | 7492  | .36    |      | 4014 | .80  | 4162            | .95  | 8C108   | .09 | 8C108B        | .09 | BY206     | .32 | ZTX50  | .20 | 2N3711 | 2.20 | 2.2  | .045 | 05  | 055 | 06 |
| 7403                         | .12  | .19 | 7493  | .32    | .60  | 4015 | .66  | 4163            | .95  | 8C108L  | .10 | 8C108H        | .10 | BYX10     | .18 | ZTX52  | .18 | 2N3712 | 2.70 | 3.3  | .045 | 05  | 055 | 06 |
| 7404                         | .13  | .23 | 7494  | .80    |      | 4016 | .36  | 4164            | .95  | 8C109   | .09 | 8C109B        | .09 | BYX36-150 | .08 | ZTX54  | .20 | 2N3713 | 1.30 | 4.7  | .045 | 05  | 055 | 06 |
| 7405                         | .13  | .23 | 7495  | .52    | .80  | 4017 | .66  | 4174            | 1.10 | 8C110   | .11 | BZ261C3-      |     | ZTX56     | .25 | 2N3714 | .20 | 6.8    | .045 | 05   | 055  | 06  |     |    |
| 7406                         | .24  |     | 7496  | .50    |      | 4018 | .70  | 4175            | 1.10 | 8C109C  | .12 | E10V          | .16 | ZTX58     | .20 | 2N3715 | .13 | 10     | .05  | 06   | 07   | .09 |     |    |
| 7407                         | .24  |     | 7497  | 1.90   |      | 4019 | .42  | 4194            | 1.10 | 8C142   | .25 | BZ782-2v7-    |     | 2N3716    | .20 | 2N3716 | .12 | 22     | .10  | 12   | 16   | 22  |     |    |
| 7408                         | .14  | .20 | 74100 | .90    |      | 4020 | .75  | 4404            | .88  | 8C143   | .25 | 8C143         | .25 | 2N3717    | .12 | 2N3717 | .12 | 33     | .07  | 08   | 10   | 15  |     |    |
| 74508                        | .40  | .20 | 74104 | .42    |      | 4021 | .75  | 4412            | .25  | 8C147   | .25 | 8C147         | .25 | 2N3718    | .12 | 2N3718 | .12 | 47     | .08  | 10   | 12   | 19  |     |    |
| 7409                         | .14  | .22 | 74105 | .40    |      | 4022 | .68  | 4428            | .68  | 8C148   | .09 | 8C148         | .09 | 2N3719    | .12 | 2N3719 | .12 | 68     | .09  | 12   | 16   | 23  |     |    |
| 7410                         | .12  | .20 | 74107 | .25    | .38  | 4023 | .15  | 4445            | 1.30 | 8C149   | .09 | 8C149         | .09 | 2N3720    | .12 | 2N3720 | .12 | 100    | .10  | 13   | 18   | 26  |     |    |
| 7411                         | .19  | .22 | 74109 | .30    | .38  | 4024 | .60  | 4449            | .28  | 8C157   | .10 | 8C157         | .10 | 2N3721    | .12 | 2N3721 | .12 | 150    | .11  | 15   | 20   | 28  |     |    |
| 7412                         | .15  | .23 | 74110 | .38    |      | 4025 | .15  | 4501            | .17  | 8C158   | .11 | 8C158         | .11 | 2N3722    | .12 | 2N3722 | .12 | 220    | .12  | 16   | 22   | 32  |     |    |
| 7413                         | .25  | .35 | 74111 | .60    |      | 4026 | .90  | 4502            | .80  | 8C159   | .11 | 8C159         | .11 | 2N3723    | .12 | 2N3723 | .12 | 330    | .14  | 18   | 26   | 36  |     |    |
| 7414                         | .50  | .76 | 74112 | .38    |      | 4027 | .36  | 4503            | .62  | 8C171   | .11 | 8C171         | .11 | 2N3724    | .12 | 2N3724 | .12 | 470    | .16  | 20   | 29   | 40  |     |    |
| 7415                         | .24  | .24 | 74113 | .30    | .38  | 4028 | .58  | 4506            | .48  | 8C172B  | .11 | 8C172B        | .11 | 2N3725    | .12 | 2N3725 | .12 | 680    | .10  | 24   | 35   | 48  |     |    |
| 7417                         | .24  |     | 74115 | 1.25   | .38  | 4029 | .66  | 4507            | .48  | 8C172H  | .11 | 8C172H        | .11 | 2N3726    | .12 | 2N3726 | .12 | 1000   | .20  | 29   | 41   | 56  |     |    |
| 7420                         | .12  | .20 | 74118 | .82    |      | 4030 | .35  | 4508            | .21  | 8C178   | .15 | 8C178         | .15 | 2N3727    | .12 | 2N3727 | .12 | 29     | .41  | .56  |      |     |     |    |
| 7421                         | .22  | .22 | 74119 | 1.30   |      | 4031 | .95  | 4511            | .80  | 8C182/L | .11 | 8C182/L       | .11 | 2N3728    | .12 | 2N3728 | .12 | 3.3    | .30  | 48   | 65   | 95  |     |    |
| 7422                         | .18  | .23 | 74120 | .85    |      | 4032 | .95  | 4510            | .80  | 8C183/L | .11 | 8C183/L       | .11 | 2N3729    | .12 | 2N3729 | .12 | 4700   | .47  | 60   | 90   |     |     |    |
| 7423                         | .22  |     | 74121 | .25    |      | 4033 | 1.20 | 4512            | .70  | 8C184/L | .11 | 8C184/L       | .11 | 2N3730    | .12 | 2N3730 | .12 | 6.3v   | .20  | 63v  | 20   |     |     |    |
| 7425                         | .22  |     | 74122 | .42    |      | 4034 | 1.80 | 4513            | 1.60 | 8C208   | .12 | 8C208         | .12 | 2N3731    | .12 | 2N3731 | .12 | 800uf  |      | 8.3v | 20   |     |     |    |
| 7426                         | .24  | .26 | 74123 | .40    | .72  | 4035 | 1.10 | 4514            | 2.50 | 8C212/L | .12 | 8C212/L       | .12 | 2N3732    | .12 | 2N3732 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7427                         | .24  | .28 | 74124 | 1.75   |      | 4036 | 2.80 | 4515            | 2.50 | 8C213/L | .11 | 8C213/L       | .11 | 2N3733    | .12 | 2N3733 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7428                         | .28  | .32 | 74125 | .35    | .46  | 4037 | .90  | 4517            | 3.80 | 8C214/L | .13 | 8C214/L       | .13 | 2N3734    | .12 | 2N3734 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7430                         | .12  | .20 | 74126 | .35    | .46  | 4038 | .90  | 4518            | .70  | 8C237B  | .16 | 8C237B        | .16 | 2N3735    | .12 | 2N3735 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 74530                        | .90  |     | 74128 | .65    |      | 4039 | 2.50 | 4519            | .42  | 8C238   | .15 | 8C238         | .15 | 2N3736    | .12 | 2N3736 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7432                         | .23  | .24 | 74130 | .90    |      | 4040 | .70  | 4520            | .70  | 8C272   | .13 | 8C272         | .13 | 2N3737    | .12 | 2N3737 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7433                         | .23  |     | 74132 | .50    | .78  | 4041 | .75  | 4521            | 1.80 | 8C278   | .13 | 8C278         | .13 | 2N3738    | .12 | 2N3738 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7437                         | .22  | .25 | 74134 | .36    |      | 4042 | .58  | 4522            | .85  | 8C282   | .11 | 8C282         | .11 | 2N3739    | .12 | 2N3739 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7438                         | .22  | .25 | 74135 | .65    |      | 4043 | .60  | 4523            | .85  | 8C287   | .11 | 8C287         | .11 | 2N3740    | .12 | 2N3740 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7440                         | .13  | .25 | 74136 | .55    | .38  | 4044 | .90  | 4524            | 1.10 | 8C290   | .11 | 8C290         | .11 | 2N3741    | .12 | 2N3741 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7441                         | .90  |     | 74137 | .80    |      | 4045 | 1.20 | 4528            | .95  | 8C292   | .11 | 8C292         | .11 | 2N3742    | .12 | 2N3742 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7442                         | .43  |     | 74138 | .60    |      | 4046 | .99  | 4529            | 1.10 | 8C297   | .15 | 8C297         | .15 | 2N3743    | .12 | 2N3743 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7443                         | .75  |     | 74139 | .60    |      | 4047 | .90  | 4530            | .90  | 8C311   | .15 | 8C311         | .15 | 2N3744    | .12 | 2N3744 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7444                         | .74  |     | 74141 | .56    |      | 4048 | .45  | 4531            | .80  | 8C312   | .15 | 8C312         | .15 | 2N3745    | .12 | 2N3745 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7445                         | .55  |     | 74142 | 2.00   |      | 4049 | .36  | 4532            | 1.05 | 8C315   | .10 | 8C315         | .10 | 2N3746    | .12 | 2N3746 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7446                         | .62  |     | 74143 | 2.50   |      | 4050 | .35  | 4534            | 4.50 | 8C317   | .10 | 8C317         | .10 | 2N3747    | .12 | 2N3747 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7447                         | .50  | .80 | 74144 | 2.50   |      | 4051 | .58  | 4536            | 3.00 | 8C321   | .13 | 8C321         | .13 | 2N3748    | .12 | 2N3748 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7448                         | .50  | .95 | 74145 | .58    |      | 4052 | .58  | 4539            | .78  | 8C324   | .11 | 8C324         | .11 | 2N3749    | .12 | 2N3749 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7449                         | 1.00 |     | 74147 | 1.10   |      | 4053 | 1.00 | 4541            | 1.00 | 8C328   | .11 | 8C328         | .11 | 2N3750    | .12 | 2N3750 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7450                         | .13  |     | 74148 | .90    |      | 4054 | 1.00 | 4543            | 1.28 | 8C333   | .80 | 8C333         | .80 | 2N3751    | .12 | 2N3751 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7451                         | .13  | .21 | 74150 | .70    |      | 4055 | .80  | 4549            | 3.25 | 8C335   | .40 | 8C335         | .40 | 2N3752    | .12 | 2N3752 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7453                         | .13  |     | 74151 | .50    | .65  | 4056 | .20  | 4555            | .82  | 8C339   | .10 | 8C339         | .10 | 2N3753    | .12 | 2N3753 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7454                         | .13  | .18 | 74153 | .50    | .55  | 4057 | .16  | 4558            | 3.65 | 8C356   | .24 | 8C356         | .24 | 2N3754    | .12 | 2N3754 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7455                         | .13  | .18 | 74154 | .85    | 1.20 | 4058 | .16  | 4559            | 1.55 | 8C358   | .23 | 8C358         | .23 | 2N3755    | .12 | 2N3755 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7456                         | .13  |     | 74155 | .52    | .96  | 4059 | .34  | 4562            | 4.45 | 8C360   | .20 | 8C360         | .20 | 2N3756    | .12 | 2N3756 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7457                         | .13  |     | 74156 | .52    | .96  | 4060 | .14  | 4565            | .80  | 8C362   | .20 | 8C362         | .20 | 2N3757    | .12 | 2N3757 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7470                         | .28  |     | 74157 | .52    | .96  | 4061 | .16  | 4569            | 1.55 | 8C368   | .24 | 8C368         | .24 | 2N3758    | .12 | 2N3758 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7472                         | .24  |     | 74157 | .53    | .55  | 4062 | .14  | 4593            | .38  | 8C371   | .18 | 8C371         | .18 | 2N3759    | .12 | 2N3759 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7473                         | .25  | .34 | 74158 | .58    | .60  | 4063 | .14  | 4594            | 1.50 | 8C375   | .18 | 8C375         | .18 | 2N3760    | .12 | 2N3760 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7474                         | .25  | .35 | 74159 | 2.00   |      | 4064 | .16  | 4599            | 1.00 | 8C379   | .18 | 8C379         | .18 | 2N3761    | .12 | 2N3761 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 74874                        | .90  |     | 74160 | .60    | 1.20 | 4065 | .64  | 4596            | .90  | 8C380   | .16 | 8C380         | .16 | 2N3762    | .12 | 2N3762 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7475                         | .32  | .40 | 74161 | .65    | .75  | 4066 | .64  | 4599            | .90  | 8C382   | .16 | 8C382         | .16 | 2N3763    | .12 | 2N3763 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7476                         | .28  | .34 | 74162 | .65    | 1.20 | 4067 | .13  | 4599            | 1.00 | 8C383   | .16 | 8C383         | .16 | 2N3764    | .12 | 2N3764 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
| 7478                         | .38  |     | 74163 | .65    | .75  | 4068 | .64  | 4599            | .90  | 8C384   | .16 | 8C384         | .16 | 2N3765    | .12 | 2N3765 | .12 | 6.3v   | .20  | 6.3v | 20   |     |     |    |
| 7480                         | .45  |     | 74164 | .70    | 1.10 | 4069 | .34  | 4597            | 3.25 | 8C385   | .16 | 8C385         | .16 | 2N3766    | .12 | 2N3766 | .12 | 4700uf |      | 6.3v | 20   |     |     |    |
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# BORIS IN CHECK

There are quite a few chess machines lying around the shops these days, and this one has a reputation for being one of the best. Armed with his "Best of Spassky Volume 2" Ron Harris went to check it out.

BORIS is a multi-level chess machine with the disconcerting ability to comment on its opponent's (your) moves. The level of its analysis is set by the user who determines how long BORIS may consider its reply. Thus a tyro may set the machine to minimum time to begin with, and steadily advance the machine as he improves.

## Present Arms

The presentation of the machine is excellent. The electronics consist of an F8 based system accessed by a 16 (multi-function) key array and interfaced to the outside world by a display consisting of eight alpha numeric devices. These are packed into a very smart wooden case which also holds the mains adaptor and chess pieces. A board is also provided, but is of a standard which suggests it is included out of duty rather than devotion. Alas, the chess pieces fall into this lamentable category also, but improvements are now being made by the importers, and the quality of replacements is much higher.

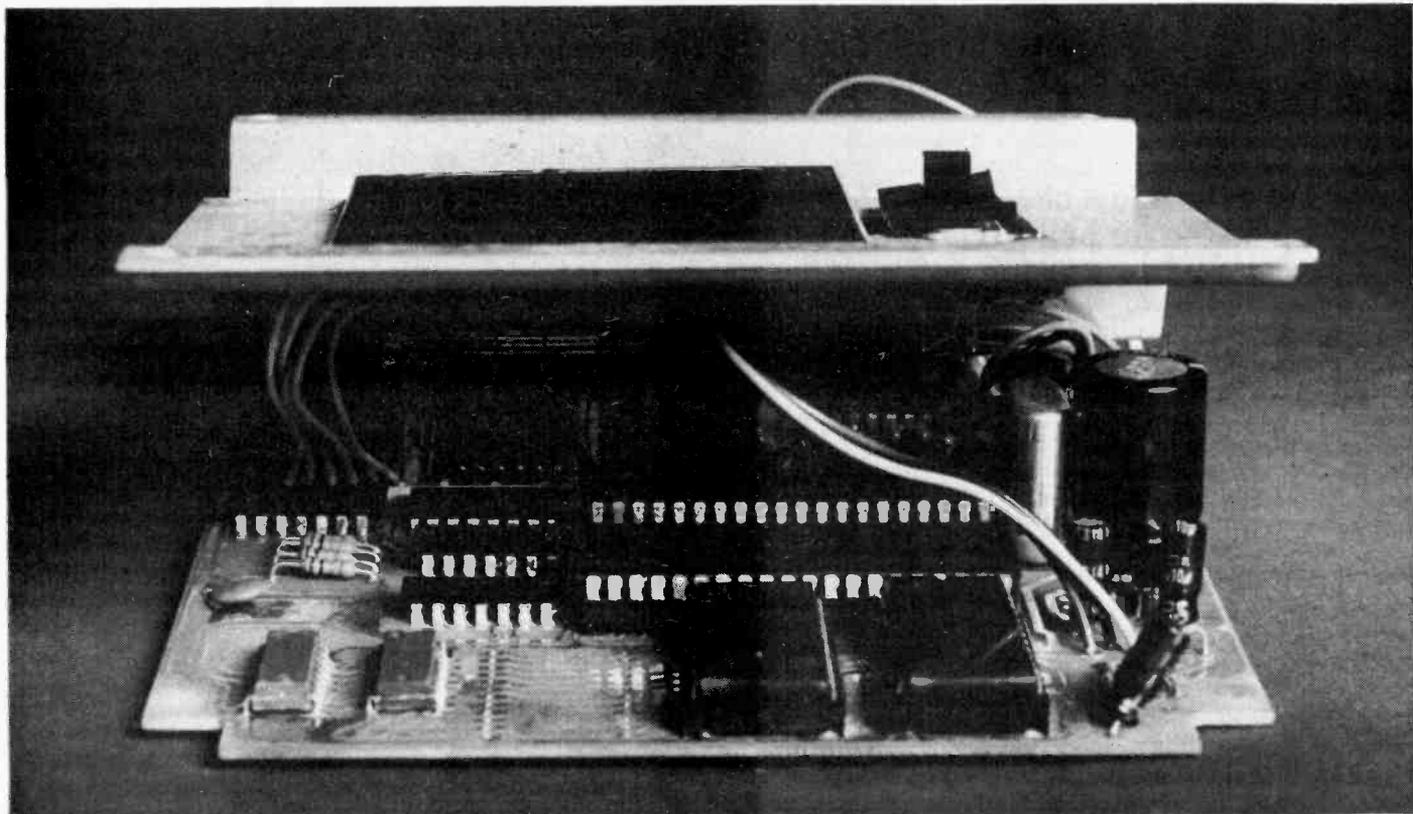
On the two units we were able to examine the mains adaptor terminates in a two pin American 'hi-fi' type of plug — which now fails BS of course. This is moulded into the adaptor body and makes life very awkward for the buyer. At first glance there is no way of getting mains into BORIS aside from wrapping wires around them. DANGEROUS. The importers *must* look into this very quickly. We are assured they are doing so — let us hope.

In the meanwhile I would advise purchasers to take a trip down to good ole Woolies and make off with one of their shaving adaptor plugs, into which BORIS's adaptor will neatly plug. 240V AC is a poor opening gambit in any game.

## Getting Rooked . . . and Pawned And . . .

Using this machine is both simple and interesting. The keyboard sets up your move on the display — which is also showing elapsed time — and the ENTRY key presents it to BORIS for reply. ▶





**BORIS exposed to the world!**

Once he's thinking about, the display flashes at 1 Hz, the timer counts down the time allotted to BORIS and the various moves he's cogitating appear on the display, settling finally at time 00 seconds. The display then counts down *your* time — but there's no penalty for not playing inside the time limits you've imposed on BORIS.

If for some reason (like cheating) you wish to alter the board at any time during a game, pressing RANK displays the contents of each row of the board using a very ingenious symbols set. The keyboard now creates or destroys pieces as required. Korchnoi could have done with *that* in his armoury. This makes correcting errors very easy.

Use of the RANK key while BORIS is having a think lets you watch the pieces moving around in his head(!?). Hypnotic.

### Alpha-numeric Big Mouth

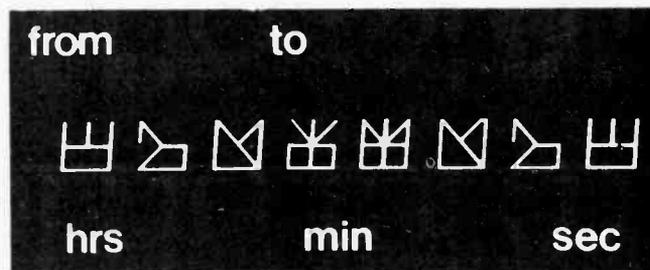
Undoubtedly the first thing to impress about BORIS has nothing to do with his chess abilities. It's his big mouth. Exactly how many comments his PROMs contains is anyone's guess — the importers Optimisation aren't saying — but we counted 47 in two evenings of chess, and I don't think we got them all!

The comments appear in the eight displays and are clocked along right to left at about 2Hz. At any position on the board the program limits BORIS to a shortlist of appropriate comments, and a 'random' choice is made amongst them — or indeed not to comment at all. Saying nothing is the most likely choice of all, which means that the sayings do not always appear and so do not become boring with repetition.

### Play It Again BORIS

Once in play BORIS is a fair match for most people. On its basic level the machine plays a good beginner's game, and will find most things you leave lying around the board. Responses differ sufficiently even at this level to make 'psyching out' difficult. The biggest drawback of BORIS's chess is his passion for exchanging pieces.

Being cowards we started at this level to see what he could do. The first comment we got was 'AWFUL' to our opening move. Frightening! From here we kept increasing the time BORIS had to think about his answers. At five minutes he was winning consistently, and at two it's a long, long struggle to get him to lie down and die!



The symbols BORIS uses to identify the chess pieces. Shown here is the back rank of the white men. The black appear upside down so you can tell which men are which. Pawns appear as triangles.

## FEATURE: Boris

Below: BORIS in play at the computer chess championship recently. He finished second to a private program.



We're only average chess players ourselves and so passed the infernal pawn-pusher onto a club standard player to get his comments.

On the longer response times, five minutes upwards, he considered BORIS a good opponent — and of course wouldn't admit how often he'd lost! Certainly everyone who had a game against him considered BORIS entertaining — the comments really do seem appropriate at times.

For example, in the middle of a game with BORIS hard pressed and the telephone ringing — I NEED LESS NOISE appears! Coincidence but fun all the same. One move away from being checkmated and he asks READY TO RESIGN? The classic must be after losing a queen to a knight fork — WHOOPS!

### Conclusions

All in all then BORIS can be confidently recommended to anyone interested in the game of chess. It can play a good game, and entertain while doing so. It is very difficult indeed *not* to think of the machine containing an (evil) little elf — a grand master type elf — plotting against your every manoeuvre, and unleashing sarcastic comments where possible. A definite winner. **ETI**

Our thanks to Kramer and Co for their assistance in the preparation of this article — they lent us a BORIS! (They also supply to the public!)

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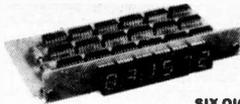
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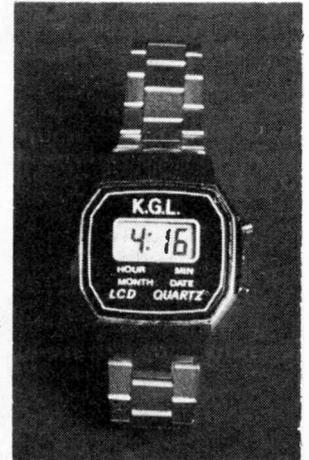
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IT HAS BEEN some time now since the launch of the V15 IV from Shure, and by now I hope all the fuss has died down. Never has a product been rumoured to appear for so long, and met with such polarised comment when it did. In the meanwhile since the release the cartridge has slowly gained ground, and now would appear to be highly regarded in all but the most partisan anti-moving-magnet circles.

## Changes By Design

There is a lot in this design to interest the engineer, so let's consider that aspect first. The criteria to be met were to produce a cartridge which performed as close to perfection as possible under ideal conditions, and which went some way to creating those conditions.

The ambition I applaud!

Naturally these days computer analysis of just about anything numerically expressible was undertaken — and quite right too! Everything down to body size and mass were considered, and then more models set up to attempt to blend the whole design successfully. (I don't think it would be an outrageous suggestion to make that the SME Series III was used as the optimum arm in all these cavortings.

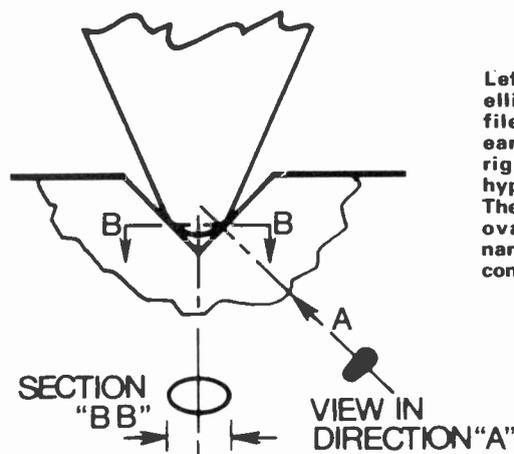
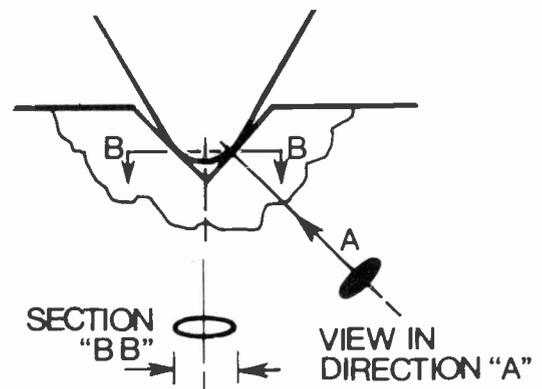
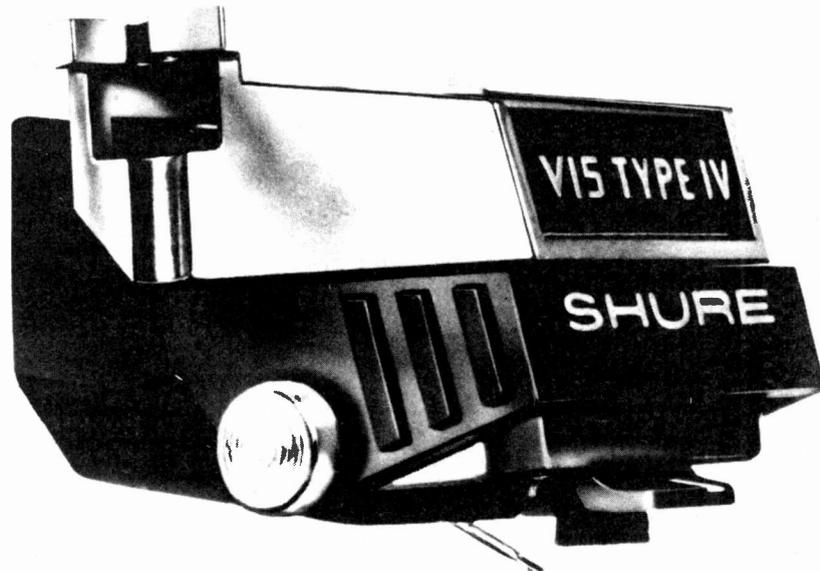
The new features to come out of all this are a dynamic stabiliser — and it's *not* just a brush, a new cantilever assembly, a new stylus shape, and a static reduction system. In addition the effective mass of the dynamic system has been lowered significantly.

## Tipped For Shape

Shure have decided, somewhat bravely, to go it alone and produce a new stylus profile. The reason is they wanted lower distortion but without sacrifice of low wear and trackability in the process.

Any design for a stylus *must* include consideration of such factors as the actual groove itself, tip mass, manufacturing cost, record wear etc etc.

As you can see from the diagram the end result of Shures endeavours is a long contact profile, basically a hyperbola from the front, termed a hyperelliptical design. Its actual contact radius is around 38 microns, while its tracing radius (parallel to groove tangent) is smaller than other types. The compromise does appear to offer advantage over other types, right enough.



Left: a conventional elliptical stylus profile, as used in the earlier V15/III, and right, the new hyperelliptical profile. The "footprint" (black oval) is longer and narrower than in the conventional profile.

## Magnetic Heart

The cantilever assembly is always the first section to come under scrutiny whenever a cartridge is to be improved, (just shows what improvements *could* be made if you ask me!) and it has not escaped this time.

After much playing with computers and trading off advantages against system requirements, Shure put themselves some prototypes together and carted them off for listening tests. Measurements, mathematical models and ears later a telescopic two element design emerged as the overall best solution, and was duly adopted.

Part of the reason for this is vibration control — presumably to suppress resonances excited by dynamic stresses — and this is assisted by an elastomer damping device. The earlier M24 featured something like this, but not so sophisticated apparently.

The magnet itself is of a new type, of lower mass but higher strength than its predecessors, allowing the cantilever unit mass as a whole to be lower. Taken together the improvements to the system are claimed to provide better high frequency tracking ability, and the shifting of the HF resonance to beyond 20 kHz.

## Brush Up On Damping

Now down to the obvious bit — which I had to do last just to keep you reading. Static on records can be blamed for most of the ills besetting disc reproduction as it now stands. It attracts dust — and holds it — leading to quicker wear of both disc and stylus and higher replay noise.

There are umpteen devices on the market for clearing static charge, most of which resemble gas lighters. But Shure make the valid point that unless you know what polarity the charge is you're trying to clear, you've a 50-50 chance of making it worse by pumping ions at it.

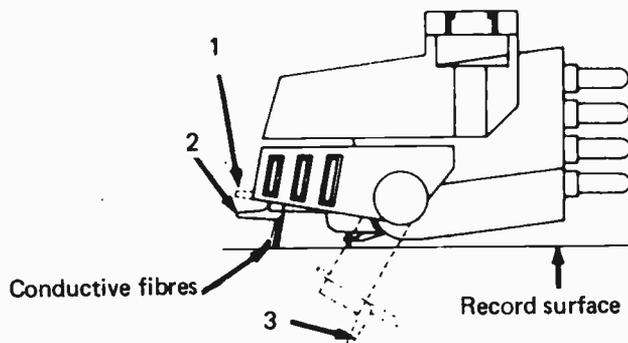
Another nasty well-known to LPs of all age groups is the warp. Warps come free with most records these days and provide such delights as variation in tracking angle, mis-tracking due to effective reduction of applied tracing force and overall disruption of the ideal conditions in which cartridges like to operate.

Damping applied at the arm pivots can help with this, but represent a compromise at best. It is better to have the control as close to the tip as possible. The dynamic stabiliser is designed to do exactly that. The carbon fibre brush is mounted to ride just ahead of the stylus, and is equipped with viscous damped pivots. These are designed to absorb the shock produced by a warp, be it gradual or sudden. The optimum distance between cartridge body and record is thus preserved.

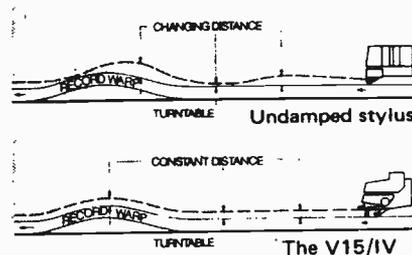
## Bristling With Pride

That brush is made up of about 10,000 carbon fibre bristles, ten of which would fit nicely into a record groove. Since it is carbon fibre it is conductive and can leak static charges to system earth since it is connected to one channel earth. Shure's research has indicated too that local static charges can increase tracking force by attracting the cartridge to the LP!

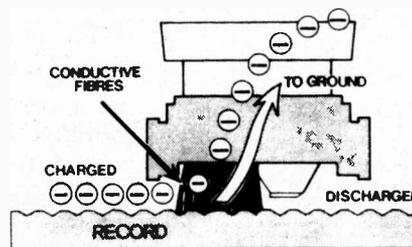
Sounds logical once someone tells you doesn't it? The brush does a good job shifting dust and muck out of the way too!



The outrigger carbon-fibre brush may be set in any one of three positions: 1) in the "Up" position. 2) the dynamic stabiliser in its operating position 3) set down as a guard.



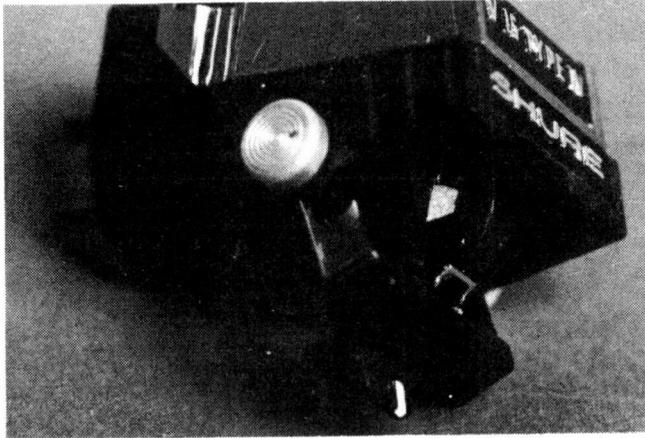
The V15 Type IV's brush with damped pivot is said to aid the tracking of warped discs by matching stylus movement more closely to the motion of the arm



The carbon-fibre brush is in continuous contact with one of the earth pins and leaks static charges to earth.

## Having A Fit

Setting up the V15 was very simple indeed. It's a shame to have to take it out of the box at all unfortunately, the packaging is superb indeed! Holding the body into the arm is done by screwing into a small metal block tapped for the bolts. Simpler than using fiddly nuts — if you'll pardon the expression — but probably more massive.



A close-up view of the stabiliser fitted to the V15 Mk-4, reposing in its guard position. The white line tells you where to line up the stylus when at play!

Because of the stabiliser, the stylus sees 0.5g less than is applied to the arm as a whole. This means that to get 1g tracking force, you set 1.5g. It can look confusing at first, and don't forget later and clip up the stabiliser, else the cantilever gets the lot!

### Tracing Class

After brief experiments, all our tests were conducted with 1g applied to the stylus, as the V15 tracked anything at this weight, regardless of how torturous we made our torture tracks. I failed to catch it out even once. Foiled again. One to Shure.

In contrast to the Mk3 the new model is sensibly specified for capacitive loading, and is apparently as insensitive to these things as it can be. Using a Sony TA-88 preamp enabled me to vary the loading while the cartridge was playing — a reviewer's delight! No adverse effects can be expected in normal use. Noise seems to be reduced too.

The stabiliser does offer real benefits as it definitely aids tracking and makes the system as a whole very tolerant of record 'flatness'. I tried the cartridge with and without pivot damping on the SME and would suggest it be used *with* damping — it somehow gains confidence that way!

### Sound Stuff?

This is the bit where I lose some 'musical' friends no doubt, because whatever anyone may have said amid the initial rash of reviews you will not find a cartridge better at information retrieval than the V15 IV. Its sound is incredibly detailed, and free from audible vices. It has a nice confidence about it altogether, and did not mis tracks — or mis-anything — even once.

The sound has an overall smoothness that is perhaps its most 'nameable' feature. The bass quality is good, although I have heard better. In the mid-range and treble the sound stands forward towards the listener presenting a good stable image with all the detail you could wish for, with no trace of hardness or brightness whatsoever.

### Conclusions

So there it is — interesting and worth the wait for its appearance. Whether you like the sound of the V15 or not only you can tell, but if you're considering spending around £70 on a cartridge you'd be ill-advised to miss listening to it.

### Main Trouble

One of the most oft repeated queries to Audiophile concerns the problem of mains borne clicks and pops appearing out of loudspeakers.

Unfortunately there is no immediate overall solution. The first thing to try is to move either the hi-fi or the appliance — usually a fridge — causing the clicks to another outlet.

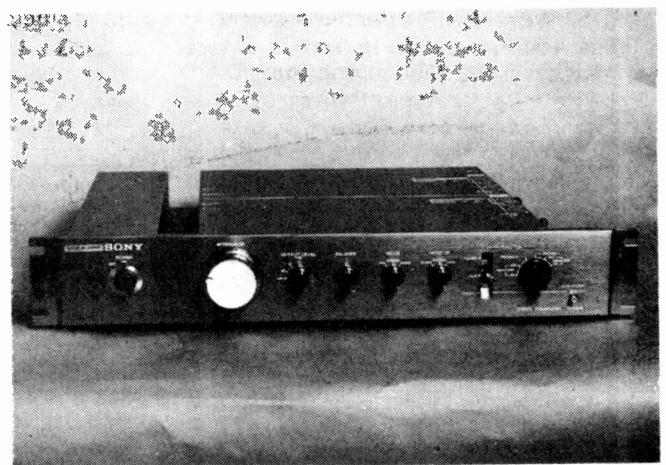
If this doesn't work then there are several suppressors on the market, at varying prices, to deal with the trouble. The most expensive is the QED unit at about £10. It does work in most cases, but no more so than some others.

The cheapest such unit available is probably the RS mains suppressor. Your local component stockist should be able to order this for you, and fitting it is pretty simple. Its input comes from the mains, and its output feeds the hi-fi in question.

### Otherwise

If none of this works then pretty obviously your problem is not mains borne. For radiated problems there's not much you can do except move things around. This is pretty rare though.

### Change Of Load



Above is the Sony TA88E preamp I mentioned a couple of months ago. Next month I'll be going through the circuits of this device in detail, as it represents a job done very very properly. At £699 so it should. The effect of all this engineering on the sound proved to be interesting too.

ETI



# A TECHNICAL MEMORANDUM

By Simian

DURING THE LAST FEW weeks some valuable research work has been incorporated into BSI and MIL standards, and this will greatly ease the specification of equipment. These standards help to combat a hitherto neglected environmental hazard; the users of equipment. A range of Standard Idiots (SIDs) has been defined, and these will be useful additions to any development laboratory.

## Using Standard Idiots

Standard Idiots are useful both for acceptance testing of incoming equipment, and for developing foolproof electronics. The latter is of particular value to manufacturers producing consumer goods. In general the technique of using SIDs is very simple: it consists merely of letting them come into contact with the equipment to be tested. Any flaws will be quickly shown up.

SIDs locate ergonomic faults very rapidly. It is instructive to watch them at work sometimes. If something is weak, they will break it; if no-one in their *right* minds would dry-off a poodle in a microwave oven, they will do just that.

Almost all old-style quality-control testing can be abolished. If SIDs are allowed to get at all products before they leave the factory, it will be found that only the perfect get through. This reduces the number of complaints received from users, but the cost of disposing of the rejects (in bulk) can be rather high.

## Types of Standard Idiot

Several specialist schools have been set up to train SIDs since these students are not well received at normal colleges. The coursework is intensive, and there are rigorous examinations to maintain standards. Over 600 people have received a Diploma in Idiocy (Dip. I) to date.

Many people have been found to have a natural aptitude for this work.

There are various grades of SID, ranging from the merely incompetent to those capable of sinking the Titanic, and there are many specialist fields:

(1) The 'non-technical' person (BS 91000-FOOL). This type normally panics when faced with more than two control knobs simultaneously. She (sometimes he) always mis-tunes radios, and would be hard put to it to recognise the difference between a watch and an oil refinery.

(2) Fiddler, or fidgeter (MIL-ID-99436/010). This

type is rapidly becoming an industry standard; the real world is full of them. If, for example, there is a switch controlling a lamp, the fiddler will flick it on and off for hours until either it breaks, or he spots something more exciting to play with. He will also use calculators to divide numbers by zero or to find  $\arcsin(-10)$ .

(3) The Ph.D (MIL-ID-12345/678) never reads instruction manuals. 'Of course, it's obvious that this piece of equipment works like so . . .' It is only when clouds of blue smoke issue from a new £2,000 oscilloscope that he scuttles back to his desk to read in the unused handbook that this model is for 110V, not 240V.

Ph.Ds are often quite intelligent.

(4) Dismantler. A member of this species is guaranteed to dismember any piece of equipment which he owns or uses. However, it is very rare for the article ever to be re-assembled. (They are usually foxed by the new child-proof pill boxes).

There are a few other specialist categories: for example, the 'jonah', whose mere presence in a room is enough to make clocks stop and television sets neurotic; or the Standard Irishman with fourteen fingers.

## Disadvantages

One major problem with SIDs is that of storage when they are not in use. Obviously they cannot be left to roam freely around the lab.! Normal work under these conditions is difficult. Even when they are stored in cupboards the voluble and plaintive cries of 'let me out' are disruptive.

There is another hazard which should not be overlooked: there have been a few unfortunate cases where standard idiots have been mistaken for engineers. Most of the companies where this has happened have now ceased trading.

## Conclusions

Standard idiots, in their present form, can be useful development tools, but there are associated hazards; on no account should they be left alone to amuse themselves. The new specifications are a major advance in a naturally chaotic field and standard idiots are adding a new dimension to destructive testing. This technological advance is helping to provide jobs for those people whose natural talents previously made them unemployable.

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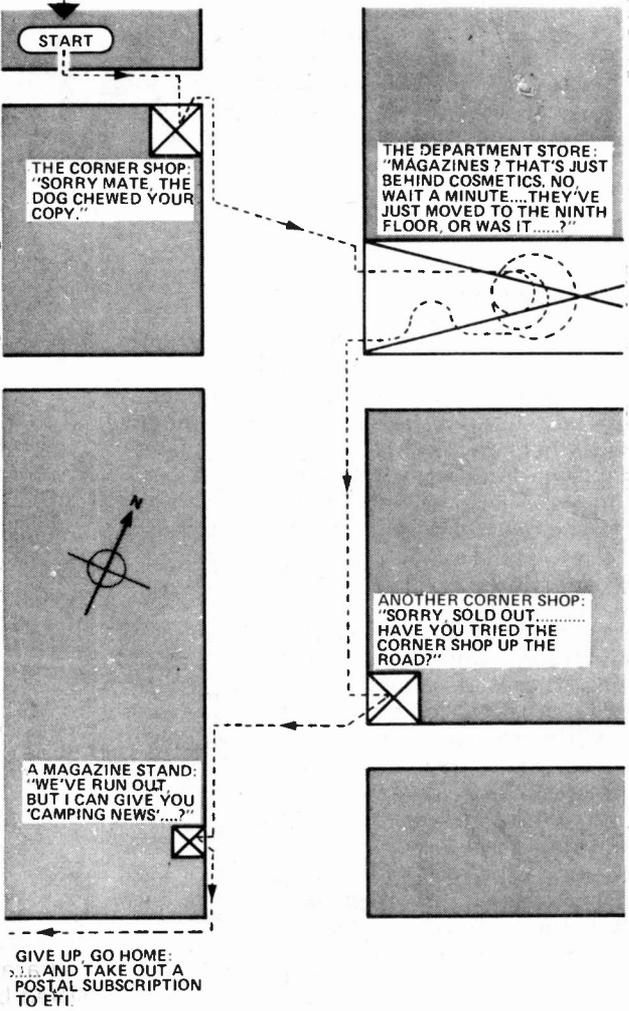
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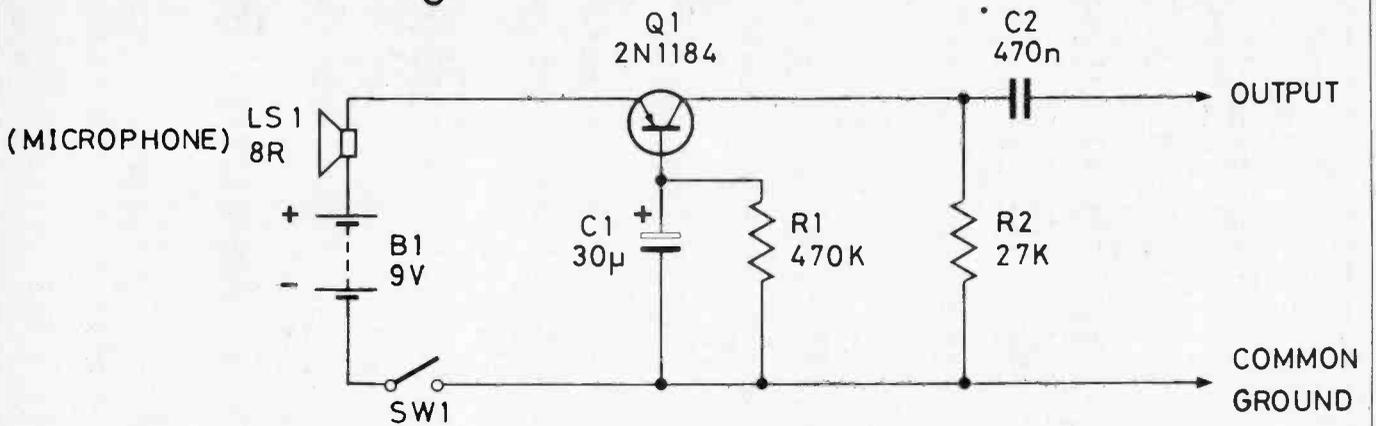
It can be a nuisance can't it, going from newsagent to newsagent? "Sorry squire, don't have it — next one should be out soon."

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### Microphone Speaker

J. Smith

What do you do if you need a microphone in a hurry — the shops are closed and your friends are on holiday? Or you are just a little short of money? The answer is to build the following circuit from your odds and ends box. This circuit uses a small speaker as a microphone, one transistor and only four other parts, draws only about 2 mA of current from a 9 volt battery so an on/off switch is not really necessary.

The transistor shown is 2N1184 and is a PNP germanium medium power type but is not critical — try the ones you have first before buying this new type. The components too are not critical and the prototype was found to work OK with 20% variation in values. The output is high impedance and is fed into the mic input of a tape recorder or pick-up input of an amplifier.

### Speed Alarm

D. Ian

It is all too easy, during a long journey on a motorway, to allow one's speed to gradually creep beyond that point which the boys in blue take an unwelcome interest; this alarm gives an audible nudge whenever you drift over a pre-set speed.

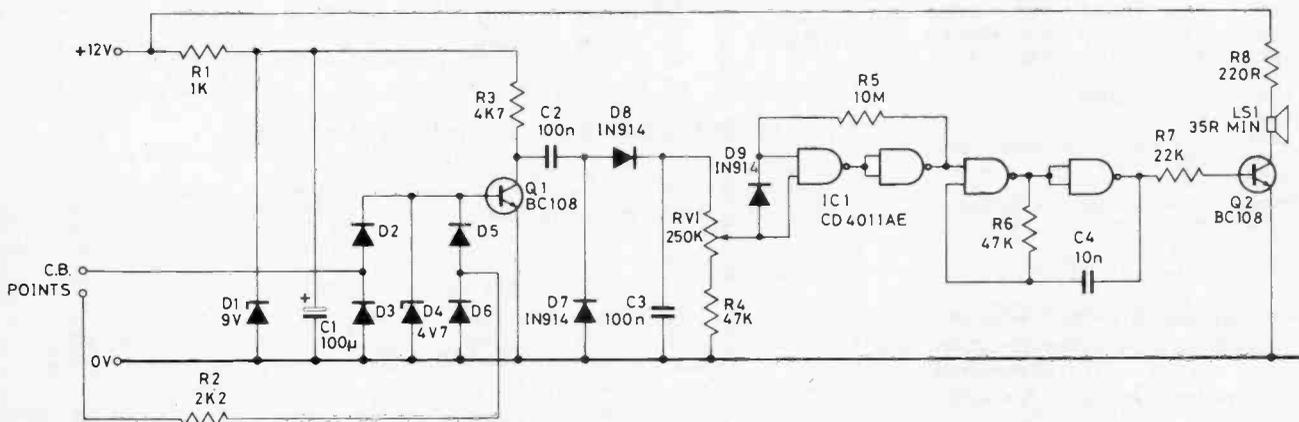
Pulses from the distributor points (due to the ignition coil up to 400V may be developed as the points open) are passed through a current limiting resistor, rectified and clipped at 4V7. Via Q1 and the diode pump a DC voltage, which is proportional to engine revs, is presented to RV1; the sharp transfer characteristic of a CMOS gate, assisted by feedback, is used to enable the oscillator formed by the remaining half of the 4011.

At the pre-set 'speed' (revs) a non-

ignorable tone emits from the speaker, and disappears as soon as the speed drops by three or four mph.

Calibration of Ca may be conducted with an accurate pulse generator remembering that, for a four stroke engine, frequency = revs per minute times the number of cylinders divided by 120; for a car with a specification of 17½ MPH per 1000 revs, in top gear,  $f = 133\text{Hz}$  at 70 MPH, 124Hz at 65 MPH (4000 RPM and 3714 RPM). The necessary frequency should be fed to Q1 and VR1 set so that the alarm is just off. Reliable switching occurs on the prototypes with a change of only 5Hz (150 RPM), ie less than 3 MPH for the above example.

Direct calibration 'on the road', while covering discrepancies due to tyre size, etc, will only be as good as the speedometer and obviously should be carried out by a passenger rather than the driver.



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

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 25-27 Oxford St., London W1R 1RF.

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|------|-----|-------|------|-------|------|--------|------|--|------|------------|------------|-------------|----------|-------------|-----------|------|--|--|--|
| 7400 | 10p | 7460  | 12p  | 74137 | 90p  | 74195  | 50p  | 4055   | 130p | CA 3140    | 60p        | LM 3909 N   | 65p      | TBA 480 Q   | 200p      |      |  |  |  |
| 7401 | 10p | 7470  | 25p  | 74138 | 100p | 74196  | 50p  | 4056   | 120p | LF 356     | 80p        | MC 1310 P   | 140p     | TBA 520 Q   | 200p      |      |  |  |  |
| 7402 | 10p | 7472  | 20p  | 74141 | 50p  | 74197  | 50p  | 4060   | 100p | LF 357     | 80p        | MC 1312 P   | 150p     | TBA 530 Q   | 200p      |      |  |  |  |
| 7403 | 10p | 7473  | 25p  | 74142 | 180p | 74198  | 100p | 4066   | 35p  | LM 211 H   | 250p       | MC 1314 P   | 190p     | TBA 540     | 200p      |      |  |  |  |
| 7404 | 12p | 7474  | 25p  | 74143 | 270p | 74199  | 100p | 4069   | 12p  | LM 300 TR5 | 170p       | MC 1315 P   | 230p     | TBA 550 Q   | 250p      |      |  |  |  |
| 7405 | 12p | 7475  | 25p  | 74144 | 270p | 74293  | 90p  | 4070   | 12p  | LM 301 AN  | 30p        | MK 50398    | 650p     | TBA 560 C   | 250p      |      |  |  |  |
| 7406 | 25p | 7476  | 25p  | 74145 | 55p  | 74L500 | 18p  | 4071   | 12p  | LM 304     | 200p       | MM 5314     | 380p     | TBA 641 A12 | 250p      |      |  |  |  |
| 7407 | 25p | 7480  | 40p  | 74147 | 100p | 745112 | 80p  | 4072   | 12p  | LM 307N    | 65p        | MM 5316     | 480p     | TBA 700     | 180p      |      |  |  |  |
| 7408 | 12p | 7481  | 85p  | 74148 | 90p  | CMOS   |      |  | 4081 | 12p        | LM 308 TO5 | 100p        | NE 529 K | 150p        | TBA 720 Q | 225p |  |  |  |
| 7409 | 12p | 7482  | 75p  | 74150 | 65p  | 4000   | 12p  | 4082   | 12p  | LM 308 DIL | 100p       | NE 555      | 25p      | TBA 750 Q   | 200p      |      |  |  |  |
| 7410 | 12p | 7483  | 75p  | 74151 | 45p  | 4001   | 12p  | 4093   | 70p  | LM 309 K   | 100p       | NE 556      | 90p      | TBA 800     | 80p       |      |  |  |  |
| 7411 | 15p | 7484  | 70p  | 74153 | 45p  | 4002   | 12p  | 4510   | 60p  | LM 310 TO5 | 150p       | NE 562 B    | 400p     | TBA 810     | 100p      |      |  |  |  |
| 7412 | 15p | 7485  | 60p  | 74154 | 70p  | 4006   | 80p  | 4511   | 70p  | LM 311 TO5 | 150p       | SAD 1024    | 1500p    | TBA 820     | 100p      |      |  |  |  |
| 7413 | 25p | 7486  | 25p  | 74155 | 45p  | 4007   | 14p  | 4516   | 65p  | LM 317 K   | 325p       | SL 917 B    | 650p     | TBA 920 Q   | 280p      |      |  |  |  |
| 7414 | 45p | 7489  | 130p | 74156 | 45p  | 4009   | 30p  | 4518   | 65p  | LM 324     | 70p        | SN 76003 N  | 150p     | TCA 270 Q   | 220p      |      |  |  |  |
| 7416 | 25p | 7490  | 25p  | 74157 | 45p  | 4011   | 12p  | 4520   | 65p  | LM 339     | 60p        | SN 76013 N  | 110p     | TCA 270 S   | 220p      |      |  |  |  |
| 7417 | 25p | 7491  | 40p  | 74160 | 55p  | 4012   | 12p  | 4528   | 80p  | LM 348 N   | 90p        | SN 76013 ND | 125p     | TCA 760     | 300p      |      |  |  |  |
| 7420 | 12p | 7492  | 35p  | 74161 | 55p  | 4013   | 30p  | 4583   | 70p  | LM 380     | 60p        | SN 76023 N  | 110p     | TCA 4500 A  | 450p      |      |  |  |  |
| 7421 | 20p | 7493  | 30p  | 74162 | 55p  | 4015   | 50p  | LINEAR   |      | LM 381 N   | 90p        | SN 76023 ND | 125p     | TDA 1008    | 350p      |      |  |  |  |
| 7422 | 15p | 7494  | 70p  | 74163 | 55p  | 4016   | 30p  | AY3 8500   | 450p | LM 382     | 90p        | SN 76033 N  | 150p     | TDA 1034    | 450p      |      |  |  |  |
| 7423 | 20p | 7495  | 45p  | 74164 | 60p  | 4017   | 50p  | CA 3039  | 70p  | LM 391     | 180p       | SN 7627 N   | 160p     | TDA 2002    | 300p      |      |  |  |  |
| 7425 | 20p | 7496  | 45p  | 74165 | 60p  | 4018   | 55p  | CA 3046  | 60p  | LM 555     | 25p        | SN 76228 N  | 180p     | TDA 2020    | 300p      |      |  |  |  |
| 7426 | 22p | 7497  | 120p | 74166 | 75p  | 4019   | 40p  | CA 3060  | 225p | LM 709 C   | 40p        | SN 76660 N  | 75p      | TL 084      | 120p      |      |  |  |  |
| 7427 | 22p | 74100 | 80p  | 74167 | 160p | 4020   | 50p  | CA 3065  | 200p | LM 710 TO5 | 60p        | TAA 300     | 100p     | XR 320      | 250p      |      |  |  |  |
| 7428 | 25p | 74104 | 40p  | 74170 | 100p | 4022   | 50p  | CA 3076  | 250p | LM 710 DIL | 65p        | TAA 350     | 190p     | XR 2206     | 450p      |      |  |  |  |
| 7430 | 12p | 74105 | 40p  | 74173 | 80p  | 4023   | 12p  | CA 3080  | 75p  | LM 723 TO5 | 40p        | TAA 550     | 35p      | XR 2207     | 450p      |      |  |  |  |
| 7432 | 20p | 74107 | 25p  | 74174 | 60p  | 4024   | 40p  | CA 3084  | 250p | LM 723 DIL | 40p        | TAA 570     | 220p     | XR 2208     | 600p      |      |  |  |  |
| 7433 | 28p | 74108 | 100p | 74175 | 60p  | 4025   | 12p  | CA 3085  | 85p  | LM 733     | 120p       | TAA 661 B   | 140p     | XR 2216     | 650p      |      |  |  |  |
| 7437 | 20p | 74166 | 75p  | 74176 | 50p  | 4026   | 80p  | CA 3086  | 60p  | LM 741     | 20p        | TAA 700     | 350p     | XR 2567     | 250p      |      |  |  |  |
| 7438 | 20p | 74109 | 25p  | 74177 | 50p  | 4027   | 30p  | CA 3088  | 190p | LM 748     | 40p        | TAA 790     | 350p     | XR 4136     | 150p      |      |  |  |  |
| 7440 | 12p | 74118 | 75p  | 74178 | 75p  | 4028   | 45p  | CA 3089  | 160p | LM 1303 N  | 100p       | TAD 100     | 150p     | XR 4202     | 150p      |      |  |  |  |
| 7441 | 45p | 74120 | 80p  | 74179 | 120p | 4029   | 50p  | CA 3090 AQ   | 360p | LM 1458    | 100p       | TAD 110     | 130p     | XR 4212     | 150p      |      |  |  |  |
| 7442 | 40p | 74121 | 25p  | 74180 | 90p  | 4030   | 30p  | CA 3123 E  | 130p | LM 3080    | 75p        | TBA 120 S   | 60p      | XR 4739     | 150p      |      |  |  |  |
| 7443 | 60p | 74122 | 35p  | 74181 | 130p | 4032   | 80p  | CA 3130  | 100p | LM 3900    | 55p        | TBA 120 T   | 85p      | ZN 414      | 100p      |      |  |  |  |
| 7444 | 60p | 74123 | 40p  | 74182 | 50p  | 4033   | 100p | IN 4148 Diodes by ITT/Texas, 100 for £1.50                         |      |            |            |             |          |             |           |      |  |  |  |
| 7445 | 65p | 74125 | 35p  | 74184 | 120p | 4040   | 60p  | Static Ram 2102 1024 x 1 bit 450 nano sec. £1.00 each              |      |            |            |             |          |             |           |      |  |  |  |
| 7446 | 50p | 74126 | 35p  | 74185 | 100p | 4043   | 60p  | 2112 256 x 4 bit 450 nano sec. £2.50                               |      |            |            |             |          |             |           |      |  |  |  |
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| 7448 | 50p | 74130 | 120p | 74190 | 70p  | 4047   | 80p  | All prices include post and VAT                                    |      |            |            |             |          |             |           |      |  |  |  |
| 7450 | 12p | 74131 | 90p  | 74191 | 70p  | 4048   | 50p  | <b>T. POWELL</b>   |      |            |            |             |          |             |           |      |  |  |  |
| 7451 | 12p | 74132 | 45p  | 74192 | 60p  | 4049   | 25p  | 306 ST. PAULS ROAD, HIGHBURY CORNER, LONDON, N.1. TEL. 01-226 1489 |      |            |            |             |          |             |           |      |  |  |  |
| 7453 | 12p | 74135 | 90p  | 74193 | 60p  | 4050   | 25p  | Barclay / Access credit cards accepted                             |      |            |            |             |          |             |           |      |  |  |  |
| 7454 | 12p | 74136 | 80p  | 74194 | 55p  | 4054   | 100p | Shop closed from 21/12/78 to 2/1/79                                |      |            |            |             |          |             |           |      |  |  |  |

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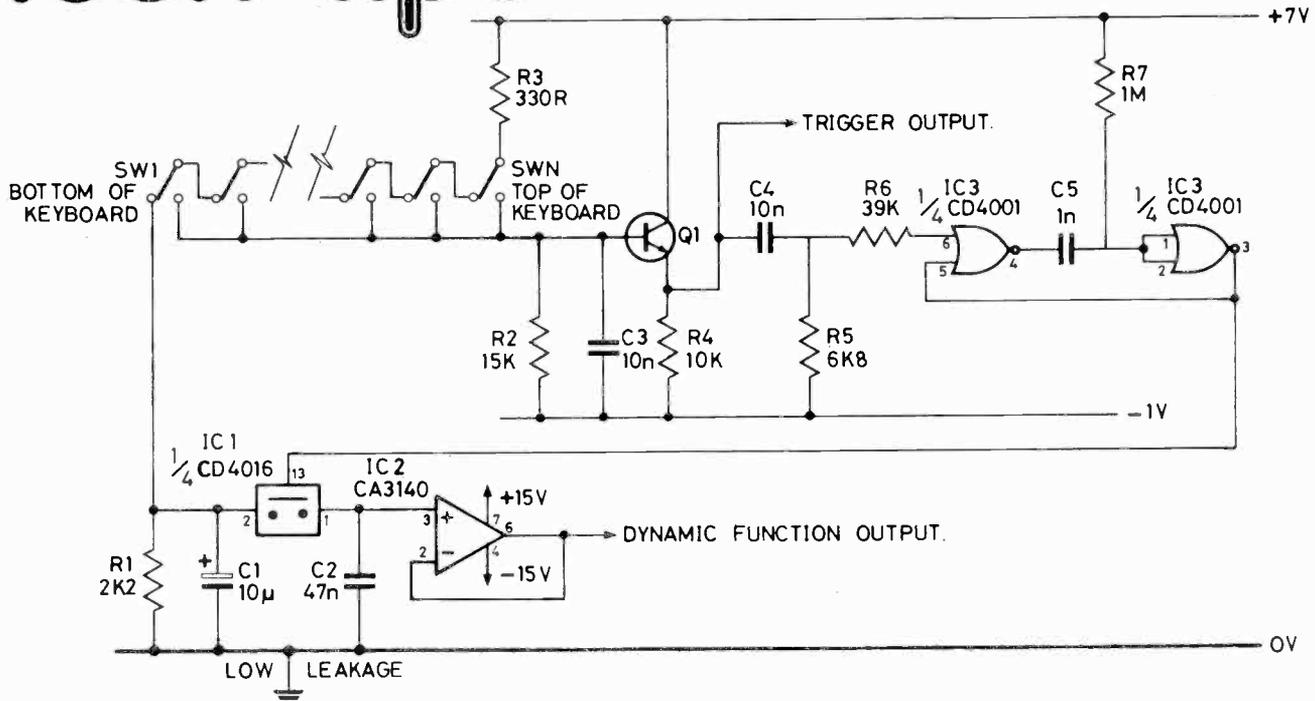
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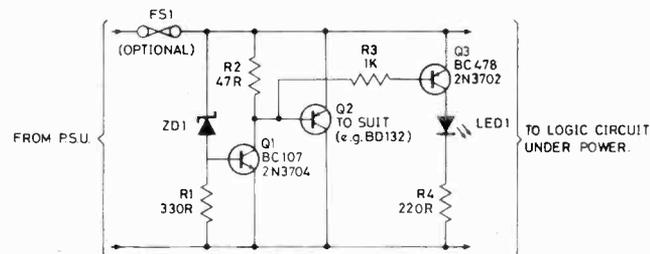
### Dynamic Sensitivity

W. Stride

A dynamic function (touch sensitivity) greatly increases the flexibility of expression available to the player of a music synthesizer. This circuit achieves the dynamic function by measuring the change over time of the keyboard switches, and hence the velocity of the key depressed.

The circuit is basically composed of three parts; firstly an RC time-constant network ( $R_1, C_1$ ) controlled by the keyboard switches, a buffer amplifier and monostable ( $Q_1, IC_3$ ) and a sample/hold circuit ( $IC_1, C_2, IC_2$ ).

Normally  $C_1$  is kept charged up to +7 volts through the 'chain' of closed keyboard switches. When a key is depressed, the 'chain' is broken and  $C_1$  discharges through  $R_1$ . As the key is further depressed, contact is made with the trigger busbar,  $TR_1$  is turned on, and the monostable triggered. The monostable gives out a 1 millisecond pulse, which causes the analog switch ( $IC_1$ ) to close allowing  $C_2$  to charge up to the voltage on  $C_1$  at that time. After this, the voltage is stored on  $C_2$ , the output being buffered by  $IC_2$ . Since the input impedance of IC is  $\sim 1.5 \times 10^{12}$  ohms the delay time of  $C_2$  is very long. An output is available from the emitter of  $TRQ_1$  to trigger envelope shapers etc. To make sure the response is the same all over the keyboard, the distance between the gold wires on all the contact assemblies should be made the same.



### Overvoltage Protection for Logic

E. Parr

With the introduction of integrated circuit voltage regulators it is very easy to make power supplies for logic circuits. Unfortunately it is only easy to blast a board of TTL by letting the voltage rise above 7V as could happen if the common line came off a regulator IC or the sense lines came off a commercial power supply.

The described circuit was designed by the author as a "last ditch" defence after a disconnected sense line allowed a commercial 5V supply to rise to 9V and blast 50 TTL chips. The circuit is simple to add onto any power supply, and it is the author's intention to build it "on board" with any future system containing more than about

10 TTL chips. Zener diode ZD1 senses the supply, and should the supply rise above 6V Q1 will turn on. In turn Q2 conducts clamping the rail.

Subsequent events depend on the source supply. It will either shut down, go into current limit or blow its supply fuse. None of these will damage the TTL chips.

The rating Q2 depends on the source supply, and whether it will be required to operate continuously in the event of failure. Its current rating obviously has to be in excess of the source supply. If the source supply is likely to sit down, LED1 should be added to indicate the circuit has operated.

The circuit will operate in approximately 500 nS space, so it will also protect the logic from transient spikes which a normal regulator would not block.

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## THIS MONTH'S

### ★ STAR BUY

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**CASIO 46CS-27B**  
ALARM/  
CHRONOGRAPH



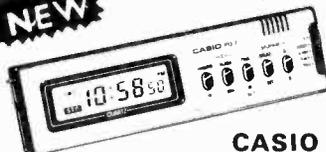
CHRONO

Net, lap and 1st and 2nd place times from 1/100 second to 6 hours. Stainless steel case 7.8mm thick. Mineral glass face. Water resistant to 100 feet. 12 months+ battery life. Available soon.

6 digits. Hrs. mins. secs AM/PM and day, and day, date, month, year. Optional 12 or 24 hr. clock. 24 hrs. alarm. Optional hourly Chime

Prov. price £74.95

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CASIO PQ-7

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Gilt  
Strap

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1803 (right)  
ALARM



6 digits. 6 functions, plus backlight and alarm setting. 5-minute snooze facility (£28.95).

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**52QS-14B**  
Right 8 mm  
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Up to 25 functions. Net, lap and first and second place times to 1/100th sec. F-100. Resin case, strap 52QS-14B. S/S encased version and bracelet.

**4 DIGIT WATCHES** (except World Time). Hours, minutes, ten seconds, seconds by flash, am/pm. Day, date, month. Stopwatch. Dual time (except 31QR-20B).



**31QR-20B** Left, 4 digit  
(£35.95)

£29.95

**51QR-19B.** 6 digit  
(£44.95)

£34.95

**6 DIGIT WATCHES** (except Sports and Alarm). Hours, minutes, seconds, day OR Hours, minutes, date, day, ten seconds, seconds by flash. Day, date, month, year. Selectable 12 hour (with am/pm) or 24 hour clock.

**54QS-16B**  
Left, 6 digit  
(£49.95)

£39.95

**54QS-15B**  
6 digit  
(£54.95)

£44.95



**CHRONOGRAPH.** 6 digits as above, with stopwatch measuring net, lap and 1st & 2nd place times from 1/100 sec to 6 hrs. Dual time facility.



**45CS-22B**  
Chronograph  
Left, 6 digit (£69.95)

£54.95

**29CS-11B**  
World Time (£84.95)

£69.95



**WORLD TIME WATCH.** The time in ten capitals plus one optional time. Instant summertime correction. Hrs, mins, 10 secs. secs by flash. Perpetual calendar, day, date, month. Running digital seconds display.

## ALARM WATCHES

**25CR-16B**  
Round (£74.95)

£54.95

**25CS-16B**  
Square (£84.95)

£69.95



Hours, mins, seconds (or hrs, mins, date) day, am/pm. Day, date, month, year. 24 hr. alarm, on/off indicator.

**ULTRA SLIM DRESS WATCHES** (Not 24 hour)

**53CS-18B**  
Left, 4 digit (£74.95)

£59.95

**49CS-25B**  
6 digit (£84.95)

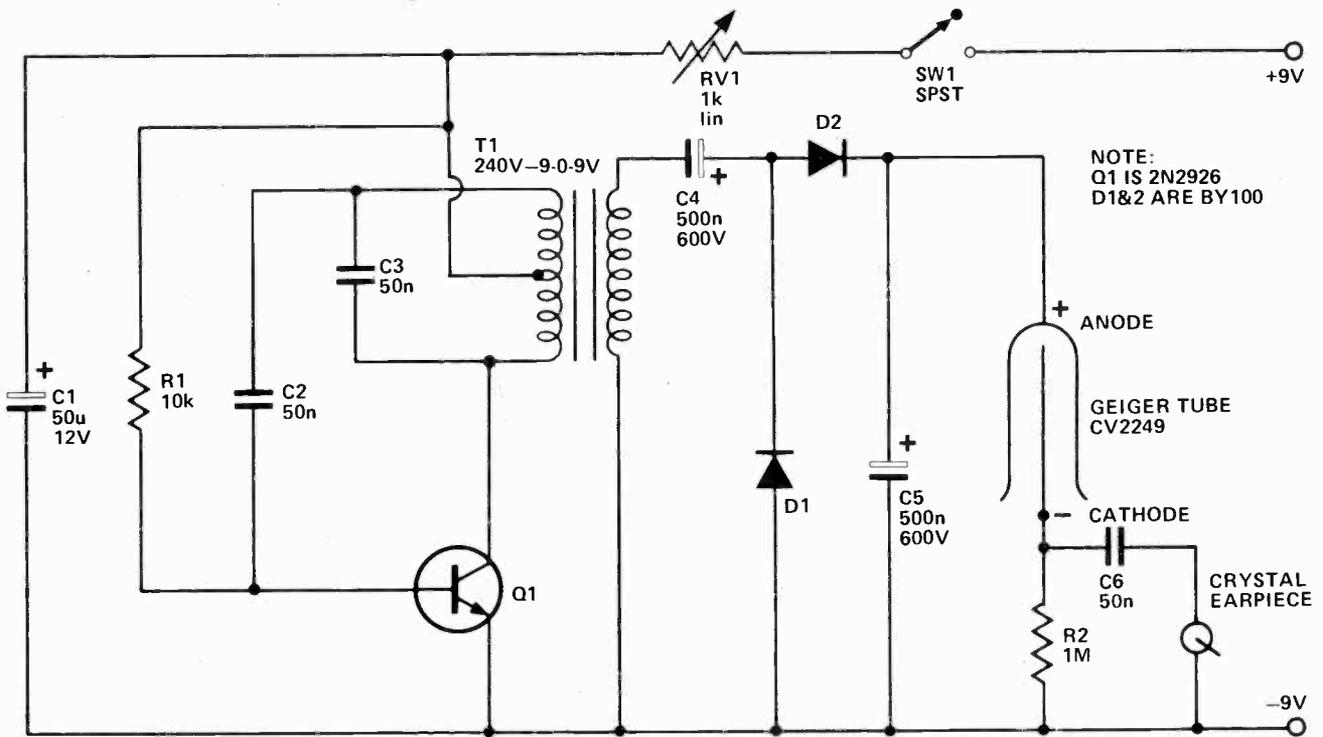
£69.95



Not illustrated 53CS-19B, 4 digit barrel shaped £64.95. 49CS-24B, 6 digit (£79.95) £64.95. 53CS-17L, Gold plated, on strap (£84.95) £69.95.

# TEMPUS

Dept. ETI, Talk of the Town  
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Cambridge CB1 1EH. Tel. 0223 312866

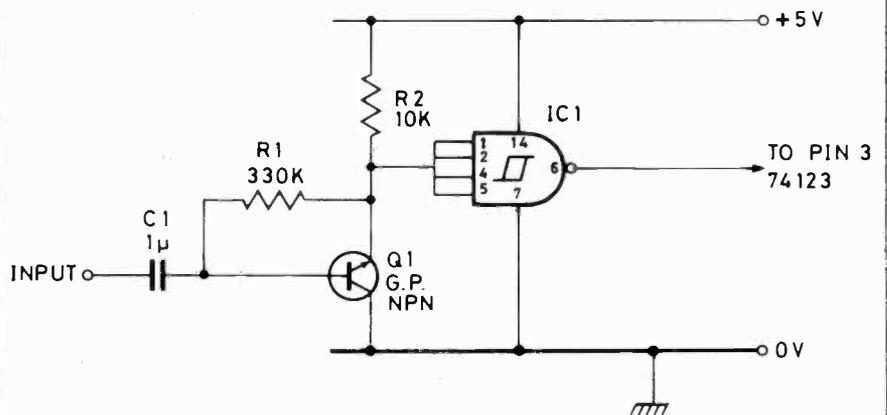


NOTE:  
Q1 IS 2N2926  
D1&2 ARE BY100

### Geiger Counter

A. Wheatley

Although the circuit is inexpensive and simple it is just as sensitive as many commercial devices. The important part is the geiger tube and this will probably cost about £1.90. It needs a high voltage supply which, in this case consists of Q1 and its associated components. The transformer is a low current 250V 9.0-9 and is connected in reverse. The secondary is connected into a Hartley oscillator, the base bias being provided by R1. RV1 is connected to control the voltage to the Geiger tube. A device to double the voltage is included because otherwise the voltage would still be insufficient to drive the tube. This comprises D1, D2, C4 and C5. This also rectifies it and smooths it. It is very important that C4 and especially C5 are of good quality and have low leakage. RV1 should be set so that each click heard is a nice clean one because over a certain voltage all that will be heard is a continuous buzz. The high voltage section is perfectly safe although if touched it will give a slight shock. This is unpleasant but quite harmless.



### Cuts Above

B. Houseley

The circuit here is an improved version of the original cuts encoder. If Q1 is preceded by a high impedance buffer, quite low signal levels can be accommodated successfully — and still trigger the 74123. A 74C02 or a 7402 was found to trigger only unreliably in this circuit.

**THIS MONTH'S SPECIAL OFFER**  
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|-------------------|------|
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switched up to 21 positions and can be reset from  
any position by energising the reset coil  
230/240v. A.C. operation. Unit is mounted on  
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## VORTEX BLOWER AND VACUUM UNIT

Dynamically balanced totally enclosed 9  
rotor with max. air delivery of 1.5 cubic  
metres per min. Max static pressure  
600mm W.G. Suction or blow from 2  
side-by-side 37mm I.D. circular apertures  
fitted to base of unit. Powerful continuously  
rated 115v a.c. motor mounted on alloy base  
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These units are ex-equipment but have had minimum use. Fully tested  
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**24V DC Blower Unit M.F.R. USA made 24V DC**  
8 amp blower that operates well on 12V. 4 amp  
DC producing 30 cu ft/min at normal air pressure  
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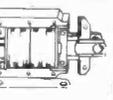
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Sub min lever m switch type MML46 10 for **£2.50**  
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Mfg by Magnetic Devices 240V AC  
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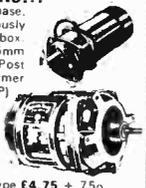
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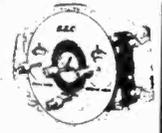


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| 7406     | 74163           | 80             | 74S124             | 3.25     | 2K3819               | 29     |    |
| 7409     | 74164           | 87             | <b>MICRO'S</b>     |          | <b>DRODES</b>        |        |    |
| 7410     | 74165           | 93             | 74S188             | 3.95     | 1M914                | 05     |    |
| 7411     | 74176           | 84             | 1702A              | 7.95     | 1M4148               | 05     |    |
| 7412     | 74180           | 86             | 2708               | 1.22     | 1M4151               | 04     |    |
| 7413     | 74190           | 1.04           | 2102-1             | 1.22     | 1M4001               | 06     |    |
| 7414     | 74192           | 98             | 2114               | 10.53    | 1M4002               | 06     |    |
| 7416     | 74193           | 98             | 8080A              | 7.02     | 1M4004               | 10     |    |
| 7417     | 74194           | 86             | 8251               | 7.06     | 1M4005               | 11     |    |
| 7420     | 74196           | 86             | <b>LINEAR</b>      |          | <b>ELECTROLYTICS</b> |        |    |
| 7426     | 74197           | 86             | LM380-14           | 80       | 1M4005               | 11     |    |
| 7427     | 74198           | 1.41           | LM3900             | 4P       | 1M4007               | 12     |    |
| 7430     | <b>74LS TTL</b> |                | LM741-8            | 21       | 1M4520               | 16     |    |
| 7432     | 74LS00          | 18             | NE555              | 29       | 1M4504               | 21     |    |
| 7433     | 74LS01          | 18             | NE565              | 7.14     | <b>UF/V</b>          |        |    |
| 7437     | 74LS02          | 18             | NE565              | 1.14     | 47/100               | 08     |    |
| 7438     | 74LS04          | 19             | NE566              | 1.43     | 1/30                 | 08     |    |
| 7440     | 74LS05          | 21             | NE567              | 1.62     | 2/253                | 08     |    |
| 7441     | 74LS09          | 21             | <b>REGULATORS</b>  |          | 3/3/83               | 08     |    |
| 7442     | 74LS09          | 21             | 7805               | 80       | 47/35                | 08     |    |
| 7443     | 74LS10          | 21             | 7812               | 80       | 47/63                | 08     |    |
| 7445     | 74LS11          | 21             | 7805               | 1.39     | 10/16                | 08     |    |
| 7446     | 74LS14          | 1.10           | 7812               | 1.39     | 10/35                | 08     |    |
| 7447     | 74LS20          | 18             | LM309              | 86       | 10/53                | 09     |    |
| 7448     | 74LS21          | 21             | LM723              | 38       | 22/16                | 08     |    |
| 7450     | 74LS32          | 24             | LM723              | 38       | 22/35                | 10     |    |
| 7451     | 74LS37          | 26             | <b>TRANSISTORS</b> |          | 22/63                | 12     |    |
| 7453     | 74LS38          | 29             | AC128              | 23       | 33/16                | 08     |    |
| 7454     | 74LS40          | 25             | AC176              | 10       | 33/35                | 11     |    |
| 7460     | 74LS42          | 54             | BC107              | 10       | 33/63                | 13     |    |
| 7410     | 74LS51          | 29             | BC108              | 10       | 47/16                | 09     |    |
| 7472     | 74LS74          | 32             | BC109              | 10       | 47/35                | 12     |    |
| 7473     | 74LS86          | 33             | BC177              | 18       | 47/35                | 15     |    |
| 7474     | 74LS90          | 86             | BC178              | 18       | 100/16               | 11     |    |
| 7475     | 74LS93          | 86             | BC179              | 18       | 100/35               | 13     |    |
| 7476     | 74LS107         | 34             | BC184              | 21       | 220/16               | 12     |    |
| 7483     | 74LS112         | 100            | BC187              | 32       | 220/25               | 17     |    |
| 7485     | 84              | 74LS123        | 85                 | BC477    | 24                   | 330/16 | 18 |
| 7486     | 25              | 74LS124        | 2.20               | BC478    | 24                   | 330/35 | 31 |
| 7489     | 1.95            | 74LS151        | 95                 | BC479    | 24                   | 470/16 | 18 |
| 7490     | 38              | 74LS153        | 64                 | BD131    | 54                   | 470/35 | 14 |
| 7491     | 62              | 74LS157        | 64                 | BD132    | 54                   | 470/16 | 18 |
| 7492     | 42              | 74LS164        | 1.14               | BFY50    | 23                   | 470/35 | 18 |
| 7493     | 29              | 74LS175        | 1.05               | BFY51    | 23                   | 100/16 | 30 |
| 7495     | 51              | 74LS193        | 1.33               | BFY52    | 23                   |        |    |
| 7496     | 67              | 74LS194        | 2.06               | BS195A   | 17                   |        |    |
| 74104    | 48              | <b>74S TTL</b> |                    | BC172    | 36                   |        |    |
| 74105    | 48              | 74S00          | 38                 | BC173    | 20                   |        |    |
| 74107    | 27              | 74S04          | 28                 | OC200    | 45                   |        |    |
| 74109    | 45              | 74S05          | 38                 | TIP 2955 | 85                   |        |    |
| 74121    | 25              | 74S08          | 38                 | TIP 3055 | 68                   |        |    |
| 74122    | 47              | 74S10          | 38                 | TIS 43   | 33                   |        |    |
| 74123    | 38              | 74S12          | 38                 | ZX300    | 17                   |        |    |
| 74141    | 71              | 74S11          | 38                 |          |                      |        |    |

All prices INCLUDE V.A.T. add 25p P&P. S.A.E. for full list

**IBEK SYSTEMS** 32 Dunsville Drive, Coventry CV2 2H5

### TRANSISTORS

|           |      |        |      |        |      |        |      |        |      |          |      |         |      |
|-----------|------|--------|------|--------|------|--------|------|--------|------|----------|------|---------|------|
| AC107     | 0.23 | BC117  | 0.15 | BC206  | 0.10 | BC559  | 0.11 | BF184  | 0.28 | BU205    | 1.30 | ZN1613  | 0.18 |
| AC125     | 0.17 | BC118  | 0.11 | BC208  | 0.11 | BC742  | 0.55 | BF185  | 0.20 | BU206    | 1.50 | ZN1671  | 1.10 |
| AC126     | 0.17 | BC119  | 0.25 | BC207  | 0.10 | BC750  | 0.20 | BF194  | 0.06 | BU208-02 | 1.75 | ZN1678  | 2.20 |
| AC127     | 0.16 | BC120  | 0.15 | BC209  | 0.09 | BC771  | 0.13 | BF194A | 0.07 | BU406    | 3.90 | ZN1711  | 2.20 |
| AC127K    | 0.23 | BC121  | 0.16 | BC210  | 0.16 | BC772  | 0.13 | BF195  | 0.06 | BU198A   | 6.75 | ZN1712  | 2.20 |
| AC128     | 0.14 | BC126  | 0.15 | BC213L | 0.10 | BD115  | 0.30 | BF195G | 0.07 | BU198B   | 2.00 | ZN1905  | 0.25 |
| AC128K    | 0.25 | BC136  | 0.15 | BC214L | 0.10 | BD116  | 0.30 | BF196  | 0.07 | BU198C   | 7.00 | ZN1906  | 0.25 |
| AC128/176 | 0.42 | BC137  | 0.15 | BC237  | 0.15 | BD123  | 0.60 | BF196  | 0.06 | BUY70A   | 5.00 | ZN2060  | 1.00 |
| AC142     | 0.18 | BC138  | 0.30 | BC237A | 0.16 | BD128  | 1.02 | BF197  | 0.06 | BUY71    | 4.50 | ZN2188  | 2.20 |
| AC153     | 0.55 | BC140  | 0.27 | BC237C | 0.21 | BD131  | 0.35 | BF198  | 0.06 | MP56517  | 0.48 | ZN2189  | 0.22 |
| AC158     | 0.50 | BC141  | 0.29 | BC238  | 0.15 | BD132  | 0.40 | BF224  | 0.19 | MP56523  | 0.27 | ZN2222  | 0.18 |
| AC176     | 0.16 | BC142  | 0.20 | BC238B | 0.10 | BD135  | 0.30 | BF255  | 0.18 | MP56528  | 0.18 | ZN2224  | 0.20 |
| AC187     | 0.50 | BC147  | 0.06 | BC238C | 0.18 | BD136  | 0.30 | BF255A | 0.18 | MP56533  | 0.72 | ZN2270  | 0.39 |
| AC187K    | 0.55 | BC147B | 0.07 | BC251A | 0.15 | BD137  | 0.30 | BF255B | 0.18 | NK1214   | 0.25 | ZN2368  | 0.10 |
| AC188K    | 0.55 | BC148  | 0.06 | BC251B | 0.17 | BD138  | 0.30 | BF257  | 0.16 | NK1224   | 0.25 | ZN2484  | 0.18 |
| AC192     | 1.02 | BC148A | 0.07 | BC252A | 0.15 | BD139  | 0.30 | BF258  | 0.28 | OC22     | 1.40 | ZN2484A | 0.18 |
| AC192K    | 1.02 | BC148B | 0.07 | BC252B | 0.17 | BD140  | 0.30 | BF259  | 0.28 | OC23     | 1.40 | ZN2484B | 0.18 |
| AD142     | 0.87 | BC149  | 0.06 | BC252C | 0.20 | BD144  | 0.40 | BF324  | 0.20 | OC29     | 0.85 | ZN3053  | 0.15 |
| AD143     | 0.87 | BC157  | 0.06 | BC258  | 0.20 | BD148  | 0.50 | BF335  | 0.25 | OC36     | 1.00 | ZN3117  | 0.15 |
| AD149     | 0.65 | BC157A | 0.07 | BC261A | 0.10 | BD178  | 0.72 | BF338  | 0.45 | OC44     | 0.12 | ZN3440  | 0.15 |
| AD181     | 0.35 | BC158  | 0.07 | BC262  | 0.20 | BD181  | 1.32 | BF457  | 0.60 | OC45     | 0.12 | ZN3638  | 0.10 |
| AD181/162 | 0.70 | BC158A | 0.06 | BC267A | 0.21 | BD183  | 1.50 | BF457A | 0.60 | OC71     | 0.09 | ZN3638A | 0.16 |
| AD182     | 0.35 | BC159  | 0.06 | BC267B | 0.22 | BD232  | 0.60 | BF594  | 0.10 | OC74     | 0.18 | ZN3643  | 0.24 |
| AD282     | 0.36 | BC159A | 0.06 | BC267C | 0.22 | BD233  | 0.60 | BF594A | 0.10 | OC75     | 0.18 | ZN3692  | 0.24 |
| AD283     | 0.36 | BC159B | 0.07 | BC304  | 0.25 | BD234  | 0.60 | BF434  | 0.54 | OC82     | 0.48 | ZN3705  | 0.06 |
| AD286     | 0.36 | BC159C | 0.07 | BC307  | 0.15 | BD235  | 0.40 | BF428  | 0.20 | OC139    | 0.50 | ZN3706  | 0.06 |
| AD211     | 4.05 | BC161  | 0.25 | BC307A | 0.15 | BD236  | 0.40 | BF434  | 0.70 | OC203    | 2.50 | ZN3707  | 0.06 |
| AF106     | 0.45 | BC167  | 0.06 | BC307B | 0.15 | BD237  | 0.40 | BF434A | 0.20 | OC207    | 2.70 | ZN3711  | 0.06 |
| AF108     | 0.36 | BC168  | 0.06 | BC307C | 0.15 | BD238  | 0.40 | BF435  | 0.20 | OC1072   | 2.50 | ZN3718  | 0.20 |
| AF124     | 0.25 | BC169  | 0.06 | BC308A | 0.15 | BD434  | 0.40 | BF435A | 0.20 | OC128    | 2.50 | ZN3809  | 3.00 |
| AF125     | 0.25 | BC170  | 0.07 | BC317B | 0.15 | BD507  | 0.50 | BF418  | 0.50 | OC208B   | 2.10 | ZN3904  | 0.06 |
| AF126     | 0.25 | BC170C | 0.07 | BC322  | 0.10 | BD508  | 0.50 | BF419  | 0.50 | TP30     | 0.35 | ZN3905  | 0.06 |
| AF127     | 0.25 | BC171  | 0.06 | BC327  | 0.16 | BD518  | 0.50 | BF433  | 0.50 | TP31     | 0.35 | ZN3906  | 0.06 |
| AF139     | 0.32 | BC171A | 0.07 | BC328  | 0.16 | BD537  | 1.02 | BF434  | 0.50 | TP31A    | 0.45 | ZN4037  | 0.25 |
| AF171B    | 0.30 | BC171B | 0.07 | BC337  | 0.16 | BD567  | 1.40 | BF435  | 0.50 | TP32     | 0.45 | ZN4038  | 0.10 |
| AF179     | 0.30 | BC172  | 0.06 | BC337A | 0.16 | BD567A | 1.40 | BF435A | 0.50 | TP33     | 0.45 | ZN4039  | 0.10 |
| AF200     | 0.36 | BC172A | 0.07 | BC348A | 0.15 | BD610  | 0.50 | BF452  | 1.12 | TP42     | 0.60 | ZN4344  | 2.00 |
| AF201     | 0.39 | BC172B | 0.07 | BC350A | 0.17 | BD620  | 0.50 | BF481  | 4.00 | TP2955   | 0.65 | ZN4448  | 1.50 |
| AS773     | 0.36 | BC172C | 0.07 | BC441  | 0.20 | BF115  | 0.35 | BF439  | 0.35 | TS90     | 0.18 | ZN4914  | 3.50 |
| AS215     | 0.60 | BC173  | 0.06 | BC461  | 0.24 | BF121  | 0.20 | BS320  | 0.10 | ZN3448   | 0.30 | ZN5172  | 0.25 |
| AS216     | 0.60 | BC173A | 0.06 | BC462  | 0.24 | BF122  | 0.20 | BS321  | 0.33 | ZN404    | 0.45 | ZN5245  | 0.30 |
| AS217     | 0.60 | BC173B | 0.07 | BC463  | 0.24 | BF123  | 0.20 | BS322  | 0.33 | ZN404A   | 0.45 | ZN5246  | 0.30 |
| AS103     | 0.60 | BC174  | 0.07 | BC464  | 0.24 | BF124  | 0.20 | BS323  | 0.33 | ZN404B   | 0.45 | ZN5247  | 0.30 |
| AS171     | 0.60 | BC177A | 0.12 | BC471A | 0.11 | BF127  | 0.20 | BS324  | 0.33 | ZN404C   | 0.45 | ZN5248  | 0.30 |
| AU107     | 1.00 | BC177B | 0.12 | BC471B | 0.11 | BF127A | 0.21 | BS325  | 0.30 | ZN527    | 0.48 | ZN5476  | 0.60 |
| AU110     | 0.90 | BC178  | 0.12 | BC471C | 0.11 | BF127B | 0.21 | BS326  | 0.30 | ZN585    | 0.50 | ZN5670  | 0.65 |
| AU210     | 0.90 | BC179  | 0.12 | BC484A | 0.11 | BF154  | 0.15 | BS329  | 0.54 | ZN705    | 0.10 | ZN5926  | 0.55 |
| BC187     | 0.06 | BC179A | 0.09 | BC484B | 0.11 | BF154A | 0.15 | BS330  | 0.15 | ZN706    | 0.10 | ZN6123  | 0.65 |
| BC107A    | 0.07 | BC179B | 0.07 | BC484C | 0.11 | BF154B | 0.15 | BS331  | 0.15 | ZN706A   | 0.10 | ZN6124  | 0.65 |
| BC107B    | 0.07 | BC183A | 0.09 | BC494A | 0.11 | BF167  | 0.25 | BS354  | 0.39 | ZN708    | 0.12 | ZN6303  | 0.90 |
| BC108     | 0.06 | BC183B | 0.09 | BC494B | 0.11 | BF173  | 0.20 | BS356  | 0.36 | ZN1039   | 0.15 | ZN6304  | 0.90 |
| BC108A    | 0.07 | BC183C | 0.10 | BC550  | 0.11 | BF174  | 0.20 | BS360  | 0.36 | ZN1050   | 0.15 | ZN6305  | 0.90 |
| BC108B    | 0.07 | BC184  | 0.08 | BC557  | 0.11 | BF177  | 0.25 | BS364  | 0.30 | ZN1111   | 0.15 | ZN6323  | 1.00 |
| BC109     | 0.06 | BC184A | 0.09 | BC557A | 0.11 | BF178  | 0.25 | BS368  | 0.30 | ZN1102   | 0.15 | ZN6324  | 1.00 |
| BC109B    | 0.07 | BC184B | 0.11 | BC557B | 0.11 | BF179  | 0.25 | BS368A | 0.30 | ZN1103   | 0.15 | ZN6325  | 1.00 |
| BC109C    | 0.07 | BC184C | 0.11 | BC557C | 0.11 | BF180  | 0.25 | BS368B | 0.30 | ZN1104   | 0.15 | ZN6326  | 1.00 |
| BC109D    | 0.07 | BC184D | 0.11 | BC557D | 0.11 | BF181  | 0.25 | BS368C | 0.30 | ZN1105   | 0.15 | ZN6327  | 1.00 |
| BC113     | 0.12 | BC187  | 0.19 | BC558  | 0.11 | BF181  | 0.20 | BS368D | 0.30 | ZN1106   | 0.15 | ZN6328  | 1.00 |
| BC114     | 0.15 | BC204  | 0.08 | BC558A | 0.11 | BF182  | 0.20 | BS368E | 0.30 | ZN1107   | 0.15 | ZN6329  | 1.00 |
| BC116     | 0.13 | BC204A | 0.09 | BC558B | 0.11 | BF183  | 0.20 | BS368F | 0.30 | ZN1108   | 0.15 | ZN6330  | 1.00 |

### TTL

|      |     |      |     |       |      |       |      |       |      |       |      |
|------|-----|------|-----|-------|------|-------|------|-------|------|-------|------|
| 7400 | .12 | 7426 | .25 | 7470  | .28  | 74107 | .28  | 74148 | 1.20 | 74176 | .90  |
| 7401 | .12 | 7427 | .25 | 7472  | .22  | 74109 | .45  | 74150 | 1.00 | 74177 | .80  |
| 7402 | .12 | 7428 | .34 | 7473  | .28  | 74110 | .46  | 74151 | .80  | 74178 | 1.20 |
| 7403 | .12 | 7429 | .33 | 7474  | .20  | 74111 | .70  | 74152 | .80  | 74179 | 1.10 |
| 7404 | .13 | 7432 | .34 | 7475  | .28  | 74116 | 1.60 | 74154 | 1.06 | 74180 | .70  |
| 7405 | .13 | 7433 | .32 | 7476  | .13  | 74118 | .82  | 74155 | .63  | 74181 | 1.95 |
| 7406 | .20 | 7437 | .24 | 7483  | .75  | 74119 | 1.30 | 74156 | .63  | 74182 | .75  |
| 7407 | .20 | 7438 | .24 | 7484  | .90  | 74120 | .82  | 74157 | .63  | 74184 | 1.20 |
| 7408 | .14 | 7440 | .13 | 7485  | .90  | 74121 | .28  | 74158 | 1.70 | 74185 | 1.20 |
| 7409 | .14 | 7442 | .62 | 7486  | .28  | 74122 | .40  | 74160 | .80  | 74186 | 0.70 |
| 7410 | .13 | 7443 | .65 | 7487  | 2.00 | 74123 | .65  | 74161 | .20  | 74188 | 5.40 |
| 7411 | .18 | 7444 | .90 | 7490  | .35  | 74125 | .65  | 74163 | .80  | 74190 | 1.10 |
| 7412 | .21 | 7445 | .70 | 7491  | .65  | 74126 | .48  | 74164 | .90  | 74191 | 1.00 |
| 7413 | .25 | 7446 | .70 | 7492  | .48  | 74128 | .62  | 74165 | .90  | 74192 | 1.00 |
| 7414 | .64 | 7447 | .66 | 7493  | .38  | 74132 | .70  | 74166 | 1.00 | 74193 | 1.10 |
| 7415 | .27 | 7448 | .80 | 7494  | .80  | 74141 | .65  | 74167 | 2.70 | 74194 | .92  |
| 7416 | .27 | 7450 | .13 | 7495  | .65  | 74142 | 2.02 | 74170 | 1.70 | 74195 | .85  |
| 7420 | .13 | 7442 | .65 | 7496  | .62  | 74143 | 2.02 | 74172 | 4.00 | 74196 | .92  |
| 7421 | .28 | 7452 | .13 | 7497  | 2.40 | 74144 | 2.02 | 74173 | 1.20 | 74197 | .92  |
| 7423 | .25 | 7454 | .13 | 74100 | .85  | 74145 | .65  | 74174 | .90  | 74198 | 1.60 |
| 7425 | .22 | 7460 | .13 | 74105 | .40  | 74147 | 1.38 | 74175 | .70  | 74199 | 1.50 |

### CMOS

|      |     |      |     |       |      |      |      |      |      |      |      |
|------|-----|------|-----|-------|------|------|------|------|------|------|------|
| 4000 | .15 | 4014 | .85 | 4025  | .20  | 4043 | .85  | 4069 | .20  | 4508 | 2.30 |
| 4001 | .15 | 4015 | .80 | 4026  | 1.35 | 4044 | .85  | 4070 | .20  | 4510 | 1.10 |
| 4002 | .25 | 4016 | .45 | 4027  | .65  | 4049 | .28  | 4071 | .20  | 4511 | .70  |
| 3006 | .95 | 4017 | .65 | 4028  | .70  | 4050 | .45  | 4073 | .20  | 4512 | .95  |
| 4007 | .20 | 4018 | .90 | 4029  | .90  | 4051 | .68  | 4075 | .20  | 4516 | .70  |
| 4008 | .94 | 4019 | .45 | 4030  | .50  | 4052 | .68  | 4076 | 1.10 | 4518 | .65  |
| 4009 | .48 | 4020 | .80 | 4033  | 1.40 | 4053 | .88  | 4078 | .20  | 4520 | 1.10 |
| 4010 | .50 | 4021 | .85 | 4034  | 1.00 | 4054 | 1.00 | 4081 | .20  |      |      |
| 4011 | .15 | 4022 | .85 | 4034A | .90  | 4055 | 1.00 | 4082 | .20  |      |      |
| 4012 | .15 | 4023 | .20 | 4040  | .90  | 4066 | .35  | 4502 | .90  |      |      |
| 4013 | .35 | 4024 | .68 | 4042  | .75  | 4068 | .20  | 4507 | .62  |      |      |

### RESISTORS

|   |  |   |  |
|---|--|---|--|
| 1/4W Values available in E12 series from 10R to 1M. Price 0.83 each.  |  | 17W Values available in E6 series from 1R0 to 22K.  |  |
| 1/4W Values available in E12 series from 1R0 to 10M. Price 0.03 each. |  | Prices 1R0 to 4K7 0.39 each.<br>6R8 to 22K 0.41 each.   |  |
| 1W Values available in E12 series from 2R2 to 10M. Price 0.06 each.   |  | 1/4W Single turn cermet potentiometer. Values available: 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 50K, 100K, 200K, 500K, 1M. Price 0.87 each. |  |
| 2W Values available in E12 series from 10R to 10M. Prices 0.11 each.  |  | 1/4W Multiturn cermet potentiometer. Values available: 20R, 50R, 100R, 200R, 500R, 1K0  |  |

# 15 — 240 Watts!

## HY5 Preamplifier

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

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

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

**SPECIFICATIONS:**

**INPUTS:** Magnetic Pick-up 3mV Ceramic Pick-up 30mV Tuner 100mV Microphone 10mV

Auxiliary 3-100mV input impedance 47k $\Omega$  at 1kHz

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

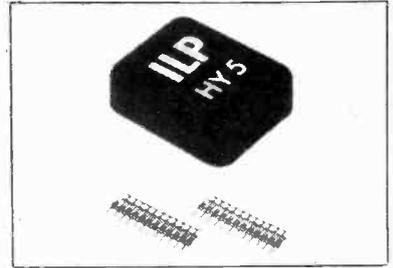
**ACTIVE TONE CONTROLS:** Treble = 12dB at 10kHz Bass = at 100Hz

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

**OVERLOAD:** 38dB on Magnetic Pick-up. **SUPPLY VOLTAGE:** 16.50V

**Price £6.27 + 78p VAT. P&P free.**

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



## HY30 15 Watts into 8 $\Omega$

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

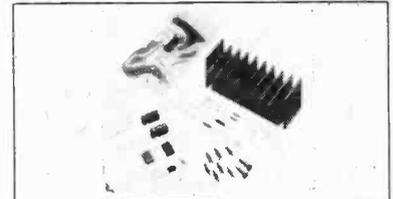
**SPECIFICATIONS:**

**OUTPUT POWER:** 15W R.M.S. into 8 $\Omega$  **DISTORTION:** 0.1% at 15W

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

**SUPPLY VOLTAGE:** 18V

**Price £6.27 + 78p VAT. P&P free.**



## HY50 25 Watts into 8 $\Omega$

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 $\Omega$  **LOAD IMPEDANCE:** 4-16 $\Omega$  **DISTORTION:** 0.04% at 25W at

1kHz **SIGNAL/NOISE RATIO:** 75dB **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB

**SUPPLY VOLTAGE:** 25V **SIZE:** 105.50 x 25mm

**Price £8.18 + £1.02 VAT. P&P free.**



## HY120 60 Watts into 8 $\Omega$

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 $\Omega$  **LOAD IMPEDANCE:** 4-16 $\Omega$  **DISTORTION:** 0.04% at 60W at

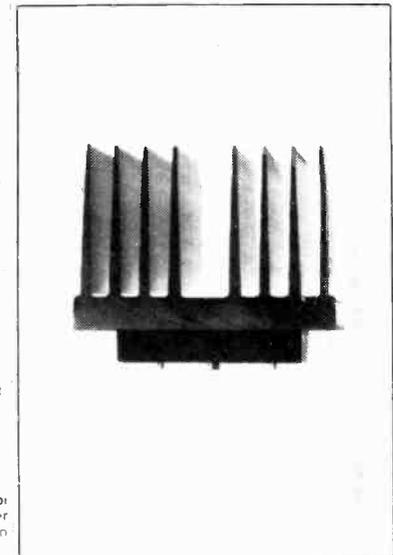
1kHz

**SIGNAL/NOISE RATIO:** 90dB **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB **SUPPLY VOLTAGE:**

35V

**Size:** 114 x 50 x 85mm

**Price £19.01 + £1.52 VAT. P&P free.**



## HY200 120 Watts into 8 $\Omega$

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 white 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 $\Omega$  **LOAD IMPEDANCE:** 4-16 $\Omega$  **DISTORTION:** 0.05% at 100W at

1kHz

**SIGNAL/NOISE RATIO:** 96dB **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB **SUPPLY VOLTAGE:**

45V

**SIZE:** 114 x 100 x 85mm

**Price £27.99 + £2.24 VAT. P&P free.**

## HY400 240 Watts into 4 $\Omega$

The HY400 is I.L.P.'s "Big Daddy" of the range producing 240W into 4 $\Omega$ ! 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 $\Omega$  **LOAD IMPEDANCE:** 4-16 $\Omega$  **DISTORTION:** 0.1% at 240W at

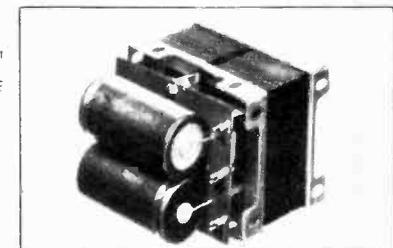
1kHz

**SIGNAL/NOISE RATIO:** 94dB **FREQUENCY RESPONSE:** 10Hz-45kHz — 3dB **SUPPLY VOLTAGE:**

45V

**INPUT SENSITIVITY:** 500mV **SIZE:** 114 x 100 x 85mm

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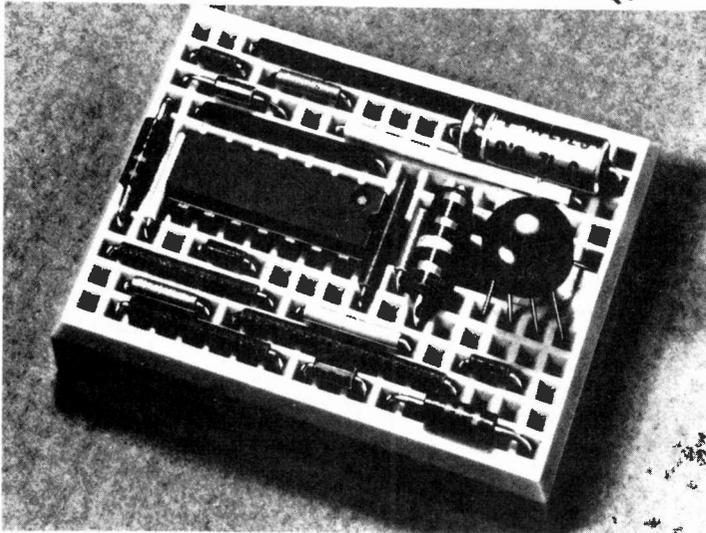
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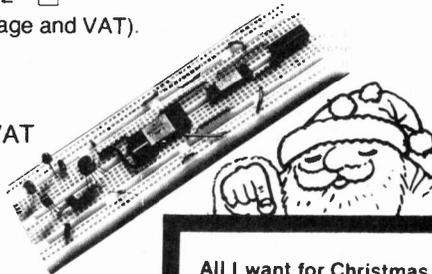
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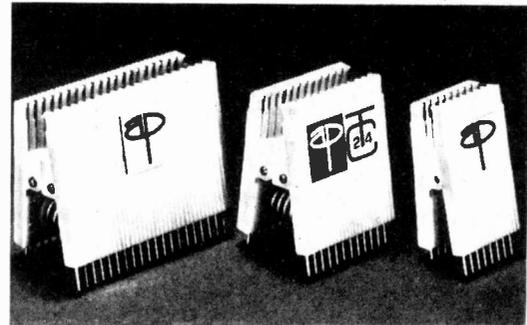
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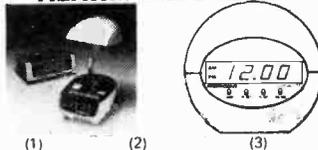
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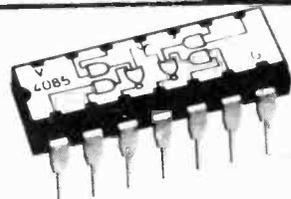
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