electronics today INTERNATIONAL

JANUARY [illegible]

50p

Take out the scratches with our

CLICK ELIMINATOR

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Power Supplies

Loudspeaker Principles

Inside: computing today no3

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

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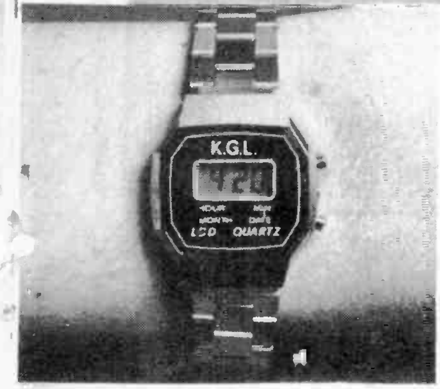
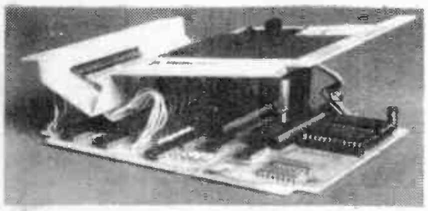
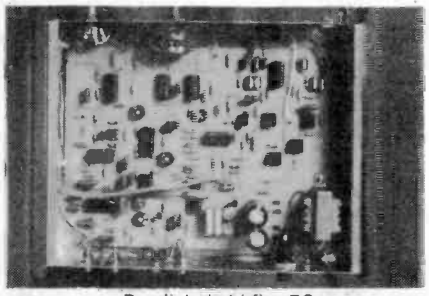
JANUARY 1979 VOL 8 NO 1



Time we did this p.84



Check it out p.81



De-click de hi-fi p.73

FEATURES

PROJECTS

INFORMATION

EDITORIAL AND ADVERTISEMENT OFFICE
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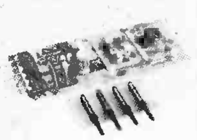
High quality audio modules for Stereo and Mono

S450
STEREO FM TUNER Fitted with phase lock-loop



£22.30 + 40p p&p + 12½% VAT

FREQUENCY RANGE	88 – 108 Mhz
SENSITIVITY	3.0μV
BANDWIDTH	250 kHz
SPURIOUS REJECTION	50 dB
SELECTIVITY ± 400 kHz	55 dB
AUDIO OUTPUT (22.5 kHz deviation)	100 mV
STEREO SEPARATION	30 dB
SUPPLY REQUIREMENTS	20 to 30V (90mA max)
AERIAL IMPEDANCE	75 ohms
DIMENSIONS	240mm x 110mm x 32mm

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

Stereo 30
COMPLETE AUDIO CHASSIS

£18.95 + 40p p&p + 12½% VAT

7 + 7w R.M.S.

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

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

AL60
AUDIO AMPLIFIER MODULE 25 Watts RMS

25w R.M.S.

£4.55 + 25p p&p + 12½% VAT

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

This high quality audio amplifier module is for use in audio equipment and stereo amplifiers and provides output powers up to 25 RMS with distortion levels below 0.1%.

AL80
AUDIO AMPLIFIER MODULE

35w R.M.S.

£7.15* + 25p p&p + 8% VAT

OUTPUT POWER	35 Watts RMS
SUPPLY	40–60 V
LOAD IMPEDANCE	8–16 ohms
TOTAL HARMONIC DISTORTION	Less than 1% (Typically .06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz x2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm x 64mm x 15mm

The AL80 is similar in design to the AL60 above and is of the same high quality but provides output powers up to 35W with distortion levels below 0.1%.

AL250
POWER AMPLIFIER

125w R.M.S.

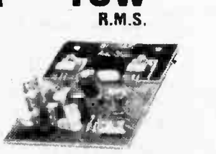
£17.25* + 40p p&p + 8% VAT

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 50 Watts DISTORTION into 4 ohms	0.1%
50 WATTS into 8 ohms	0.06%

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

AL30A
AUDIO AMPLIFIER MODULES

10w R.M.S.



£3.75 + 25p p&p 12½% VAT

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
FREQUENCE RESPONSE	50 Hz kHz ± 3 dBs
SENSITIVITY	75 mV for full output
DIMENSIONS	74mm x 63mm x 28mm

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

SPM80
STABILISED POWER SUPPLY

£4.25 + 25p p&p + 12½% VAT

INPUT A.C. VOLTAGE	33–40V
OUTPUT D.C. VOLTAGE	33 V nominal
OUTPUT CURRENT	10 mA–1.5 amps
OVERLOAD CURRENT	1.7 amps approx.
DIMENSIONS	105mm x 63mm x 30mm

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

PA100
STEREO PRE-AMPLIFIER

£15.80 + 40p p&p + 12½%VAT

FREQUENCY RESPONSE	20Hz to 20 kHz x 1dB
TOTAL HARMONIC DISTORTION	Less than 1% (Typically .07%)
SENSITIVITY INPUTS 1. TAPE	100 mV/100 K ohms) For an
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)

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 gives a choice of inputs together with two filters for high and low frequencies.

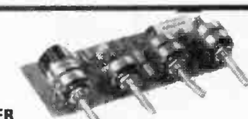
MPA30
MAGNETIC CARTRIDGE PRE-AMPLIFIER

£2.95 25p p&p + 12½% VAT

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

SENSITIVITY	3.5 mV for 100 mV output
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
INPUT IMPEDANCE	50 K ohms
SUPPLY	18 to 30 V–re earth
DIMENSIONS	110x50x25mm (inc DIN socket)

PA12
STEREO PRE-AMPLIFIER



£7.10 30p p&p + 12½% VAT

The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL 20/30 Audio Amplifier Modules, the PS12 power supply and the T538 Transformer. Features 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

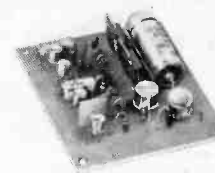
PS12 POWER SUPPLY MODULE

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 60×43×26 mm.

£1.30 + 12½% VAT P&P 25p

BP124 SIREN ALARM MODULE

American Police screamer powered from any 12 volt supply into 4 or 8ohm speaker. Ideal for car burglar alarm, freezer breakdown, and other security purposes.



ONLY £3.00 +8% VAT P&P 25p

MA60 HI-FI AMPLIFIER KIT

Build your own reliable top quality amplifier and save yourself pounds. The MA60 kit comprises the following BI-kits modules: 2x AL60 amps, 1x PA100 pre-amp 1x SPM80 stabilised power supply 1x BMT80 transformer, thus giving 17 watts RMS per channel STEREO. All modules are covered by the usual BI-PAK satisfaction or money back guarantee. Further details of all the above modules are in this advert.

PRICE £32.00 + 12½% + 62p p&p

TC60 KIT

A beautiful designed genuine TEAK WOOD veneered canbinet to put the professional touches to your home built amplifier. Full set of parts incl. front and back panels, knobs, chassis, fuses, sockets, Noen, etc. Ideal for the MA60. Size 425mm x 290mm x 95mm.

PRICE £19.95 + 12½% VAT + 86p p&p

TRANSFORMERS

T538 For use with S 450 AL30A MPA30
Order No **2036** — Price **£3.20** + 55p p&p + 12½% VAT

T2050 For use with Stereo 30
Order No **2050** — Price **£3.25** + 55p p&p + 12½% VAT

BMT80 For use with AL60 SPM80
Order No **2034** — Price **£5.40** + 86p p&p + 12½% VAT

BMT250 For use with AL250
Order No **2035** — Price **£6.35** + £1 10p p&p + 12½% VAT

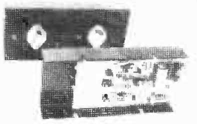
BI-PAK

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	50 Watts R.M.S.
SUPPLY	70 Watts
LOAD IMPEDANCE	8-16 Ohms
TOTAL HARMONIC DISTORTION	05% Max. (typically 02%).
FREQUENCY RESPONSE ± 1dB	25Hz-20kHz
SENSITIVITY	500mV
MAX HEAT SINK TEMP.	45 deg. C
DIMENSIONS	192×89×49mm

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	40-48V
SPM120/55	50-55V
SPM120/65	60-65V
OUTPUT CURRENT	2.5A
RIPPLE	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

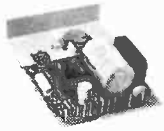
NEW

CONTROL RANGE	±12dB
DYNAMIC RANGE	110dB
MAXIMUM OUTPUT	+15dB
FREQUENCY RESPONSE	30Hz-20kHz (±1dB)
POWER SUPPLY	15-0-15V
VOLTAGE HANDLING INPUT	3V R.M.S.
T.H.D.	005%

Only 155mm×65mm×50mm including the 10×10K 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 ±12dB 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	25V
VOLTAGE REGULATION	2-30V
REGULATED CURRENT	0-2A
Incorporating short circuit protection	

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	20 Hz to 20 kHz × 1dB
TOTAL HARMONIC DISTORTION	Less than .1% (typically .07%)
SENSITIVITY 1. TAPE	100mV/100K ohms For an
INPUTS 2. RADIO TUNER	100mV/100K ohms output
3. MAGNETIC	P.U. 3.5mV/50K
ohms 500mV	
EQUALISATION	Within ±1dB from 20Hz to 20kHz
BASS CONTROL RANGE	±15dBs at 75Hz
TREBLE CONTROL RANGE	+10-20dBs at 15kHz
SIGNAL/NOISE RATIO	Better than 65dBs (all inputs)
INPUT OVERLOAD	Better than 26dBs (all inputs)
SUPPLY	35 to 75V
DIMENSIONS	300×90×33mm (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 "a" (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

GROOV-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 8ohm speakers up to 30 watts. Frequency 3kHz o/n 1905 **£1.65** +12½% VAT P&P 35p

3-WAY for 8ohm speakers up to 30 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 **£5.45** +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: 23×22×26mm. o/n 1318. **£1.95** +8% VAT P&P 35p.

Balance and Tuning Meter
Clear view edgewise meter. Centre zero application. Sensitivity: 100-0-100uA. Dimensions: 45×22×34mm. 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: 23×22×26mm. 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: 40×40×29mm. 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.×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 at 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 'Busby' 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.×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.×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. Stow-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 & skt	£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	6.6m Coiled Guitar Lead Mono Jack Plug to Mono Jack Plug BLACK	£1.50*
124	3 pin DIN plug to 3 pin DIN plug. Length 1.5m	£0.75*
125	5 pin DIN plug to 5 pin DIN plug. Length 1.5m	£0.75*
126	5 pin DIN plug to Tinned open end. Length 1.5m	£0.75*
127	5 pin DIN plug to 4 Phono Plugs. All colour coded. Length 1.5m	£1.30*
128	5 pin DIN plug to 5 pin DIN socket. Length 1.5m	£0.80*
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m	£1.05*
130	2 pin DIN plug to 2 pin DIN 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

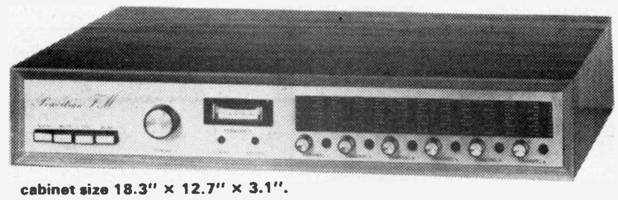
cabinet size 18.3" × 12.7" × 3.1".

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

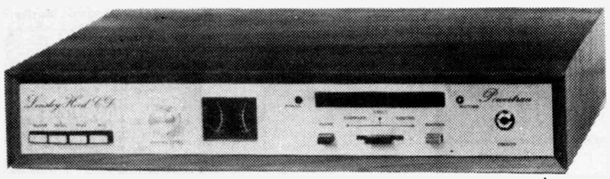
This easy to build version of our world-wide acclaimed 75W amplifier kit based upon circuit boards interconnected with gold plated contacts resulting in minimal wiring and construction delightfully straightforward. The design was published in Hi-Fi News and Record Review and features include rumble filter, 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" × 12.7" × 3.1".



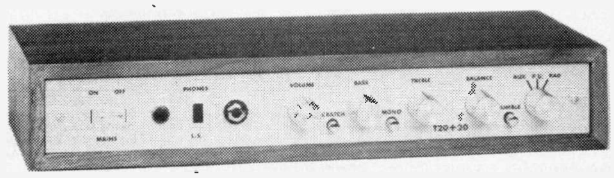
cabinet size 18.3" × 12.7" × 3.1".

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" × 6.7" × 2.8".

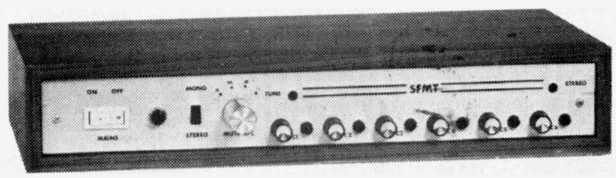
cabinet size 15.5" × 6.7" × 2.8".

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" × 6.7" × 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.

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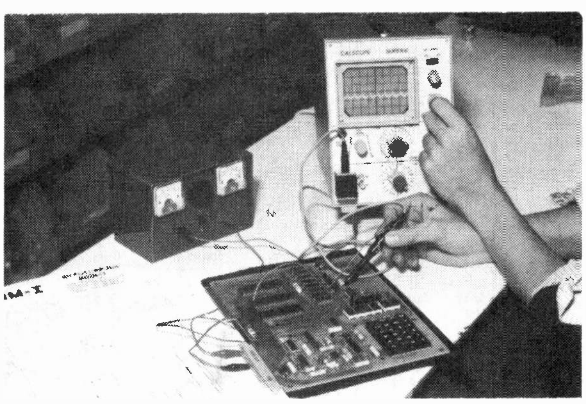
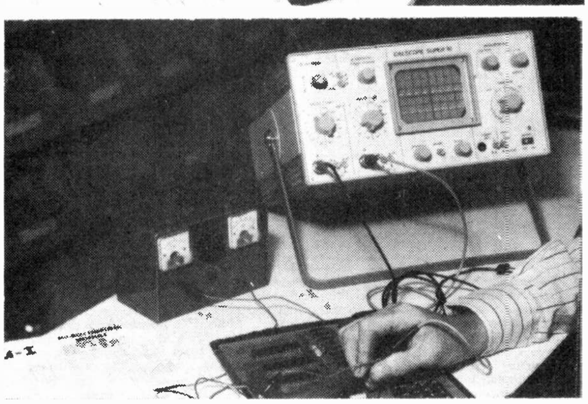
news digest

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.

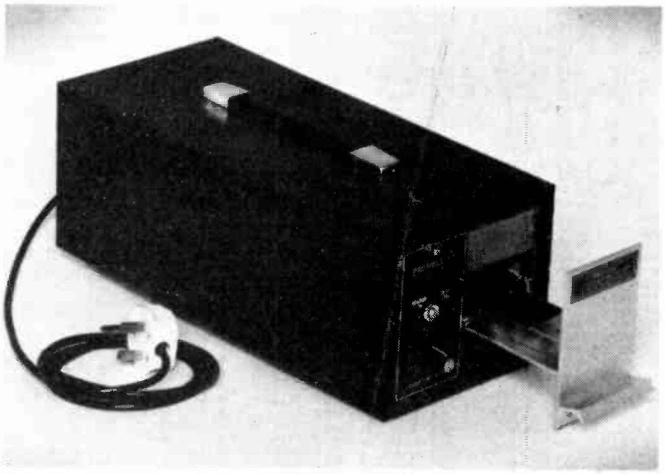
PUT THESE TO GOOD USE

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. ▶

.... 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.

.......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.

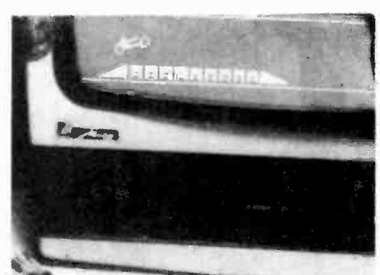
SHORTS

● Every Ready — now called Berec — have released four rechargable 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.

● Direct drive turntables yes. But direct drive MPUs? Also yes — now. The S2000 is a new release from AMI which can drive flouorescent 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.

● 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.



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 handfull 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.

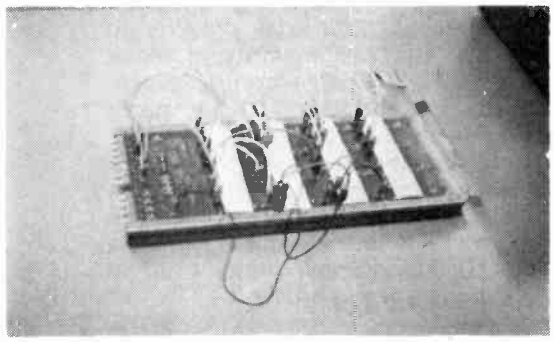
The setup works roughly like this: A computer terminal is situated in the centre of the 'lab' and is surrounded by 16 benches, each provided with an oscilloscope, a signal generator and other relevant test equipment and peripherals. Each bench also has a perspex case with several dozen sockets and LEDs 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.

LOUDSPEAKER PRINCIPLES

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!

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

MOVING COIL

This system dominates the field at present, and is certain to do so for the forseeable 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

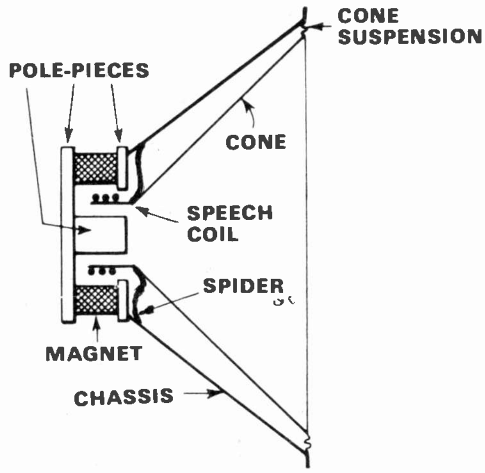
$$F = B.I.k \qquad k = \text{a const.}$$

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.

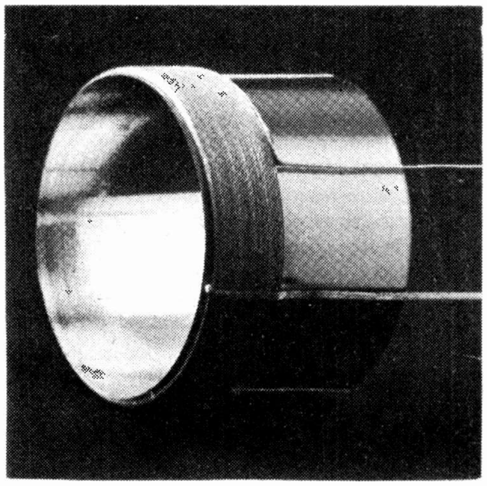


Basic schematic of moving coil loudspeaker. In practice the coil winding would be longer relative to the magnets, so that it did not move out of the field.

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.

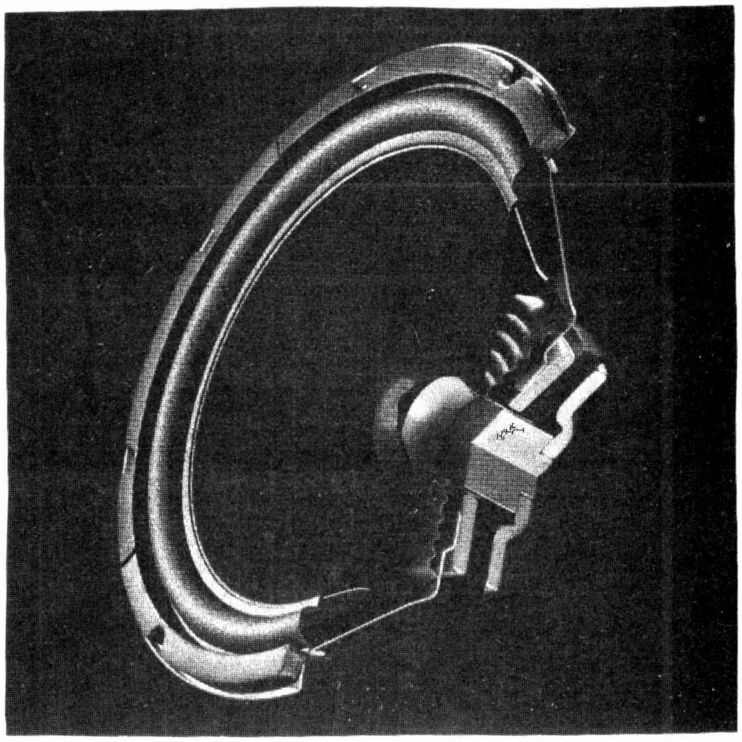


Close-up of a voice coil. This is a machine wound unit belonging to a Bose driver. Note the winding is butted very close to the edge of the paper former, and the precise nature of the winding necessary for linearity.

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



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.

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)
(ii) 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!

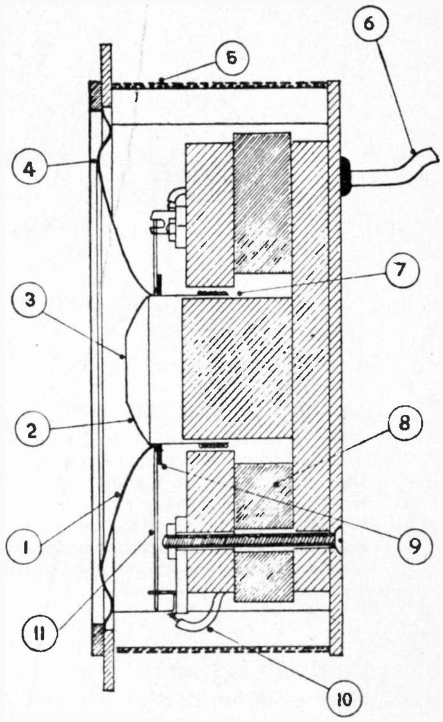
Sinclair marketed a finite baffle speaker some years ago but this seems to have ceased to be.

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 absorbtion 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 berylium 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.

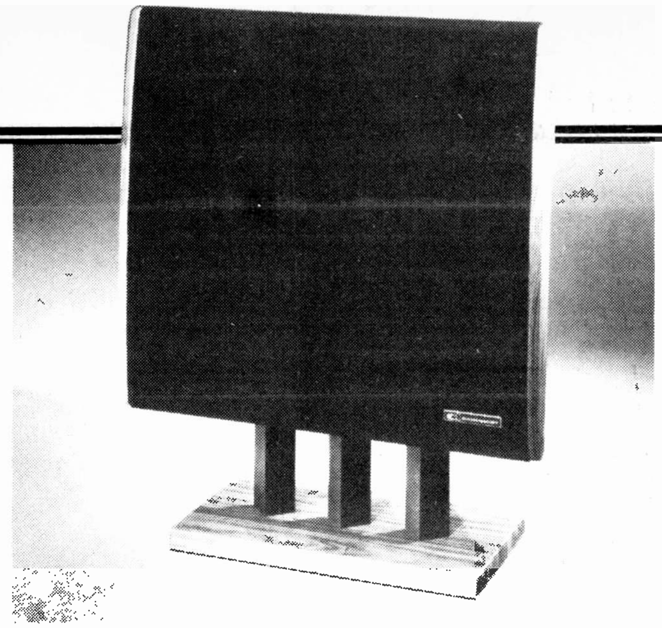
Bass Reflex

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.

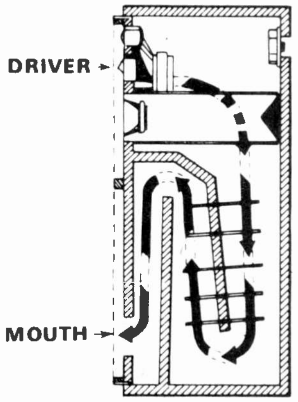
If the far end of the column is open then help is afforded to the bass performance in much the same way as bass reflex cabinets.

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 exampled 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!

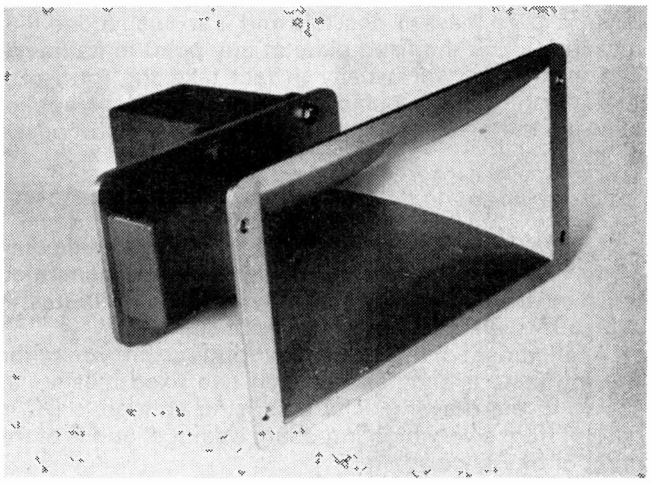


The basic principle behind the transmission line speaker enclosure. The air from the rear of the cone gets 'lost' down the line.

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 exponental 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 propogation. The advantages of this type of loading are good damping of the driver, low distortion but a limited frequency response.

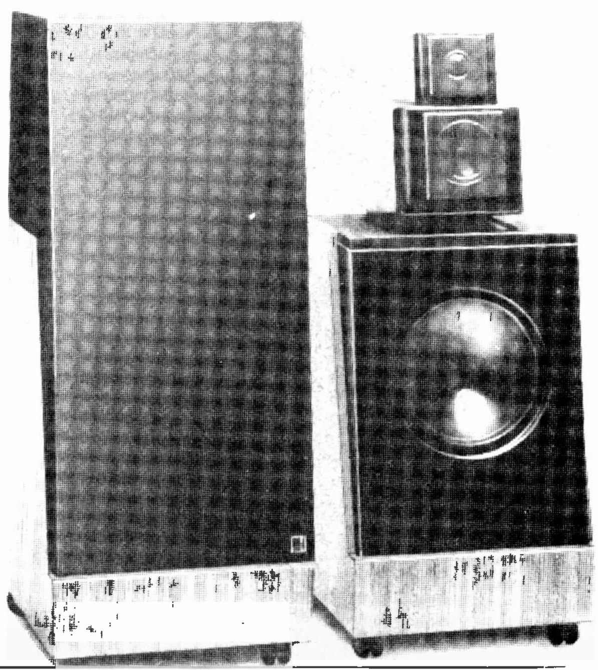


The Decca London ribbon unit, loaded by a caternoidal horn. The flare can be clearly seen in this photo leading down to the ribbon itself somewhere in that block at the back!

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. ▶

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. ▶



ELECTROSTATIC

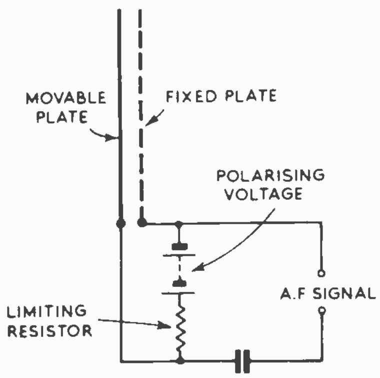
As we have seen the moving coil design suffers because the cone area is unevenly driven by the electrical music signal. The electrostatic principle, developed by both David Tombs and Peter Walker (of the Acoustical Manufacturing Company) is an attempt to produce a unit in which the entire surface of 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 etal 'mesh'. A high polarising voltage≈5kV 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 5kV 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.

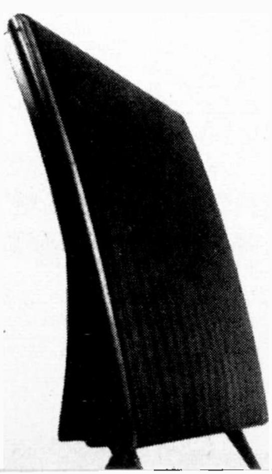
KLH made a brave attempt to reach the theoretical size of plate for good bass response with their superb KLH9 full range units. These are almost exactly door sized—and you need **two** per channel! And they cost £2000 a pair. And they are probably unbeatable by any speaker on the market for sheer accuracy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

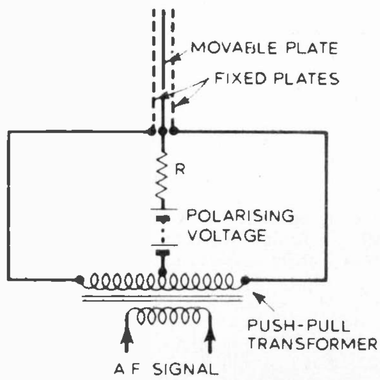
Loading Problems

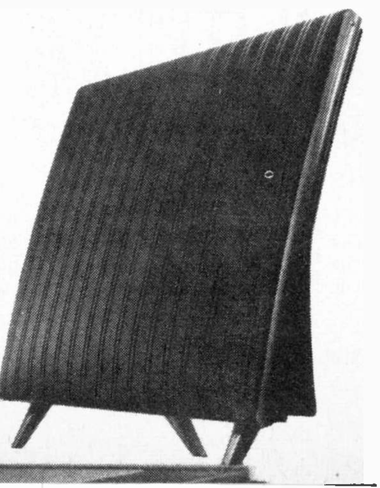
Another less serious drawback is that transformer into which the electrical signal is fed: This presents an awkward load to the amplifier, and can produce some nasty effects from transistor amps.

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

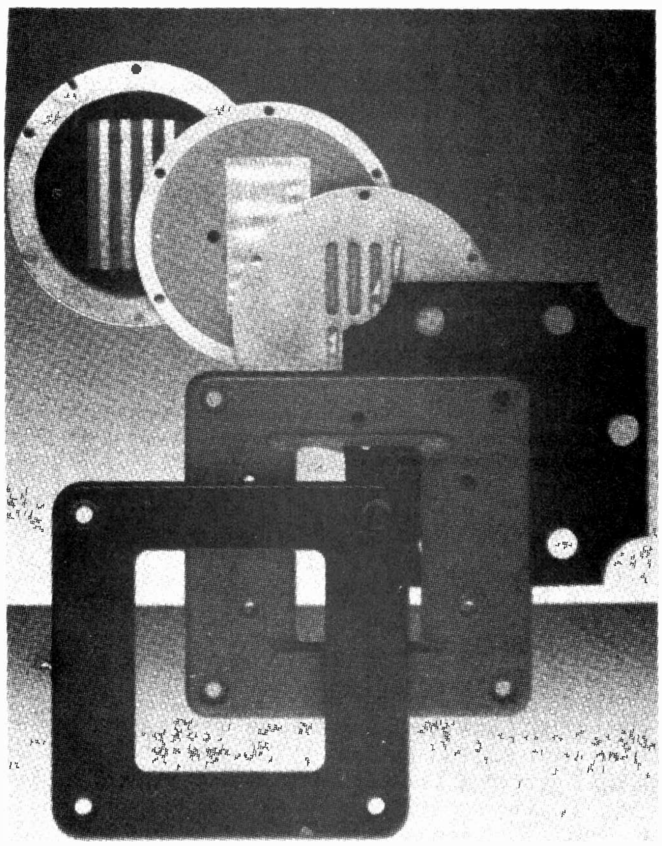
With the release of the Stathearn 21000 speakers, and the new Wharfedale series incorporating Isodynamic tweeters, this approach is gaining ground. It certainly has a lot of promise, which we shall undoubtedly see exploited as time goes on.

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.

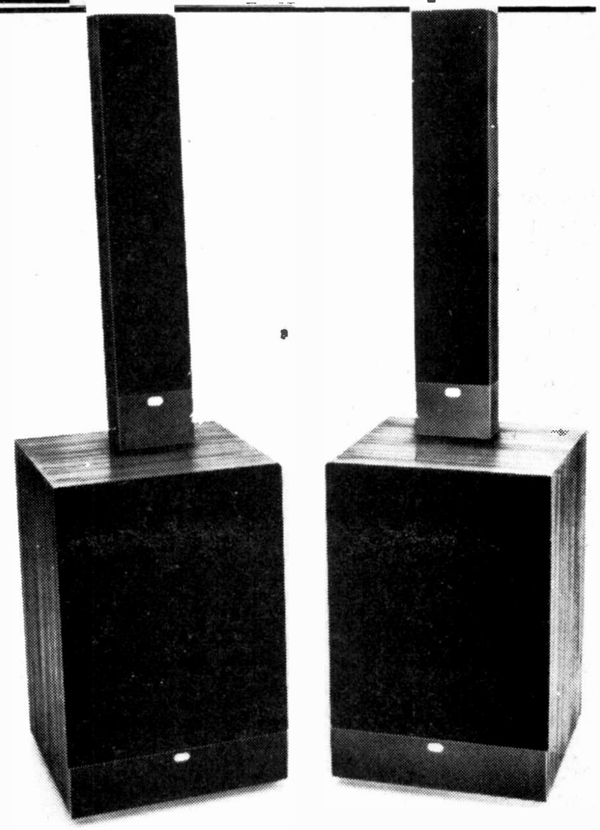
A drive unit built to this principle consists of a thin sheet of mylar, or some such material, with a conductive track bonded onto it in a pattern which covers the surface in as symetrical manner as possible. This conductor acts as the voice coil of the speaker, and when an electrical signal is passed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

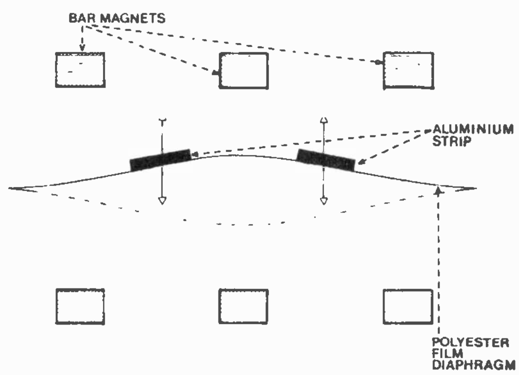
Once again colouration is low, and driver mass small—but also once again to obtain bass means large areas, and conductors capable of handling large currents. Strathearns units are above 500Hz operators only and are transformer coupled to the input. Wharfedale employ their invention in high frequency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

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

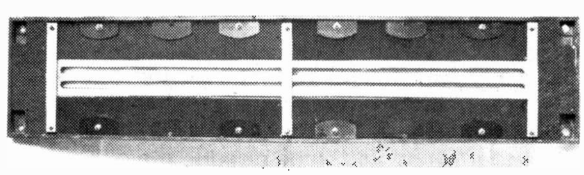


Exploded view of the Whardedale Isodynamic tweeker. The driver plane — second from the rear — uses a material 25 microns thick with an etched aluminium circuit.





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 diaphram 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

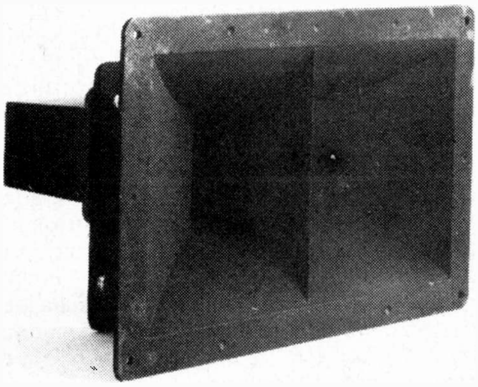
If we take the voice coil of moving coil speakers, and make this the active element, instead of the cone, we would do away with a lot of the causes of colouration in the process. Mass would be much smaller, break-up or rippling would be greatly reduced, if not eliminated and thus transient handling improved.

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.

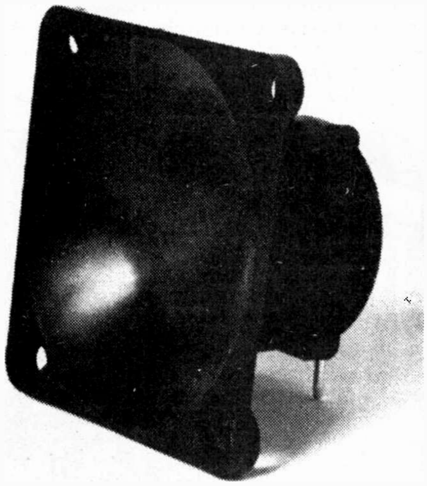
PIEZO-ELECTRIC

In the July 1976 edition of ETI we reviewed the Motrola 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, phenominal 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 aare required, and no coil is used.

In the Motorola design two thin slices of ceramic material—lead zirconite-lead titante in case it makes your life the fuller for knowng 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.



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.

Pros . . . . . .

Since the impedence 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 dissipa tion 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 impedence, it is difficult to compare efficiency with normal units, suffice it to say that 4V RMS produces 105d BA at 18ins distance, and that this can be considered efficient!

. . . . . . 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

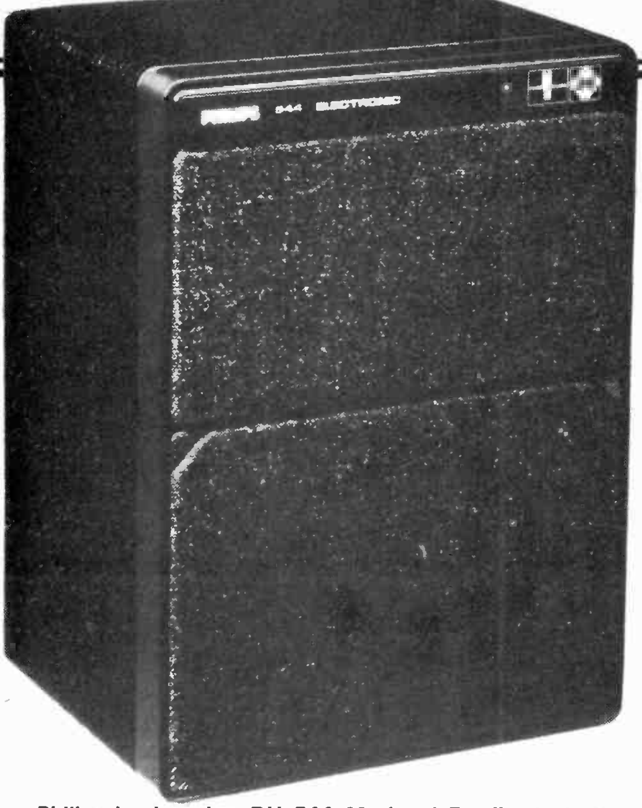
Although this perhaps only a modification of earlier systems, the performance gains at LF are such that it warrants a closer look.

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.

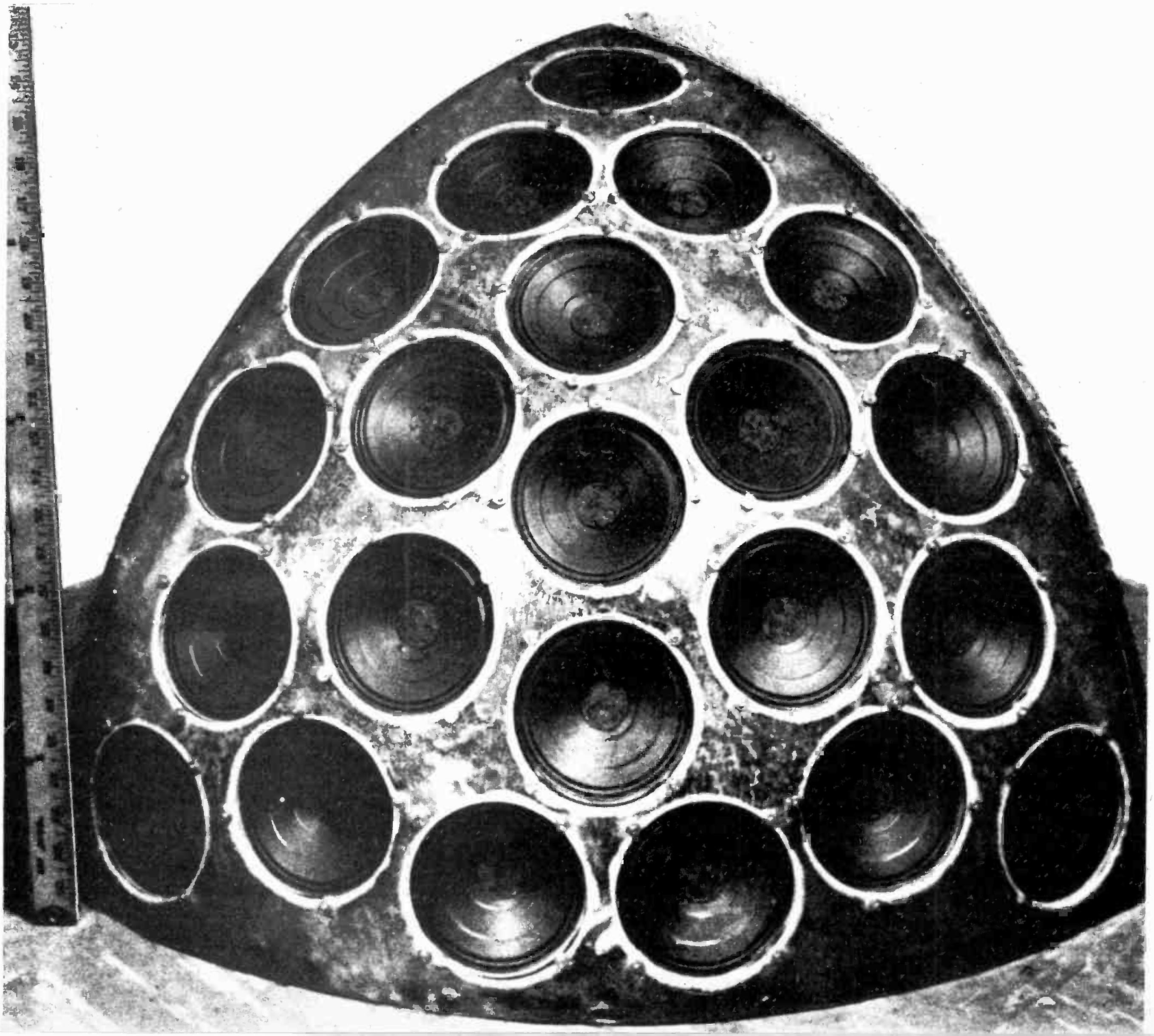
This is mounted on a small PCB and is a ceramic acceleration sensor. This generates a signal proportional to the actual driver output, and this is compared electronically to the incoming audio. Correction is applied to remove any errors present. Cross over is carried out at small signal level, and active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



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TRANSISTORS

2N696	0.39	2N2218	0.35	2N3393	0.17	2N4037	0.60	2N5192	0.80
2N697	0.31	2N2218A	0.38	2N3394	0.17	2N4058	0.22	2N5193	0.75
2N698	0.49	2N2219	0.38	2N3395	0.19	2N4059	0.17	2N5194	0.80
2N699	0.58	2N2219A	0.39	2N3396	0.19	2N4060	0.22	2N5195	0.97
2N706	0.30	2N2220	0.39	2N3397	0.19	2N4061	0.19	2N5245	0.37
2N706A	0.30	2N2221	0.25	2N3438	0.85	2N4062	0.20	2N5246	0.38
2N708	0.30	2N2221A	0.25	2N3440	0.75	2N4064	1.35	2N5247	0.44
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2N727	0.50	2N2646	0.80	2N3702	0.14	2N4124	0.19	2N5298	0.44
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2N929	0.37	2N2905	0.31	2N3707	0.14	2N4287	0.22	2N5458	0.35
2N929A	0.37	2N2905A	0.31	2N3708	0.12	2N4288	0.22	2N5459	0.32
2N930	0.37	2N2906	0.25	2N3709	0.12	2N4289	0.22	2N5460	0.65
2N930A	0.95	2N2906A	0.25	2N3771	2.16	2N4347	2.20	2N5484	0.37
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2N2194A	0.45	2N3390	0.50	2N3905	0.18	2N5087	0.30	2N6109	0.55
2N2195	0.40	2N3391	0.40	2N3906	0.18	2N5088	0.30	2N6111	0.49
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				2N4036	0.72	2N5191	0.75	2N6123	0.48

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40361	0.55	BC108C	0.17	BC179A	0.25	BC213LB	0.17	BC547	0.13
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40363	1.45	BC109B	0.17	BC179C	0.26	BC214	0.17	BC547B	0.13
40408	0.82	BC109C	0.18	BC182	0.12	BC214B	0.17	BC548	0.13
40409	0.82	BC140	0.30	BC182A	0.12	BC214C	0.17	BC549	0.14
40410	0.82	BC141	0.32	BC182B	0.13	BC214L	0.18	BC549B	0.14
40411	3.10	BC147	0.13	BC182L	0.15	BC214LB	0.18	BC549C	0.15
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40669	1.30	BC148C	0.13	BC183A	0.12	BC238B	0.13	BCY70	0.21
AC126	0.48	BC149	0.15	BC183B	0.13	BC238C	0.13	BCY71	0.26
AC127	0.48	BC149C	0.15	BC183C	0.13	BC239B	0.16	BCY72	0.18
AC128	0.48	BC157A	0.15	BC183L	0.15	BC239C	0.17	BD115	0.88
AC151	0.43	BC158A	0.15	BC183LA	0.15	BC257A	0.18	BD131	0.55
AC152	0.54	BC158B	0.15	BC183LB	0.15	BC258B	0.19	BD132	0.75
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AD162	1.00	BC169B	0.13	BC212B	0.15	BC308B	0.16	BD187	0.95
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BC107B	0.16	BC178	0.22	BC213A	0.15	BC328	0.20	BD239A	0.44
BC108	0.16	BC178A	0.25	BC213B	0.15			BD239C	0.59

BD240A	0.49	BF160	0.33	BFR79	0.30	ME4001	0.16	TIP30C	0.70
BD240C	0.59	BF161	0.65	BFR80	0.30	ME4002	0.16	TIP31A	0.54
BD241A	0.49	BF167	0.37	BFR81	0.30	ME4003	0.16	TIP31C	0.72
BD241C	0.65	BF173	0.37	BFX29	0.34	ME4101	0.11	TIP32A	0.59
BD242A	0.55	BF177	0.27	BFX30	0.34	ME4102	0.11	TIP32C	0.82
BD242C	0.62	BF178	0.27	BFX84	0.30	ME4103	0.11	TIP41A	0.76
BD243A	0.65	BF179	0.33	BFX85	0.38	ME4104	0.11	TIP41C	0.97
BD243C	0.87	BF180	0.37	BFX86	0.30	ME6101	0.22	TIP42A	0.86
BD244A	0.70	BF181	0.37	BFX87	0.35	ME6102	0.22	TIP42C	1.08
BD244C	0.87	BF182	0.37	BFX88	0.30	MJ2955	1.35	TIP2955	0.70
BD245A	0.69	BF183	0.44	BFX89	1.37	MJE340	0.62	TIP3055	0.59
BD245C	0.85	BF184	0.41	BFY50	0.27	MJE370	0.62	TIS34	1.05
BD246A	0.72	BF185	0.37	BFY51	0.27	MJE371	0.86	TIS42	0.50
BD246C	0.93	BF194	0.16	BFY52	0.27	MJE520	0.50	TIS43	0.47
BD433	0.44	BF195	0.16	BFY90	1.35	MJE521	0.70	TIS90	0.22
BD434	0.46	BF196	0.16	BR101	0.55	MJE2955	1.65	TIS91	0.27
BD435	0.46	BF197	0.18	BRY39	0.55	MPF3055	1.05	TIS92	0.33
BD436	0.46	BF198	0.19	BSX19	0.35	MPF102	0.33	TIS93	0.36
BD437	0.55	BF199	0.19	BSX20	0.35	MPF103	0.44	ZTX300	0.17
BD438	0.55	BF224J	0.22	BSX21	0.36	MPF104	0.44	ZTX301	0.17
BD529	0.49	BF225J	0.27	BU104	1.80	MPSA05	0.44	ZTX302	0.27
BD530	0.55	BF244A	0.38	BU105	1.55	MPSA05	0.27	ZTX303	0.27
BD535	0.70	BF244B	0.33	BU126	1.08	MPSA06	0.27	ZTX304	0.27
BD536	0.70	BF245A	0.44	BU204	2.20	MPSA12	0.44	ZTX330	0.22
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BD538	0.77	BF257	0.35	BU206	2.70	MPSA55	0.27	ZTX530	0.25
BD539	0.60	BF258	0.35	BU208	2.70	MPSA56	0.27		
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BDX14	1.32	BF336	0.42	ME0402	0.22	R2010B	2.15		
BDX18	1.90	BF337	0.49	ME0404	0.17	TIP29A	0.49		
BDY20	1.10	BF338	0.52	ME0412	0.22	TIP29C	0.65		
BDY55	1.90	BFR39	0.30	ME0414	0.22	TIP30A	0.54		
BDY56	2.10	BF240	0.29						
BF115	0.39	BFR41	0.30						

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CA3020	2.20	LM380N14	1.08	LM78L05CZ	0.30	TBA540	2.60
CA3020A	2.50	LM381AN	2.70	LM78L12CZ	0.30	TBA540Q	2.70
CA3028A	0.90	LM381N	1.69	LM78L15CZ	0.30	TBA550	3.60
CA3028B	1.25	LM382N	1.32	MM5314	4.60	TBA550Q	3.80
CA3030	1.50	LM384N	1.55	MM5316	4.60	TBA5600Q	3.00
CA3030A	2.20	LM386N	0.88	NE555	0.33	TBA570	2.10
CA3038	2.90	LM387N	1.10	NE556	0.85	TBA570Q	2.20
CA3038A	4.10	LM388N	1.00	NE558N	1.98	TBA700Q	2.20
CA3045	1.55	LM389N	1.00	NE560	4.50	TBA720AQ	2.06
CA3046	0.77	LM702C	0.81	NE561	4.50	TBA750	2.36
CA3048	2.45	LM709	0.70	NE562	4.50	TBA750Q	2.45
CA3052	1.78	LM7098	0.50	NE565	1.39	TBA800	1.30
CA3080	0.85	LM70914	0.49	NE566	1.75	TBA810S	1.30
CA3080A	2.10	LM710	0.67	NE567	1.90	TBA820	0.80
CA3086	0.50	LM71014	0.64	NE571N	4.95	TBA920	2.99
CA3088B	1.87	LM711CN	0.72	SAS560	2.70	TCA160C	2.36
CA3089B	2.90	LM723C	0.75	SAS570	2.70	TCA160B	2.55
CA3090Q	4.40	LM723C14	0.45	SAJ110	2.10	TCA270	2.99
CA3130	1.06			S041P	1.35	TCA730	4.50
CA3140	1.04	LM741C	0.70	S042P	1.35	TCA740	4.50
LM301	0.30	LM741C8	0.30	SN76001N	1.30	TCA750	3.00
LM307N	0.50	LM741C14	0.30	SN76003N	2.38	TCA760	2.00
LM308N	0.95	LM747CN	0.99	SN76013N	1.50	TCA105	1.49
LM309KC	1.95	LM7488	0.50	SN76023N	1.50	TCA440	1.65
LM317K	3.35	LM74814	0.90	SN76033N	2.35	TDA1022	7.50
LM318N	2.45	LM1303N	1.15	TAA263	1.35	TDA1024	1.24
LM320T5	2.15	LM1304N	1.52	TAA300	3.70	TDA1034	4.75
LM320T12	2.15	LM1305N	1.52	TAA320A	1.15	TDA2020AD	4.50
LM320T15	2.15	LM1307N	1.22	TAA350A	3.00	UAA170	2.15
LM320T24	2.15	LM1310N	2.10	TAA521	1.10	UAA180	2.15
LM320P5	1.15	LM1351N	1.30	TAA522	2.10	TL080CP	1.25
LM320P12	1.15	LM1458N	0.45	TAA550	0.48	TL081CP	0.90
LM320P15	1.15	LM1496N	0.97	TAA550	2.10	TL082CP	1.10
LM320P24	1.15	LM1808N	2.10	TAA570	2.20	TL083CN	1.40
LM323K	6.95	LM1812N	6.20	TAA370A	5.45	TL084CN	1.45
LM339N	0.60	LM1820N	1.16	TAA630	2.40	LF355N	0.80
LM340T5	0.88	LM1828N	1.90	TAA960	3.90	LF356N	0.80
LM340T15	0.88	LM1830N	1.90	TAA970	4.20	LF357N	0.80
LM340T24	0.88	LM1841N	1.90	TAA611B	2.50	LF13201N	3.00
LM341P5	0.80	LM1845N	1.50	TAA621	2.50	LF13331N	3.00
LM341P12	0.80	LM1848N	1.98	TAA661A	1.65	LF13741H	0.80
LM341P15	0.80	LM1850N	1.90	TAA661B	1.45	LF13741N	0.55
LM341P24	0.80	LM1889N	4.90	TAA700	4.50		
LM348N	0.95	LM3301N	0.60	TAA930A	1.45		
LM358N	0.60	LM3302N	0.55	TAA930B	1.45		
LM360N	3.00	LM3401N	0.55	TAD100	2.00		
LM370N	3.30	LM3900N	0.68	TBA120	0.80		
LM371H	2.35	LM3905N	1.15	TBA500	2.24		
LM350K	6.45	LM3909N	0.78	TBA500Q	2.34		
LM373N	3.35	LM3911N	1.10	TBA510	2.35		
LM374N	3.36	LM7805K	1.75	TBA510Q	2.48		
LM377N	1.80	LM7812K	1.75	TBA520	2.60		
LM378N	2.40	LM324	0.75	TBA520Q	2.70		

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		4022B	1.00	4051B	0.85	4078	0.27
4000	0.22	4023B	0.22	4052B	0.86	4081B	0.24
4001B	0.22	4024B	0.76	4053B	0.98	4082	0.27
4002	0.22	4025B	0.22	4054	1.48	4085	0.89
4006	1.25	4027B	0.55	4055	1.65	4086	0.89
4007	0.22	4028B	0.92	4056	1.65	4089B	2.10
4008B	0.99	4029B	1.10	4059	6.00	4093B	1.00
4009	0.58	4030	0.84	4060B	1.15	4094	2.30
4010	0.58	4031B	2.25	4063	1.35	4095	1.30
4011B	0.22	4035B	1.30	4066B	0.75	4096	1.30
4012	0.22	4037	1.20	4067	4.85	4097	4.65
4013B	0.52	4041B	0.85	4068	0.27	4098	1.00
4014	1.00	4042B	0.86	4069B	0.24	4510B	1.20
4015	1.05	4043	1.05	4070B	0.85	4511	1.75
4016	0.52	4044	1.00	4071B	0.24	4516	2.10
4017B	105	4045	1.76	4072	0.27	4518B	1.20
4018B	1.05	4046B	1.50	4073B	0.24		
4019B	0.52	4047B	0.96	4075B	0.24		
4020B	1.15	4049	0.96	4076B	0.99		

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74LS00N	0.26	74LS168N	2.43	7404N	0.17	7496N	0.70
74LS01N	0.26	74LS169N	2.43	7405N	0.22	7497N	1.95
74LS02N	0.26	74LS174N	1.33	7406N	0.56	74100N	1.40
74LS03N	0.26	74LS175N	1.26	7407N	0.55	74107N	0.35
74LS04N	0.29	74LS181N	3.95	7408N	0.22	74118N	0.95
74LS10N	0.26	74LS189N	3.74	7409N	0.22	74119N	1.40
74LS12N	0.26	74LS190N	1.00	7410N	0.20	74121N	0.28
74LS13N	0.58	74LS191N	1.00	7411N	0.26	74122N	0.55
74LS14N	1.43	74LS192N	1.98	7412N	0.20	74123N	0.55
74LS20N	0.26	74LS193N	1.98	7413N	0.36	74125N	0.45
74LS26N	0.39	74LS196N	1.28	7414N	0.80	74141N	0.86
74LS27N	0.50	74C00N	0.24	7416N	0.36	74148N	1.35
74LS28N	0.42	74C02N	0.24	7417N	0.36	74145N	0.86
74LS30N	0.26	74C04N	0.24	7420N	0.22	74150N	1.20
74LS37N	0.32	74C08N	0.24	7423N	0.32	74151N	0.76
74LS38N	0.32	74C10N	0.24	7425N	0.32	74153N	0.76
74LS40N	0.29	74C14N	1.41	7427N	0.32	74154N	1.20
74LS42N	1.07	74C20N	0.24	7430N	0.22	74155N	0.70
74LS47N	1.09	74C30N	0.24	7432N	0.30	74157N	0.78
74LS48N	1.09	74C32N	0.24	7437N	0.35	74160AN	1.10
74LS49N	1.09	74C42N	0.92	7438N	0.32	74161AN	1.10
74LS51N	0.26	74C48N	1.38	7440N	0.20	74162AN	1.10
74LS54N	0.26	74C73N	0.54	7441AN	0.84	74163AN	1.10
74LS73N	0.42	74C74N	0.56	7442N	0.76	74164N	1.36
74LS76N	0.42	74C76N	0.54	7445N	1.40	74165N	1.36
74LS78N	0.42	74C83N	1.30	7446AN	0.90	74167N	2.50
74LS83AN	1.20	74C85N	1.30	7447AN	0.80	74174N	1.60
74LS85N	1.10	74C86N	0.64	7448N	0.80	74175N	1.00
74LS90N	1.10	74C89N	4.39	7450N	0.22	74176N	0.90
74LS91N	1.20	74C90N	0.85	7451N	0.22	74177N	0.90
74LS92N	0.86	74C93N	0.85	7453N	0.22	74180N	1.00
74LS93N	1.10	74C95N	1.04	7454N	0.22	74181N	2.00
74LS95AN	1.10	74C107N	1.22	7460N	0.22	74182N	0.80
74LS96N	1.35	74C150N	4.14	7470N	0.46	74184N	1.50
74LS107N	0.42	74C151N	2.47	7472N	0.30	74185N	1.50
74LS109N	0.42	74C154N	3.68	7473N	0.44	74188N	3.25
74LS122N	0.80	74C157N	2.21	7474N	0.32	74189N	2.60
74LS123N	0.83	74C160N	1.11	7475N	0.80	74190N	1.40
74LS124N	2.70	74C161N	1.11	7476N	0.45	74191N	1.20
74LS125N	0.50	74C162N	1.11	7480N	0.60	74192N	1.20
74LS126N	0.50	74C163N	1.11	7481N	1.00	74193N	1.20
74LS136N	0.44	74C164N	1.04	7482N	0.90	74196N	1.20
74LS156N	1.20	74C193N	1.11	7483N	1.05	74197N	1.00
74LS158N	0.65	74C195N	1.04	7484N	1.20	74198N	2.00
74LS160N	1.43	7400N	0.17	7492N	0.45	74199N	2.00
74LS161N	0.85	7401N	0.17	7493N	0.45		
74LS162N	1.43	7402N	0.17	7494N	0.90		
74LS164N	1.43	7403N	0.17	7495N	0.76		

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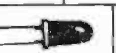

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400v 0.54	400v 0.68	400v 0.90

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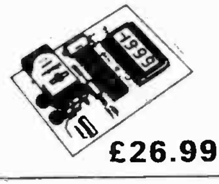

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MAKES COMPONENTS BUYING EASY

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 load, 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. ▶

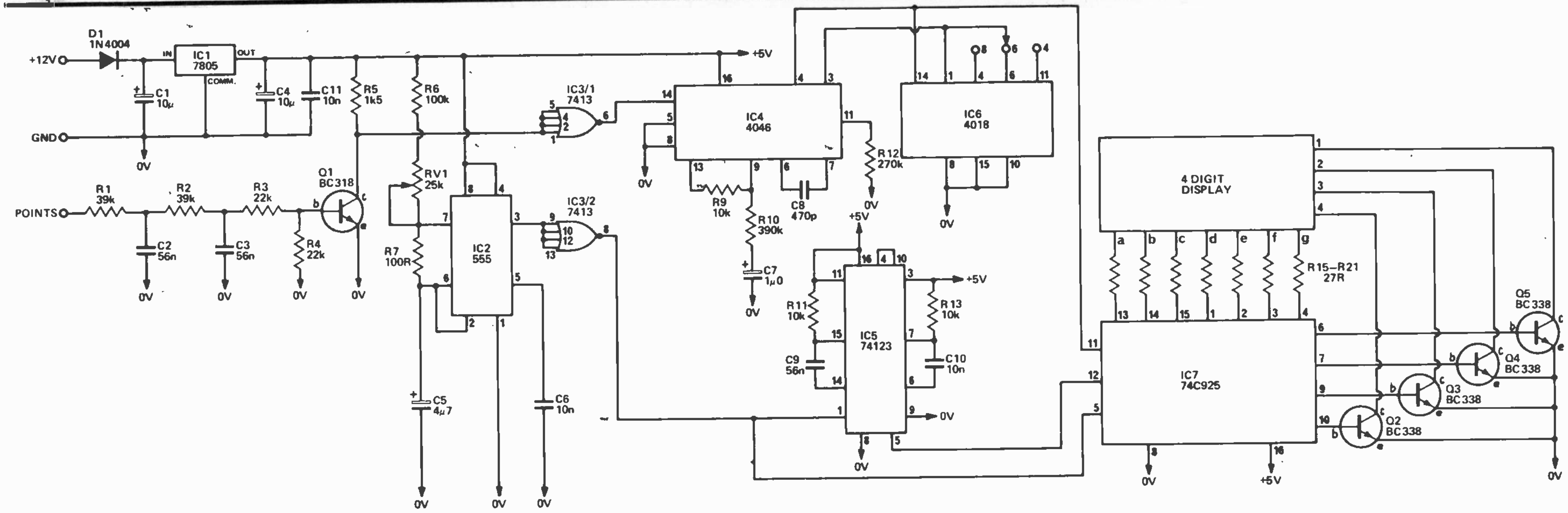


Fig. 2. Full circuit diagram for the digital car tacho unit.

HOW IT WORKS

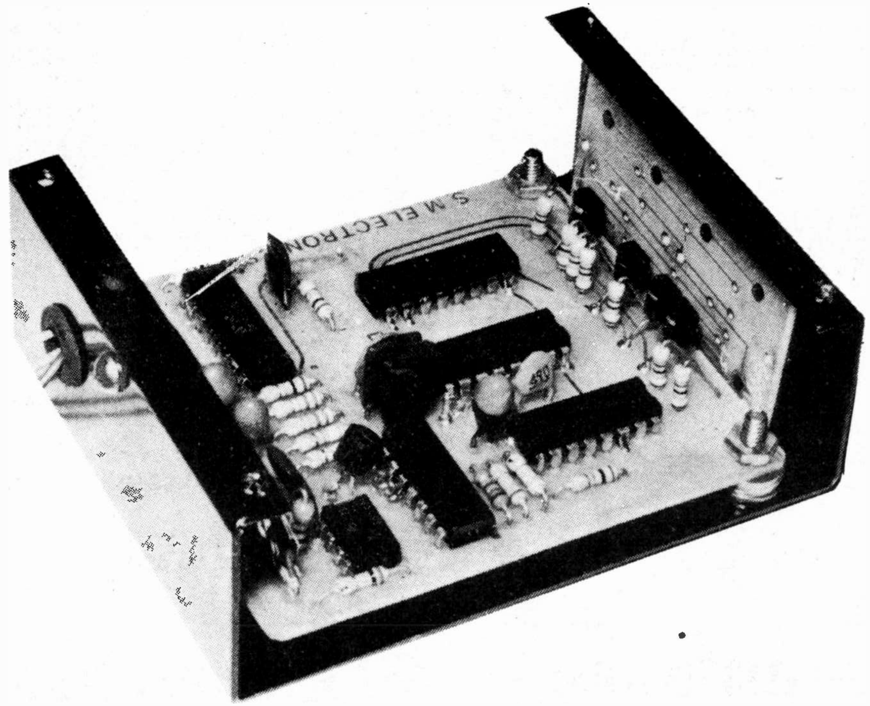
The output from the points of the distributor is basically a 0 to 12V square wave with a 200 volt pulse on the rising edge. A filter network, R1-R4, C2, 3 is used to remove the high voltage pulse (and points bounce) and Q1 buffers it giving a +5 to 0V output on its collector. As the filter network removes 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 μs 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 μs delay before triggering the second half of IC5; this gives a 40 μs pulse to reset IC7 back to zero.

IC7 is a 4 digit counter with a latch (store) and seven segment decoder driver. It needs four external transistors 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.



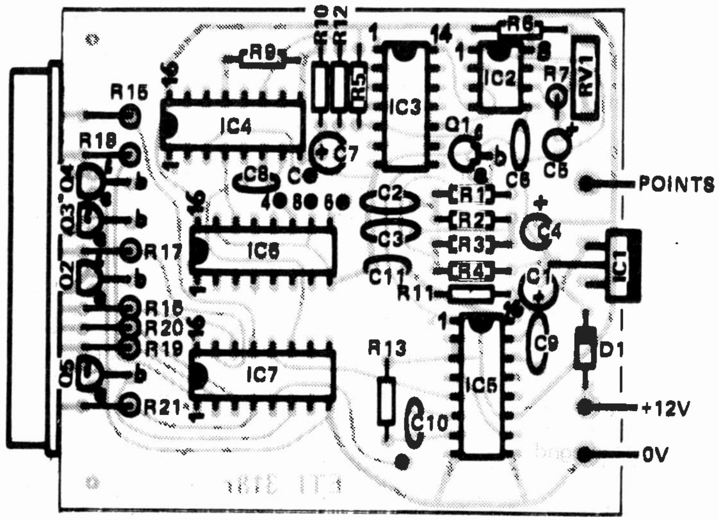
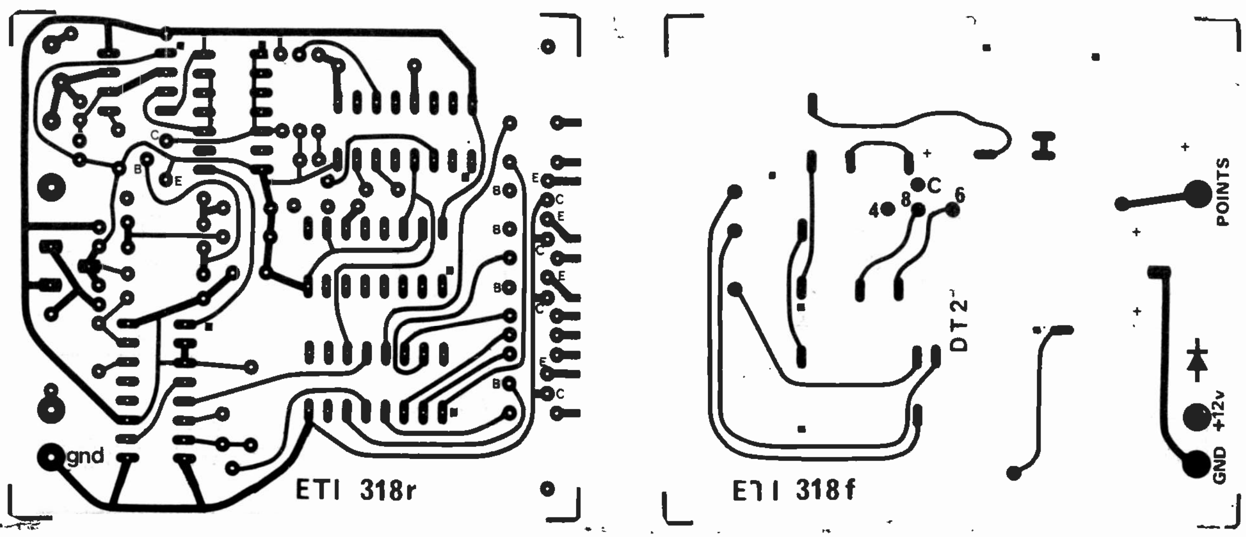


Fig. 1. The component overlay for the board. The board is double sided although only the lower surface is shown here. Note the link between the two surfaces of the board near C10.

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



SPECIFICATION

Range	**100 to 9990 RPM**
Resolution	**10 RPM**
Reading rate	
4 or 8 cylinders	**2.66 per second**
6 cylinders	**3 per second**
Power supply	**7 to 15V@ 400mA**
Suitable ignition systems	**standard**
	CDI
	transistor assisted
	'it will not operate on 'pointless' systems

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.

PARTS LIST

RESISTORS	all ¼ 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	4μ 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
Q2-Q5	BC338
D1	1N4004
Display	NSB5881
MISCELLANEOUS	
PCB	
Case to suit	

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.

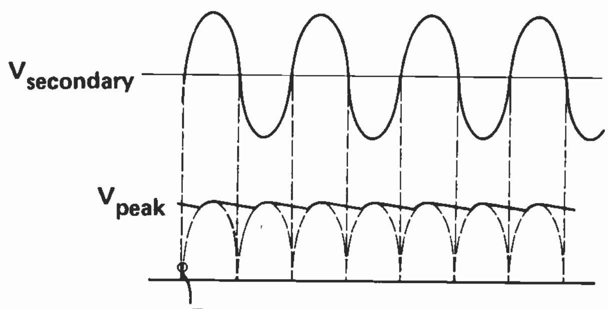


Figure 1. Below: an unregulated power supply. Above: The output (with a load resistor).

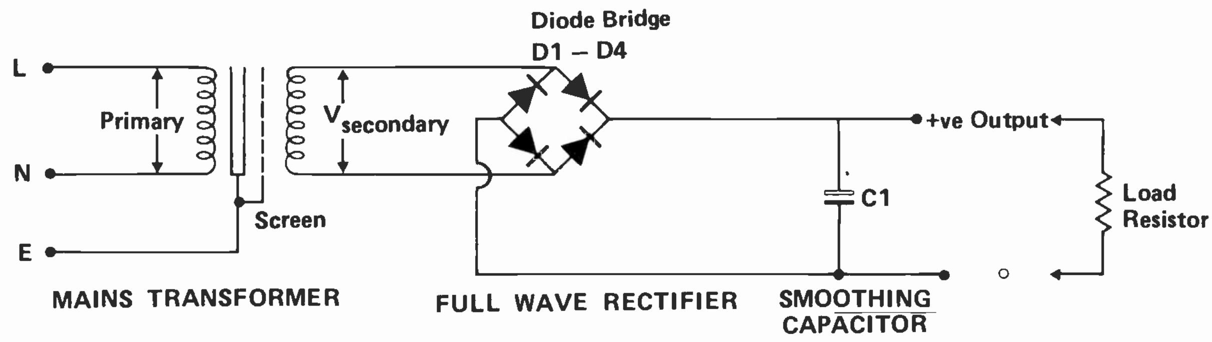
The function of a mains isolating transformer is to physically separate the user end of a piece of equipment from the 'potentially'(!) lethal mains voltage. The transformer also provides a suitable voltage which can be rectified and smoothed and connected to a voltage regulator. This is the secondary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

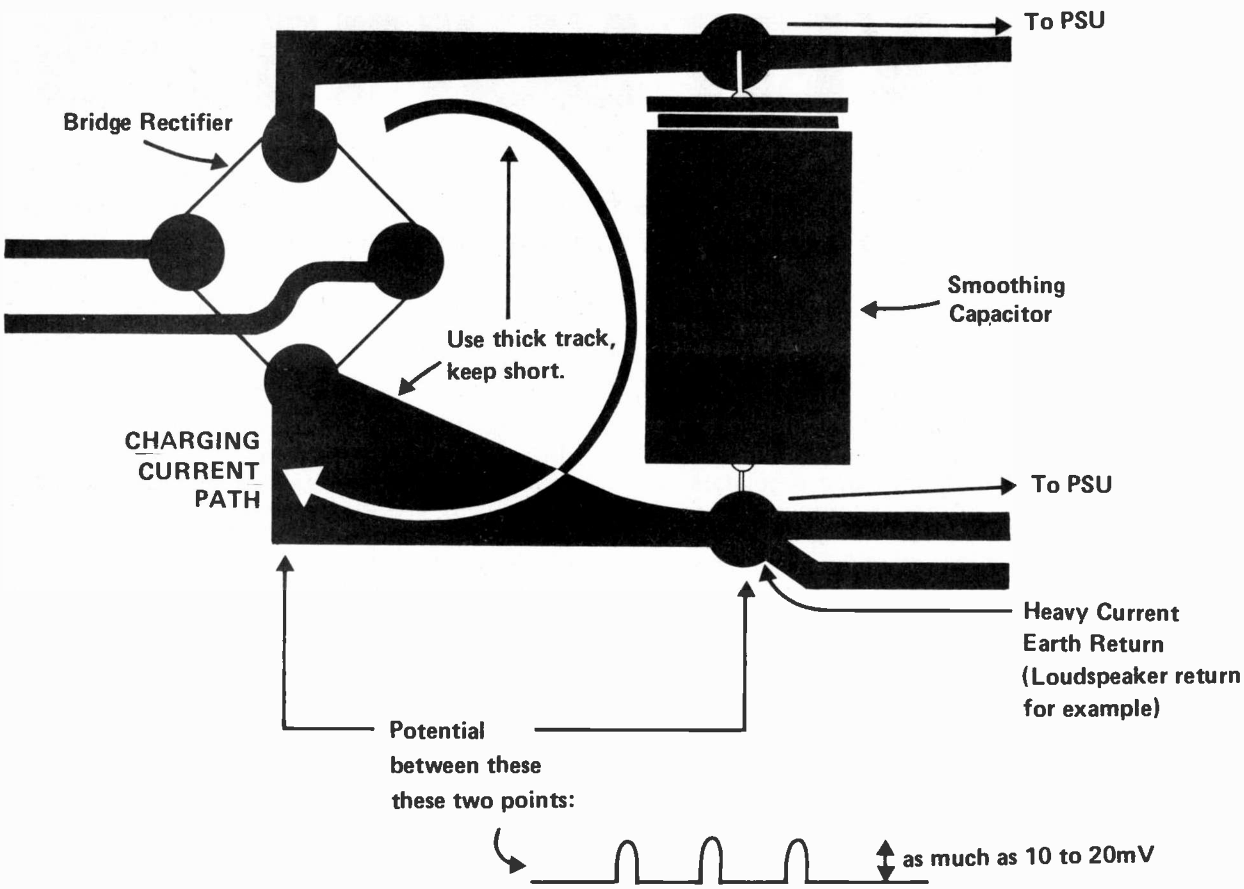
Thus care has to be taken when selecting a transformer such that the smoothing capacitor working voltage is not exceeded. Also, make certain that the polarity on this capacitor is correct, they can LITERALLY explode if wired up backwards! ▶



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 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 torroidal transformer which is constructed from circular laminations. The primary and secondary windings are wound through the centre of the torroid (see if you can imagine how). The torroidal 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.



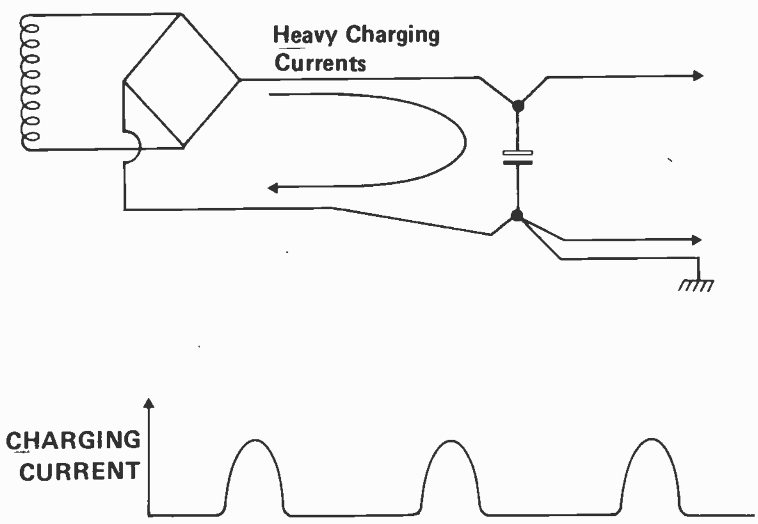
When a load is placed upon the power supply shown above, the output voltage appears as a DC voltage on top of which is a ripple voltage. This can be thought of as two separate periods, a charge period where the capacitor is charged up by the power supply and a discharge period where the load discharges 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 100U capacitor will result in a ripple voltage (Vpp) of about V7

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 700,000U-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 ± 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 disproportionally faster.

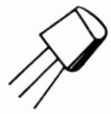
Some applications of voltage regulators are given below.

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

TO92 plastic

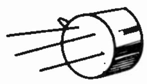


or

TO5 metal

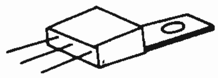
(100mA rating)

TO5 metal



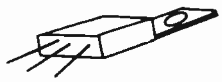
or

TO202 plastic power

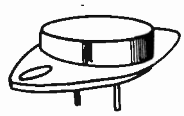


(200mA rating)

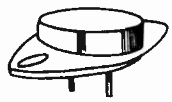
TO202 TO220 (500mA)

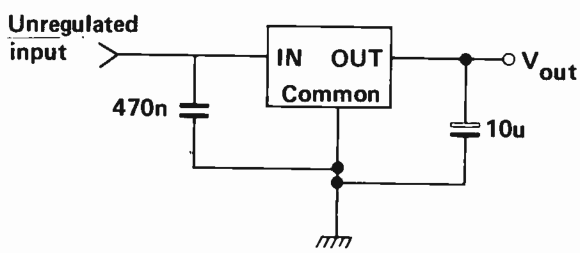


TO3 metal (2A)

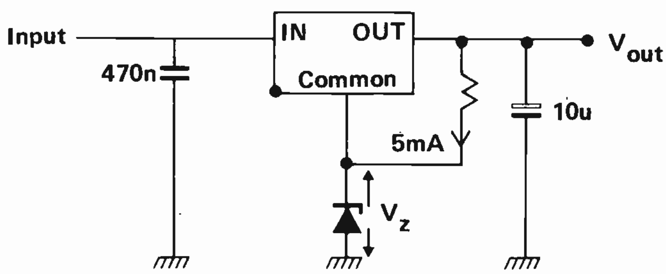


TO3 metal (3A)

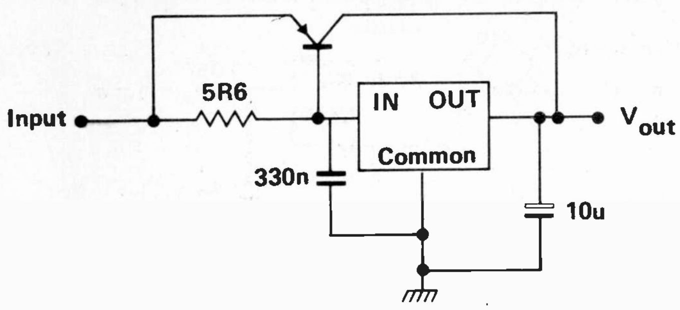




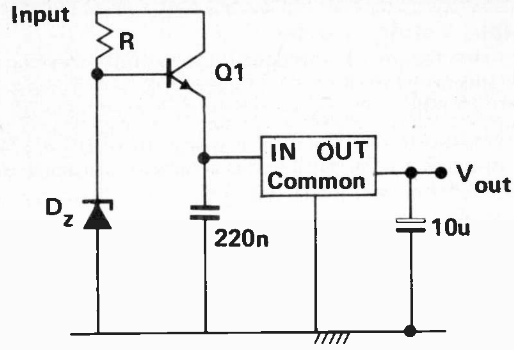
A)
This circuit shows a conventional arrangement of a three terminal device. It is advisable to use a decoupling capacitor connected close to the input terminals. This prevents high frequency instability. If this capacitor is left out then regulation can sometimes be greatly reduced. The decoupling capacitor 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.



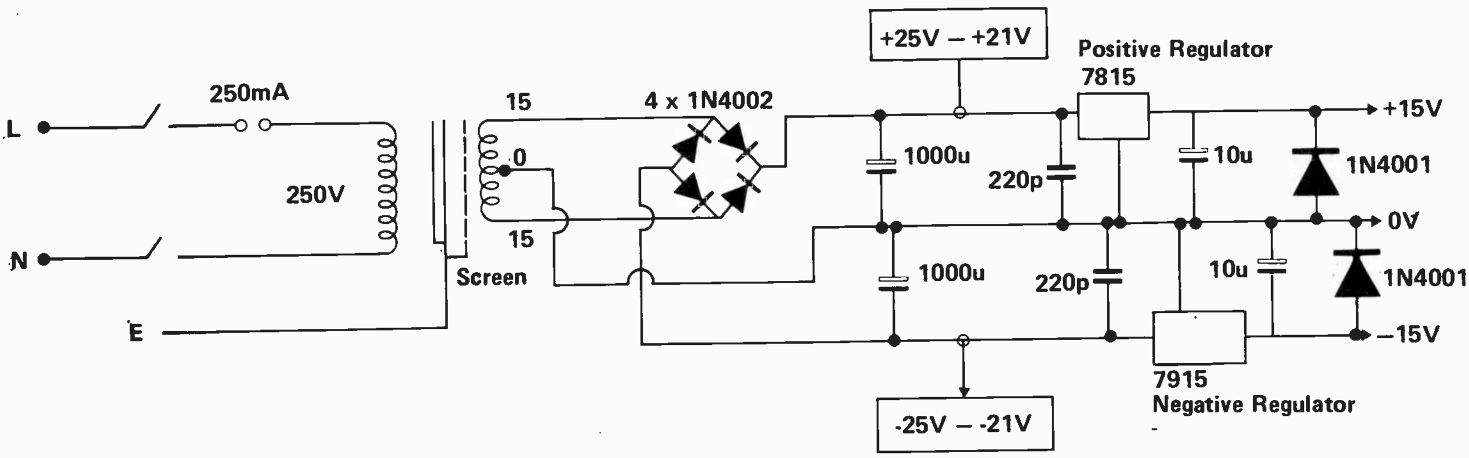
C)
The output current can be increased by using a bypass transistor. When the current flowing through the voltage regulator exceeds 100 mA (the voltage across the 5R6 being 560 mV), the bypass transistor begins to turn on. This transistor takes all currents in excess of 100 mA and yet the output still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

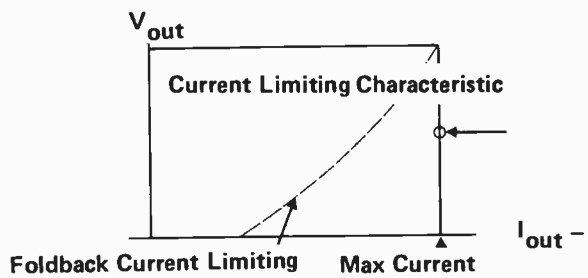
Dual Power Supply

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.

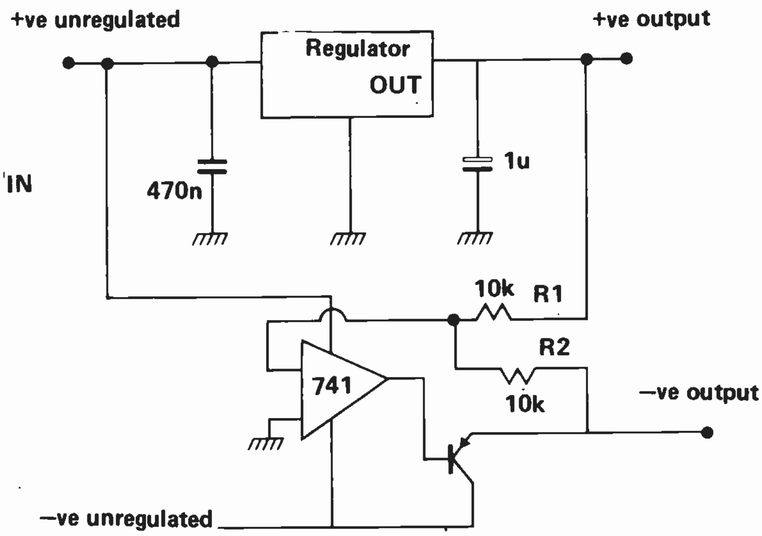


Tracking Regulator

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).

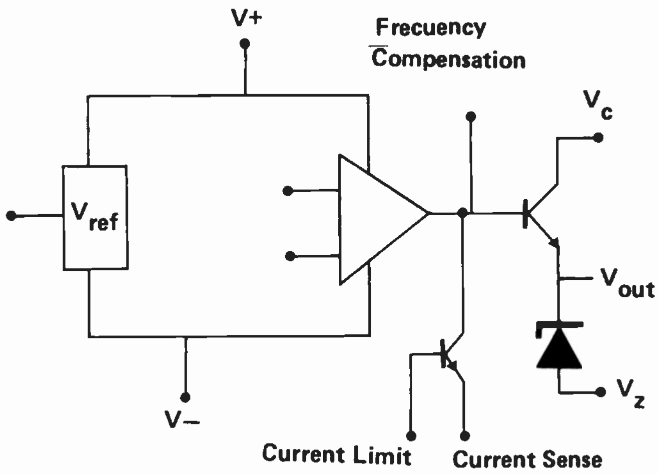


−ve output = −(+ve output × R2/R1)

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

723 Voltage Regulator

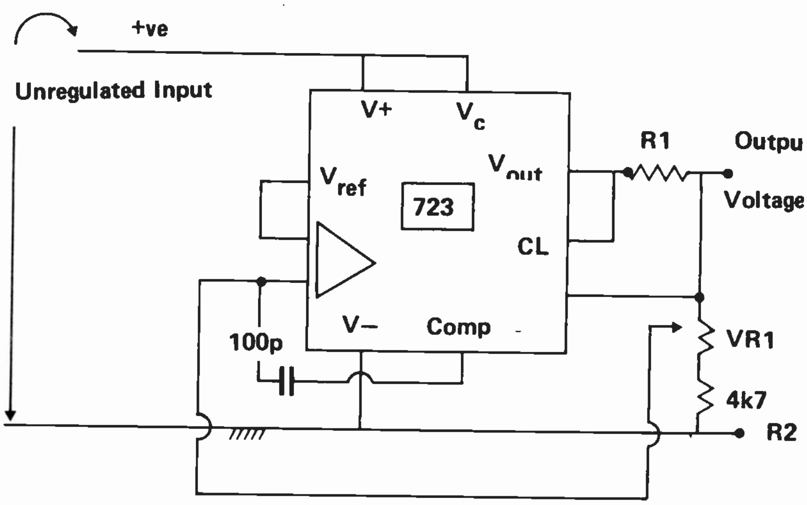
The 723 is an industry 'standard' device. Many manufacturers produce it and the device itself is versatile. It comes in a 10 pin TO5 can or a 14 DIL pack. The device contains a precision voltage reference, with a temperature coefficient of 50ppm/°C, an error amplifier, an internal transistor capable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

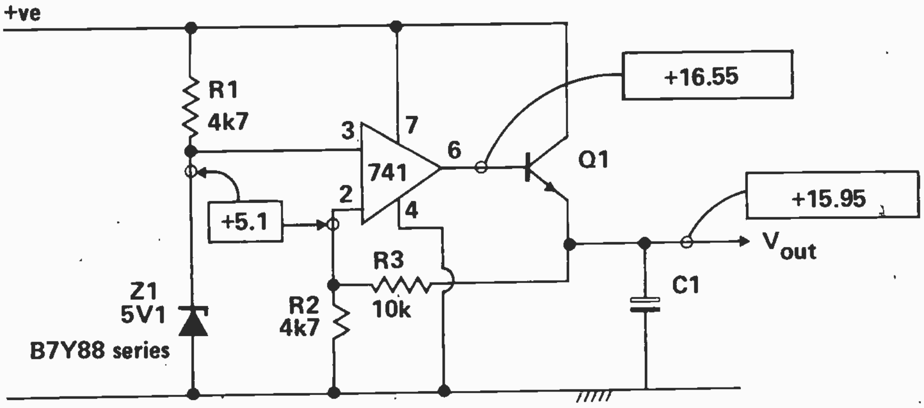
Adjustable Positive Voltage Regulator

By using a variable feedback path (RVI), 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 RVI), 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.



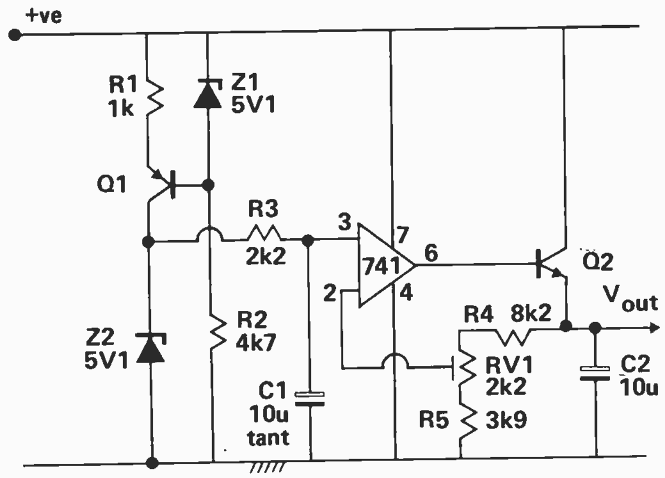
Left: Circuit diagram of discrete component PSU. Voltage measurements are taken with high impedance voltmeter.

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 —1.2mV/°C (a 5V6 zener is best at —0.2mV/°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 76Ω, 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 10ppm/°C. When using this level of stability, high stability resistors (TC=10ppm/°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. ETI

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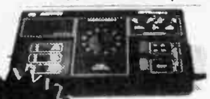

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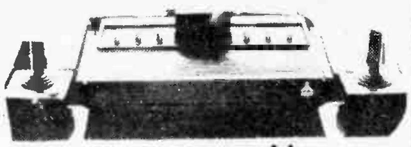

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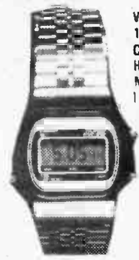

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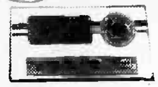

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0-6, 0-6	100	13	1.85	.40
9-0-9	330 330	235	1.95	.40
0.9, 0.9	500 500	207	2.35	.55
0-8-9, 0-8-9	1A 1A	208	3.50	.55
0-15, 0-15	200 200	236	1.95	.40
0-20, 0-20	300 300	214	2.35	.70
20-12-0-12-20	700(DC)	221	3.10	.70
0-15-20, 0-15-20	1A 1A	206	4.20	.85
0-15-27, 0-15-27	500 500	203	3.65	.70
0-15-27, 0-15-27	1A 1A	204	4.75	35

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Amps 12V	24V	Ref.	Price £	P&P
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4	2	18	3.75	.70
8	4	108	6.25	1.00
10	5	72	6.95	1.00
12	6	116	7.85	1.00
16	8	17	9.25	1.10
20	10	115	12.75	1.30
30	15	187	16.60	1.30
60	30	226	22.90	1.60

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

Amps	Ref. No.	Price £	P&P
0.5	112	2.45	.70
1.0	79	3.05	.70
2.0	3	4.80	.85
3.0	20	5.80	1.00
4.0	21	6.85	1.00
5.0	51	7.75	1.00
6.0	117	9.50	1.00
8.00	88	11.35	1.30
10.0	89	12.00	1.30

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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)
Sec: 0-24-30-40-48-60V

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
5.0	40	11.80	1.30
6.0	120	14.75	1.40

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300	66	7.15	1.00
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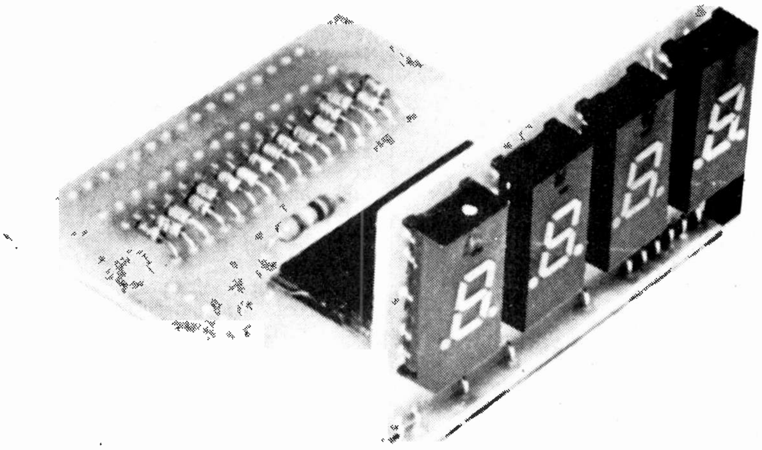


SPECIFICATION

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

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.

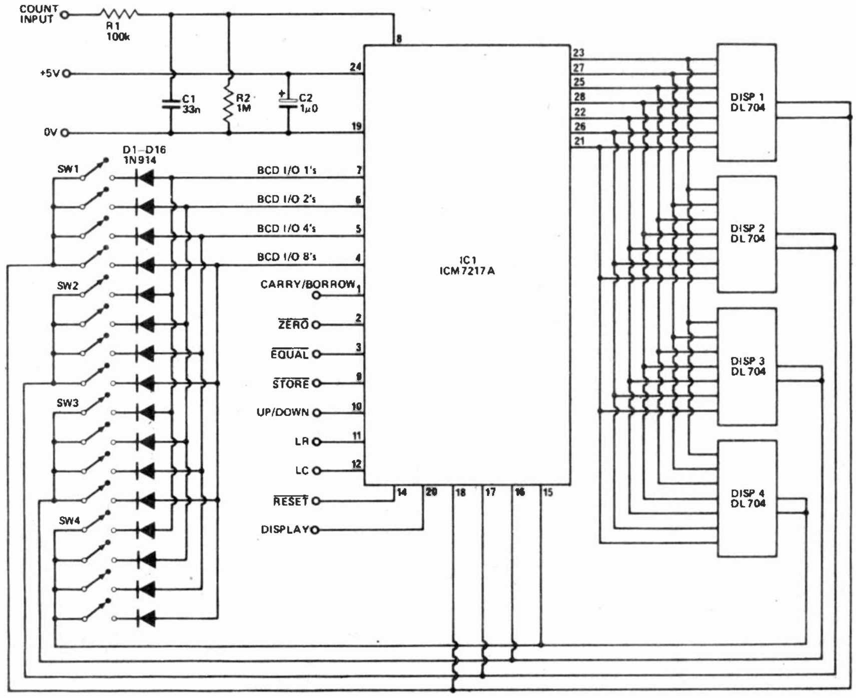
Many people have asked us for a 4 digit version and we have been looking round at ICs available. We have chosen this Intersil device because we believe it offers the best versatility at the moment. Apart from being a 4-digit counter-latch-decoder driver needing no external components except the displays, 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?



(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

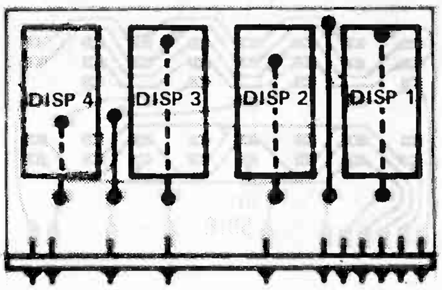


Fig. 2. The positioning of the displays and the links which must be installed before the displays.

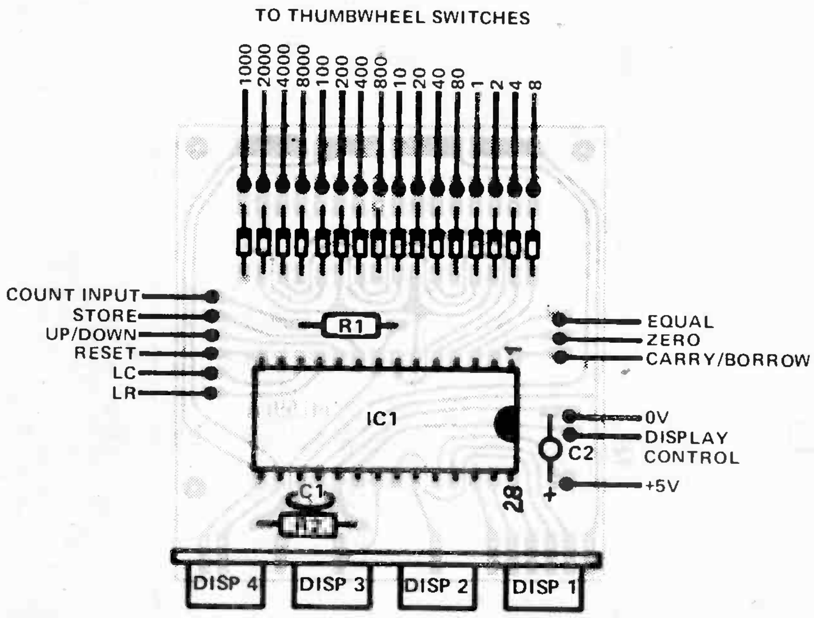
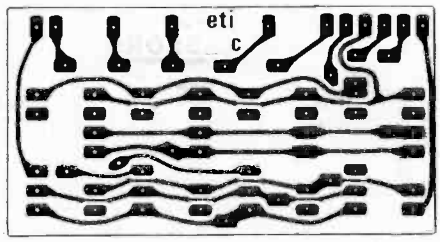
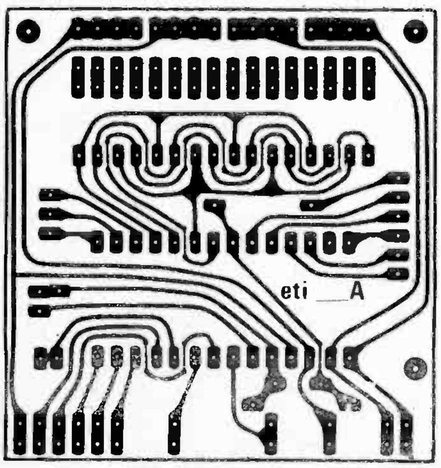
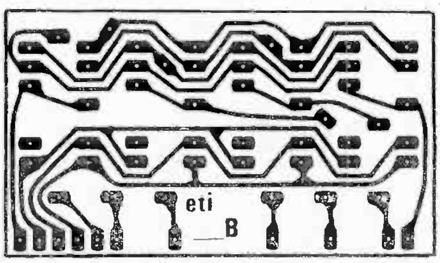


Fig. 3. The component overlay for the main board. The common connection from each of the thumbwheel switches goes to the track next to the other connections.





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

Ig 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.

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 ½W 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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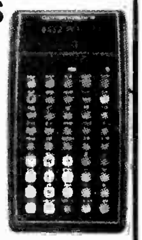

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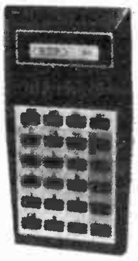

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A HISTORY OF ELECTRONICS IN MEDICINE

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).

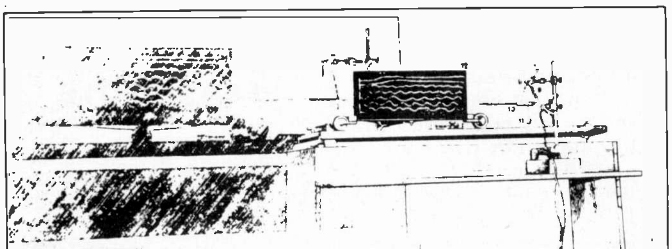


Fig. 2. Apparatus used by McKendrick to give lectures on life in motion to Royal Institution, London, audiences around 1890.

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 electromedical 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 sphygmometrograph (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.

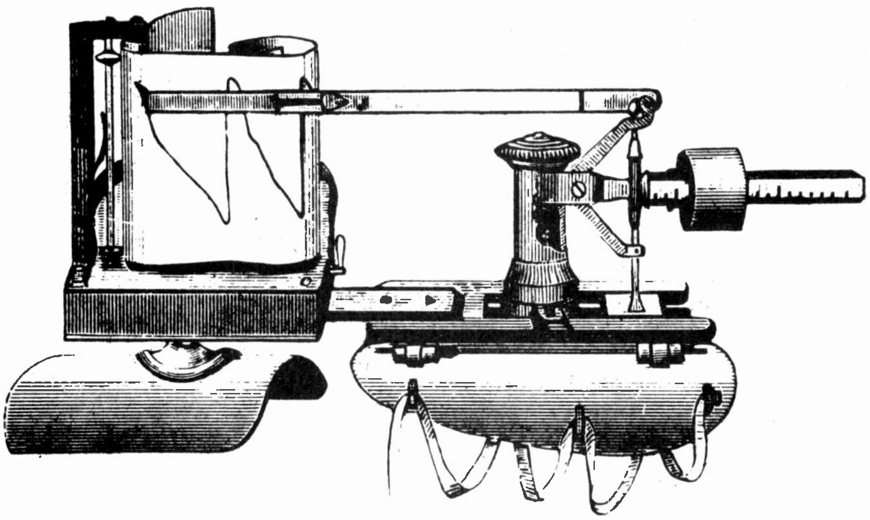


Fig. 3. Verdin's apparatus of the 1890s for recording action of the pulse.

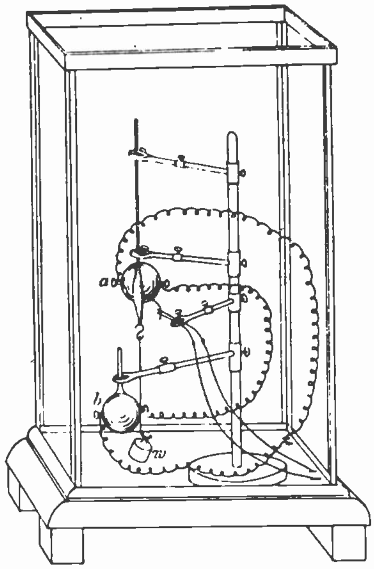


Fig. 4. Schematic of McKendrick's 1891 method for measuring heat generation in muscle.

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.

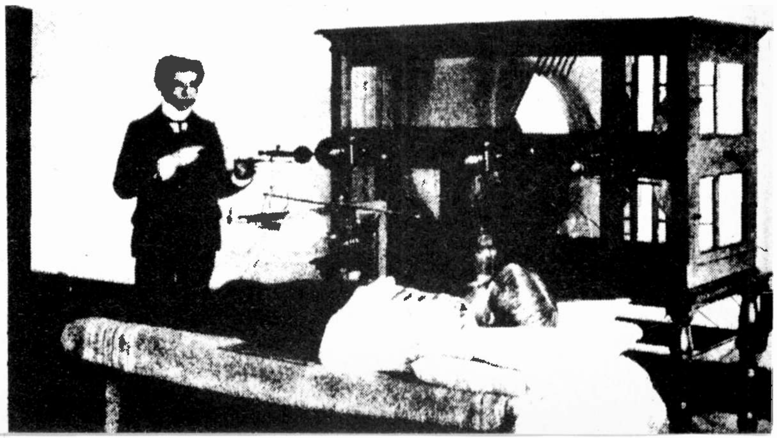
As with all disciplines, electronic method opened the door to new accomplishments. In medical electronics it happened from the 1920s onward. Equipment for researching physiology at Oxford University, in 1949 is shown in Fig 7 The unit, advanced for its time, incorporated amplifiers, a temperature control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



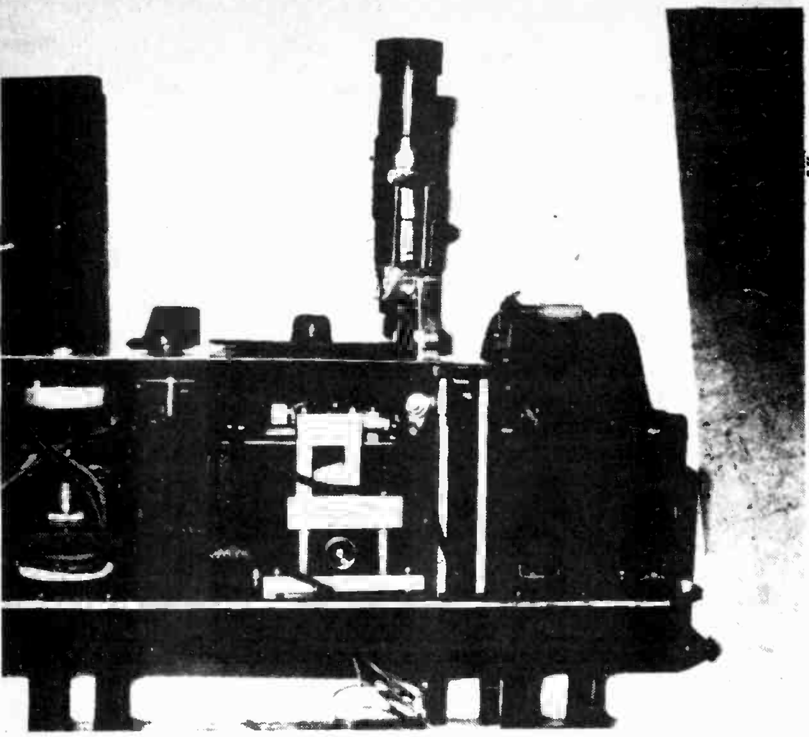


Fig. 6. Interior view of a Both portable electro-cardiograph machine made in Adelaide around 1930.

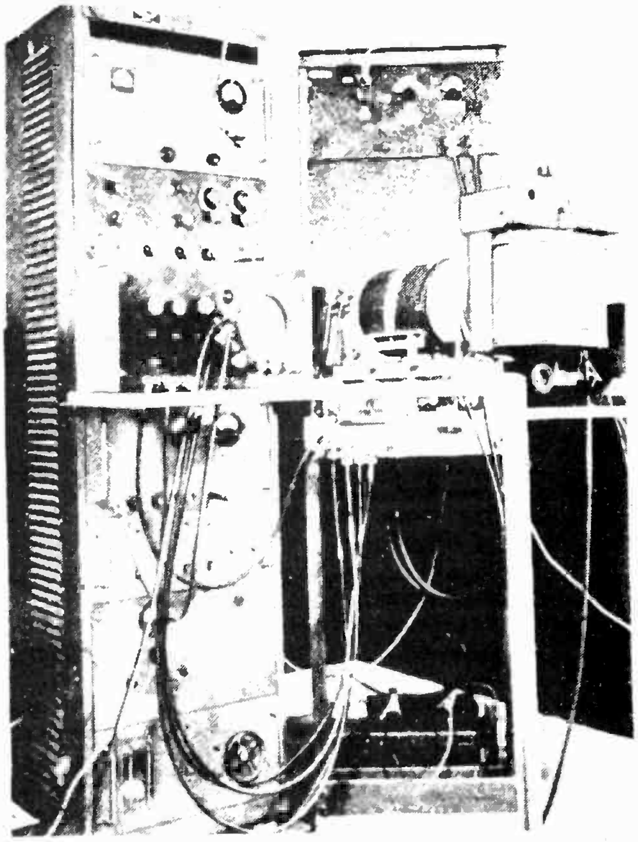


Fig. 7. E Electro-physiological research equipment used by Dickinson at Oxford University in 1949.

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.

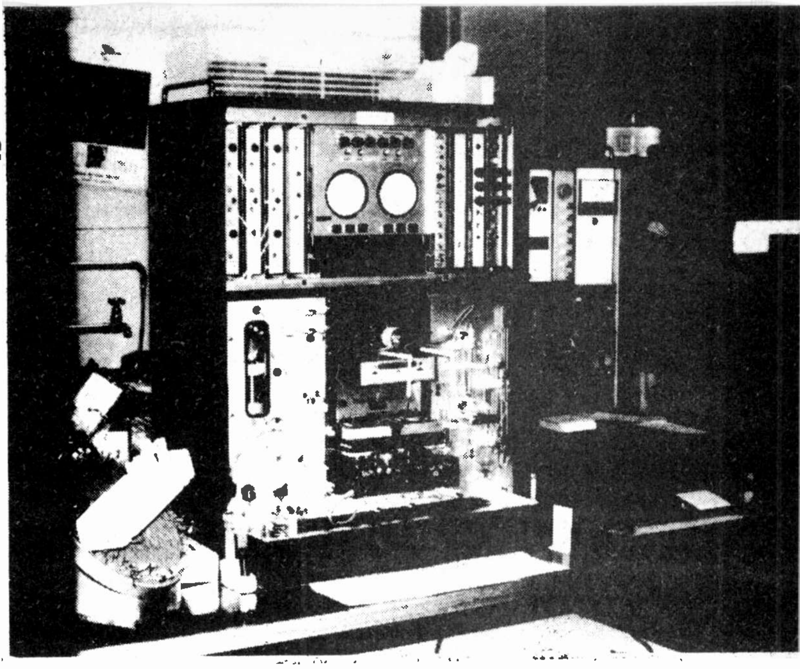


Fig. 8. Coulter counter unit of today that analyses blood sample particles providing a printout (IMUS, Adelaide).

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.

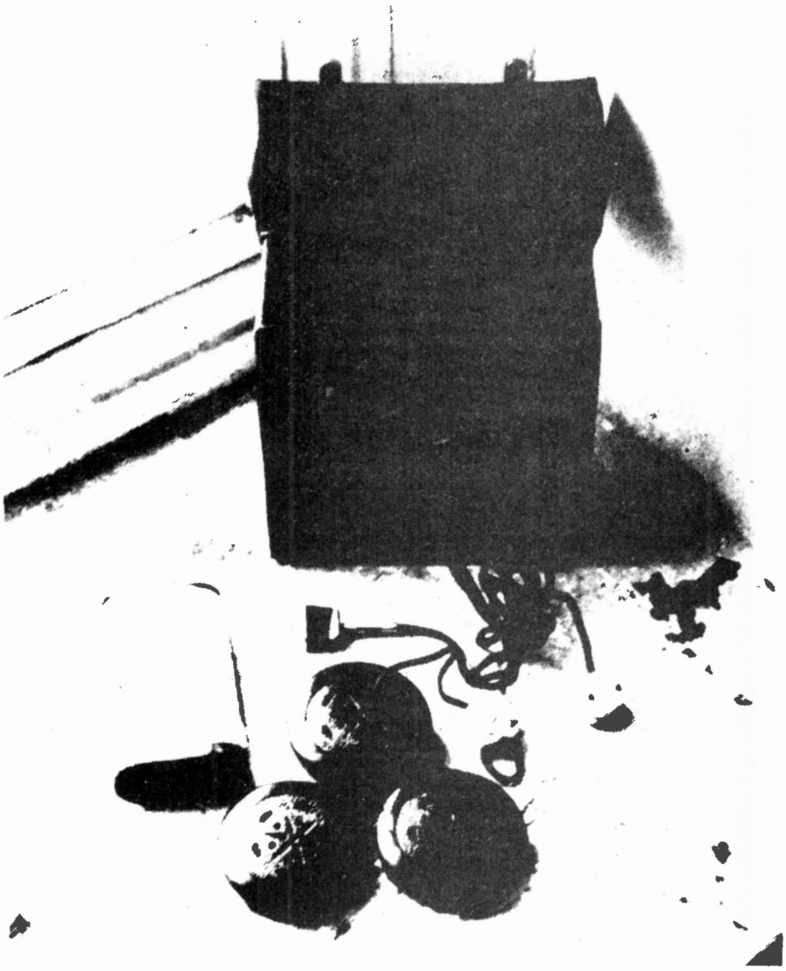


Fig. 9. 1900's hearing aid. The three receivers, which fit into the case, provide signal to the two earpieces. No active amplifier was involved. (Birdwood Mill Museum, S.A) ▶

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 (smell 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 privides 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 that time 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.

ETI

ELECTROVALUE Buying Guide

Section 2

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270 — 1000pF	3p
E6 values	
1500 — 4700pF	3p
6800pF	3p

CERAMIC FEED THROUGH ●

1000pF 350V	6p

ELECTROLYTIC, REVERSIBLE ●
EX50 series, 50V

2µF	25p
4µF	27p
6, 8, 10, 16µF	30p
25µF	35p
40, 60µF	56p
100µF	65p

ELECTROLYTIC, CANS ●
Siemens B41070, *unsleeved*

1000µF 40V	.99p
1000µF 63V	1.07
1000µF 100V	1.50
2200µF 25V	1.08
2200µF 40V	1.21
2200µF 63V	1.50
4700µF 25V	1.46
4700µF 40V	1.50
4700µF 63V	2.04

ELECTROLYTIC, CANS ●
Daly, *sleeved*

1000/25	46p
2200/50	94p
5000/25	98p
4700/100	3.61

ELECTROLYTIC, axial lead ●
Siemens B41313/B41283/B41010

µF	Volts	
0.47	63	21p
0.47	100	12p
1.0	40	21p
1.0	100	12p
2.2	25	12p
2.2	63	12p
2.2	100	12p
4.7	16	21p
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
47	25	14p
47	40	15p
47	63	16p
47	100	19p
100	3	12p
100	10	14p
100	16	15p
100	25	16p
100	40	16p
100	63	22p
100	100	28p
220	3	13p
220	6.3	15p
220	10	15p
220	16	17p
220	25	20p
220	40	24p
220	63	30p
220	100	47p
470	10	19p
470	16	24p
470	25	22p
470	40	31p
470	63	49p
470	100	74p
1000	3	18p
1000	6.3	22p
1000	10	21p
1000	16	30p
1000	25	40p
1000	40	45p
1000	63	76p
2200	3	23p
2200	10	30p
2200	16	45p
2200	25	70p
2200	40	77p
4700	16	85p
4700	25	96p
10000	3	40p

ELECTROLYTIC PLUGGABLE ●
Siemens B41316 series

µF	Volts	
1.0	63	13p
2.2	63	13p
4.7	63	13p
10	63	13p
22	40	13p
22	63	14p
47	16	13p
47	40	14p
47	63	18p
100	6.3	14p
100	16	14p
100	25	15p
100	40	18p
100	63	24p
220	3	8p
220	10	16p
220	16	18p
220	25	19p
220	40	23p
470	6.3	16p
470	10	19p
470	25	25p
470	40	29p
1000	16	26p

ELECTROLYTIC TANTALUM BEAD
Siemens B45134 series

µF	Volts	
0.1	35●	14p
0.15	35●	12p
0.22	35●	14p
0.47	35●	14p
0.68	35●	14p
1.0	35●	14p
2.2	16●	14p
2.2	35●	14p
3.3	16●	14p
4.7	16●	16p
4.7	35●	18p
6.8	25●	18p
10	6.3●	16p
10	16●	18p
10	25●	20p
15	25	31p
22	6.3●	18p
22	16	22p
22	25	45p
33	10	22p
47	6.3	22p
47	16	35p
100	3●	22p
100	6.3	45p
100	10	67p

ELECTROLYTIC, TANTALUM, AXIAL
Siemens series D

0.1/35, 0.47/35, 1/35	35p
2.2/20, 4.7/10	25p
2.2/35, 4.7/35	37p
10/20, 22/15	37p
47/10	66p

LACQUER FILM
(non-polarised)
Siemens B32110 series 20% tol.

µF	Volts	
0.1	100	76p
0.15	63	62p
0.22	63	65p
0.33	63	70p
0.47	63	78p
0.68	63	84p
1.0	63	91p
1.0	100	1.45
1.0	250	2.01
1.5	63	93p
2.2	63	1.60
3.3	63	1.82
4.7	63	2.07
6.8	63	2.59
10	63	3.00
10	100	5.06

SILVERED MICA, 350V
1% (Or ½pF) ●

R611, 12.7 x 8mm. All in pF

2.2, 3.3, 5	11p
6 8, 10, 15	11p
18, 20, 22, 25	11p
27, 30, 33	11p
39, 47, 50	11p
56, 68	11p
100	12p
150	14p
220	17p
330	20p

R1015, 16.5 x 11.4mm

82, 100	11p
120, 150	11p
180, 200, 220	12p
250, 270, 300	12p
330	15p
470	16p
1000	20p

R1524, 28.0 x 17.8mm

330	18p
390, 470, 500	18p
560, 680	18p
820, 1000	22p
2200	24p
3300	36p
4700	46p

R2032, 35.6 x 23.0mm

1500, 1800	18p
2200, 2700	24p
3600, 3900	29p
4700, 5000	33p
6800	41p
8200, 10,000	56p

MIXED DIELECTRIC
M.D.C.

600V
0.1 **28p** 0.47 **77p**
1.0µF **84p**

1000V
0.001, 0.0022, 0.0047 **20p**
0.01 **22p** 0.022 **23p**
0.1 **32p** 0.22 **57p**
0.47 **81p** 0.047 **32p**

POLYESTER
Mullard C280, PC mtg.

0.01, 0.015	●	6p
0.022	●	6p
0.033, 0.047	●	6p
0.068	●	7p
0.1	●	7p
0.15	●	8p
0.22	●	9p
0.33	●	13p
0.47	●	15p
0.68, 1.0		24p
1.5, 2.2		42p

POLYESTER,
PC mounting
Mullard 344 — or Siemens B32234 — series as available

100V		
0.047	●	9p
0.068	●	9p
0.1	●	10p
0.15	●	11p
0.22	●	12p
0.33	●	16p
0.47	●	18p
0.68		22p
1.0		27p
2.2		46p
4.7		79p
6.8		1.08
250V		
0.01	●	6p
0.015	●	6p
0.022	●	8p
0.033	●	8p
0.047	●	8p
0.1	●	11p
0.68		24p
0.82		24p
1.0		27p
2.2		48p
400V		
0.01	●	7p
0.015	●	7p

POLYESTER, Axial lead
Siemans B32231 series

µF	Volts		
0.01	630		13p
0.015	630		13p
0.022	630		13p
0.033	400	●	13p
0.047	250	●	13p
0.047	400	●	14p
0.047	630		16p
0.068	250	●	14p
0.1	250	●	14p
0.1	400	●	15p
0.1	630		25p
0.12	250	●	13p
0.15	250	●	14p
0.22	250	●	15p
0.33	250	●	18p
0.47	250	●	21p
0.68	250		27p
1.0	250		31p
1.0	400		46p
2.2	250		51p
4.7	250		1.04
10	250		1.81

POLYESTER,
B32560 PCM 7.5mm

µF	Volts		
0.001	250	●	6p
0.0015	250	●	6p
0.0022	250	●	6p
0.0033	250	●	6p
0.0047	250	●	6p
0.0068	250	●	6p
0.0082	250	●	7p
0.01	250	●	6p
0.012	250	●	7p
0.015	250	●	6p
0.018	250	●	8p
0.022	250	●	7p
0.027	250	●	8p
0.033	250	●	7p
0.039	250	●	8p
0.047	250	●	7p
0.056	250	●	9p
0.068	250	●	8p
0.082	250	●	11p
0.1	250	●	9p
0.1	100	●	9p
0.12	100	●	12p
0.15	100	●	10p
0.18	100	●	14p
0.22	100	●	12p
0.27	100	●	19p
0.33	100	●	16p
0.39	100	●	23p
0.47	100	●	20p
0.56	100		30p
0.68	100		25p

POLYESTER,
B32561 PCM

0.01	250	●	5p
0.022	250	●	6p
0.047	250	●	7p
0.1	250	●	9p
0.22	100	●	11p
0.47	100	●	17p
1.0	100		28p

POLYESTER,
B32562 PCM

0.47	100	●	17p
1.0	100		30p
2.2	100		48p

POLYESTER
B32563 PCM

1.0	400	72p

(Good pulse discharge ratings)

POLYPROPYLENE
B33063, 160V ●

100, 470, 680pF	4p
2200, 4700, 5600pF	6p
5100pF	4p
6800, 10,000pF	6p

POLYSTYRENE
B31110, 160V

5, 7, 10, 12pF	6p
15, 22, 27, 33pF	6p
39pF	6p
47, 56, 68, 82pF	5p
100, 120, 150pF	5p
160, 180, 220pF	5p
270, 330, 390pF	5p
470, 560pF	5p

POLYSTYRENE
B31310, 160V

560, 680, 820pF	5p
1000, 1500	5p
2200, 3300pF	5p
1200, 1800, 2700	8p
3900, 4700	8p
5600, 6800, 8200	8p
10000pF	8p
12000, 15000	12p
18000, 22000	13p

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2-22pF	27p

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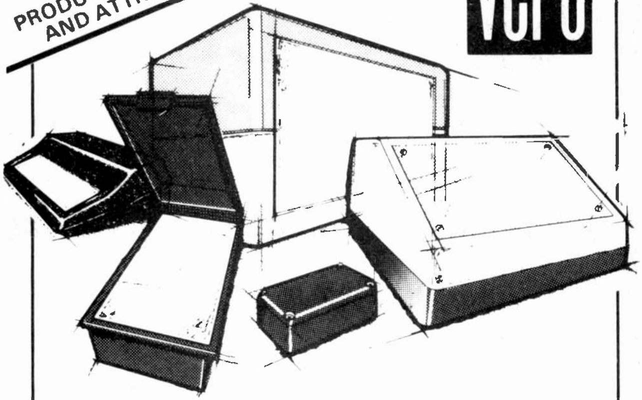

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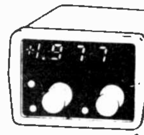
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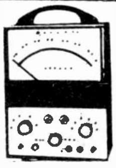
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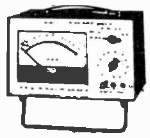
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DIGITAL DIAL

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.

SPECIFICATION

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

Design Features

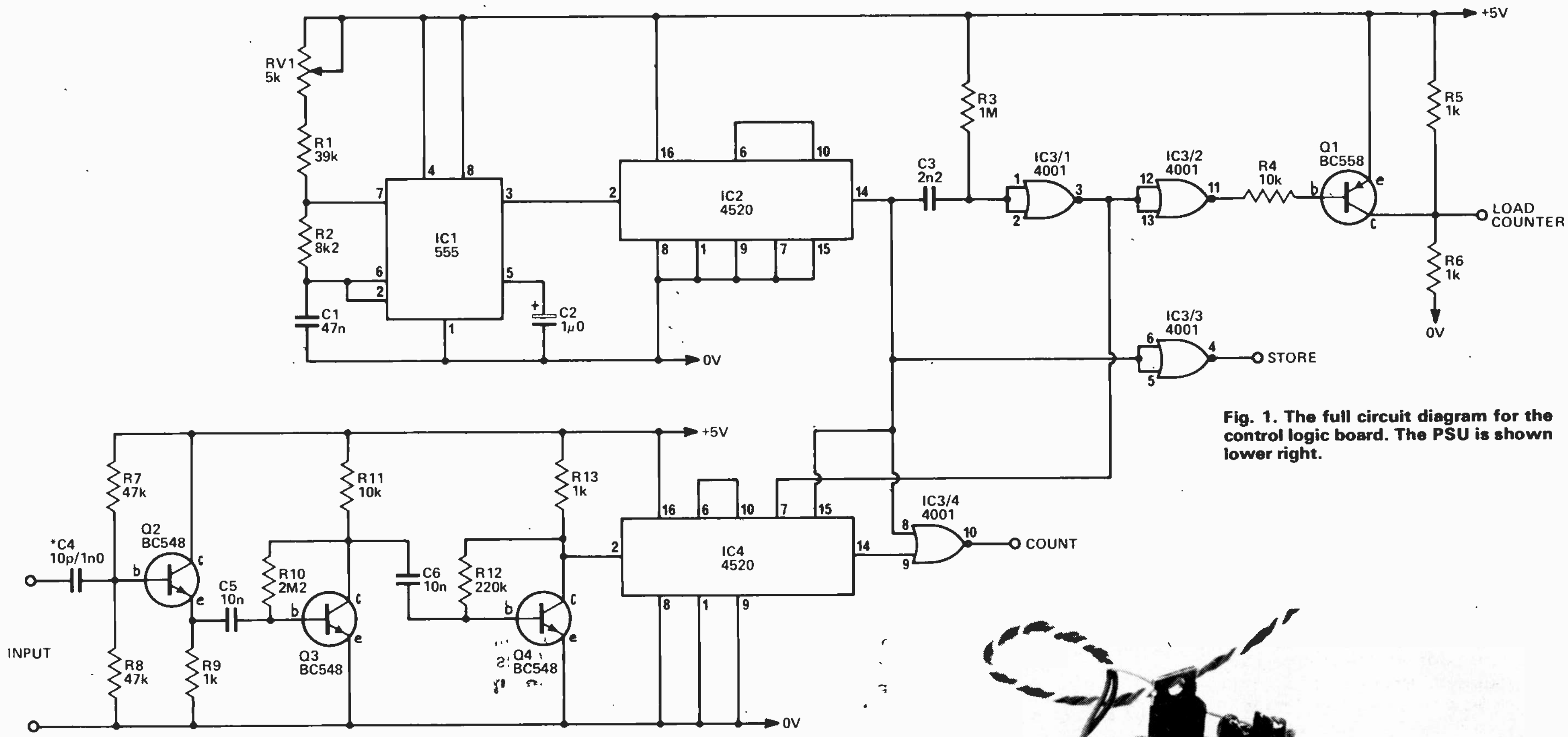
This project is the first to employ our four digit module presented elsewhere in this issue. We will be using the module again over the next few months so don't lose track of it!

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 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



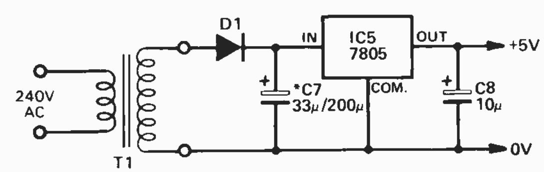
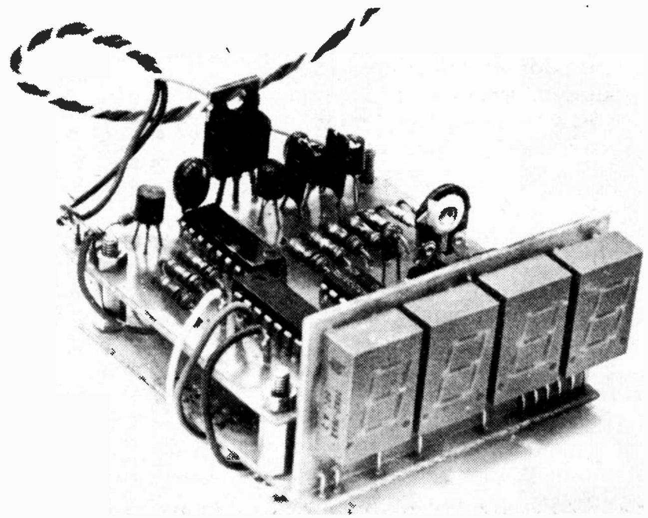


Fig. 1. The full circuit diagram for the control logic board. The PSU is shown lower right.

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	2100μCd @ 20mA
HDSP 3733	red	10.9 mm	1800μCd @ 20mA
5082-7663	yellow	10.9 mm	1500μCd @ 20mA
5082 -7653	red	10.9 mm	1720μCd @ 20mA
DL704	red	7.6 mm	320μCd @ 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 (2^8) 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 NE55 as the time base with its output being divided by 128 to improve stability. However if an accuracy of ± 5 kHz is to be maintained its frequency has to be better than ¼% 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).

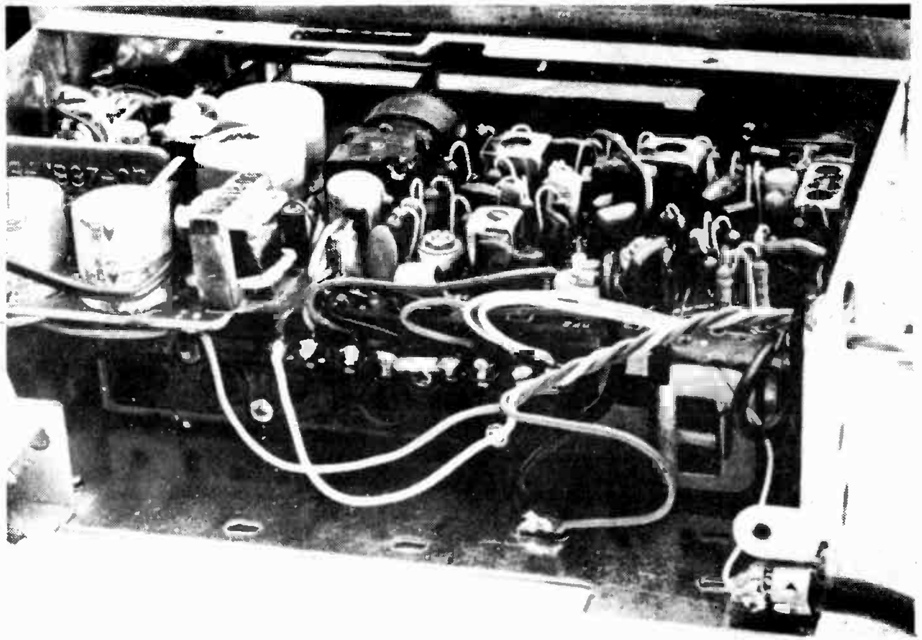
When connecting into a car radio, tune the set to a local station and try the pickup wire on the terminals of the tuning coils in turn until one is found which will give a reading without moving it off station. Permanently connect to this point. With a portable radio try moving the pickup coil around the set, probably in line with the aerial coil, until the best results are obtained.

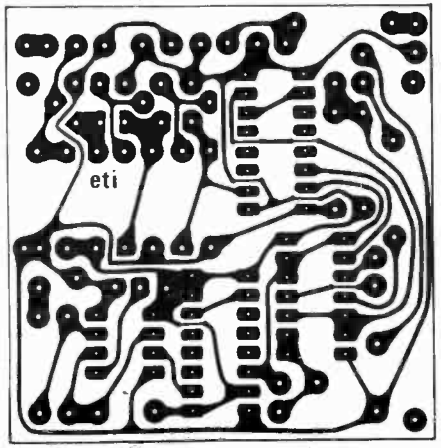
Calibration

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.

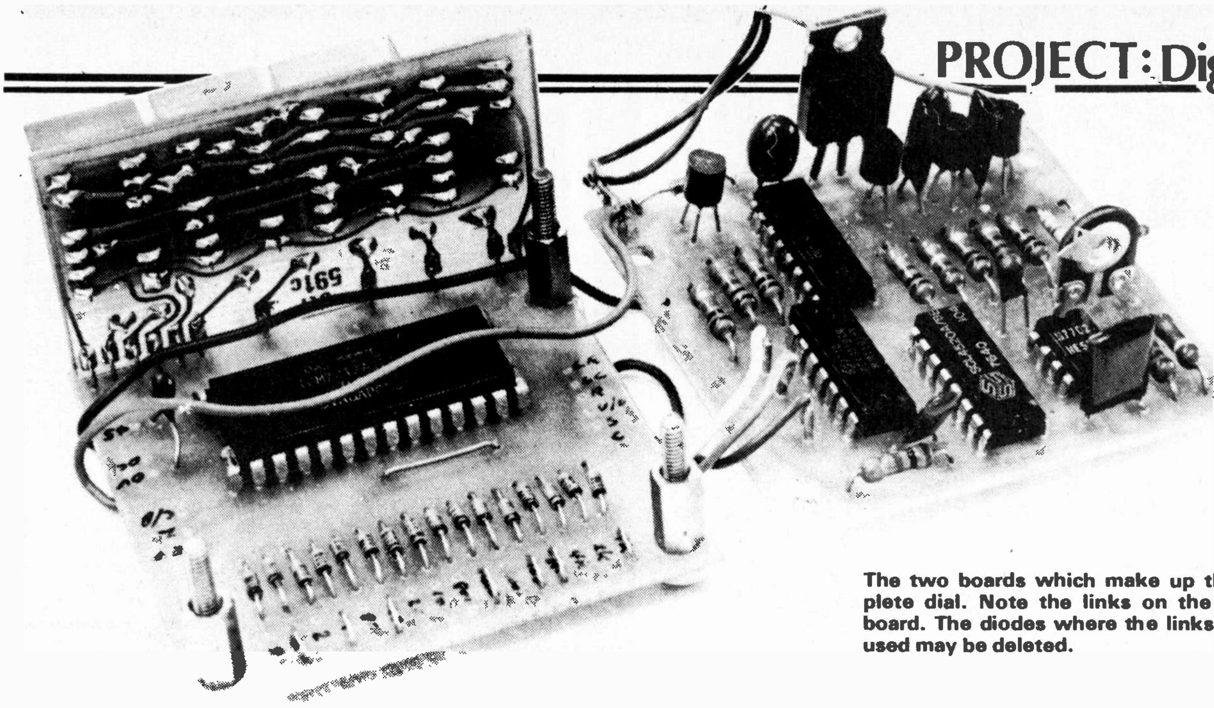
Alternatively feed a known signal of between 1 and 2 MHz from an oscillator into the input and adjust RV1 until it reads 455 less than that frequency.

Photo showing where we tapped into the car radio.





Right: full site foil patterns for the Digidial 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.



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.

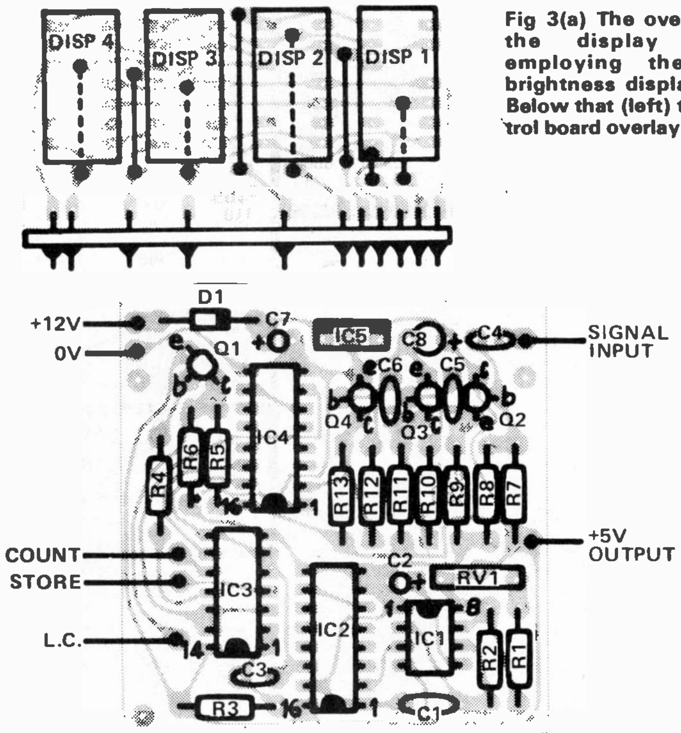


Fig 3(a) The overlay for the display board employing the high brightness displays. (b) Below that (left) the control board overlay.

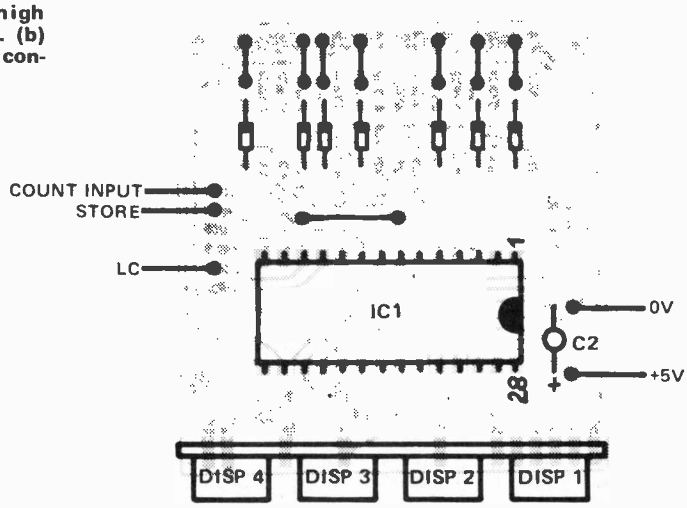


Fig. 4. The component overlay of the display module showing the diodes and links required.

PARTS LIST

RESISTORS	all ½W, 5%
R1	39k
R2	8k2
R3	1M
R4, 11	10k
R5, 6, 9, 13	1k
R7, 8	47k
R10	2M2
R12	220k
POTENTIOMETER	
RV1	5k trimmer
CAPACITORS	
C1	47n polystyrene
C2	1u0 tantalum
C3	2n2 polyester
*C4	10p ceramic
C5, 6	10n polyester
*C7	33u tantalum
C8	10u 25V electrolytic
SEMICONDUCTORS	
IC1	555
IC2	4520
IC3	4001
IC4	4520
IC5	7805
Q1	BC558
Q2-Q4	BC548
D1	1N4004
MISCELLANEOUS	
*Transformer 240V-12V6, 150 mA	

*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.
2.5 x 1	14p	13p
2.5 x 3.75	42p	40p
2.5 x 5	52p	50p
3.75 x 5	60p	60p
3.75 x 17	195p	180p

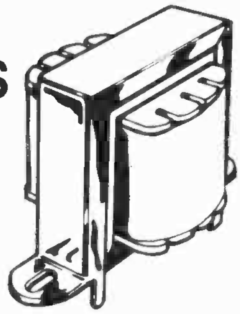
Veropins – single sided per 100
0.1in 35p
0.15in 40p

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

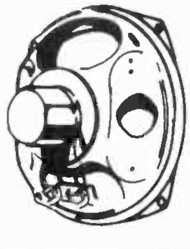
Secondary rated at 100mA. Available with secondaries of: 6 - 0 - 6, 9 - 0 - 9 and 12 - 0 - 12. 92p each

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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AD161	38p	BD132	35p
AD162	38p	BD135	38p
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BC108	8p	BD140	35p
BC109	8p	BF244B	36p
BC147	7p	BFY50	15p
BC148	7p	BFY51	15p
BC149	8p	BFY52	15p
BC158	9p	MJ2955	98p
BC177	14p	MPSA06	20p
BC178	14p	MPSA56	20p
BC179	14p	TIP29C	60p
BC182	10p	TIP30C	70p
BC182L	10p	TIP31C	65p
BC184	10p	TIP32C	80p
BC184L	10p	ZTX107	14p
BC212	10p	ZTX108	14p
BC212L	10p		
BC214	10p		
BC214	10p		
BC477	19p		
BC478	19p		
BC479	19p		
BC548	10p		
BCY70	14p		

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ZTX300	16p
2N697	12p
3N1302	38p
2N2905	22p
2N2907	22p
2N3053	18p
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2N3702	8p
2N3704	8p
2N3705	9p
2N3706	9p
2N3707	9p
2N3708	8p
2N3819	22p
2N3904	8p
2N3905	8p
2N3906	8p
2N4058	12p
2N5457	32p
2N5458	30p
2N5459	32p
2N5777	50p

DIODES

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

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LS03	16p	LS139	50p
LS04	16p	LS151	50p
LS08	16p	LS153	50p
LS10	16p	LS155	80p
LS13	30p	LS156	80p
LS14	70p	LS157	45p
LS20	16p	LS164	90p
LS30	16p	LS174	60p
LS32	24p	LS175	60p
LS37	26p	LS190	80p
LS40	22p	LS192	70p
LS42	53p	LS193	70p
LS47	70p	LS196	80p
LS48	48p	LS251	60p
LS54	16p	LS257	55p
LS73	29p	LS258	55p
LS74	29p	LS266	40p
LS75	44p	LS283	60p
LS76	35p	LS290	55p
LS78	35p	LS365	45p
LS83	60p	LS366	45p
LS85	70p	LS367	45p
LS86	33p	LS368	45p
LS90	45p	LS386	35p
LS93	45p	LS670	180p

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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	TDA1022	650p
LM318N	125p	NE555	25p	ZN414	75p

TTL

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

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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

CMOS

FULL DETAILS IN CATALOGUE

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		4040	68p
4001	15p	4042	54p
4002	15p	4046	100p
4007	15p	4049	28p
4011	15p	4050	28p
4013	35p	4066	40p
4015	60p	4068	20p
4016	35p	4069	16p
4017	55p	4071	16p
4018	65p	4075	16p
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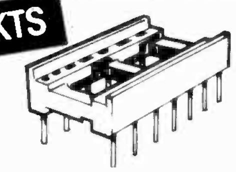
	100	13p
	220	20p
25V	10 22 33 47	5p
	100	8p
	220	10p
	470	15p
	1000	23p
10V	220	5p
	470	9p
	1000	13p
	2200	23p

SKTS



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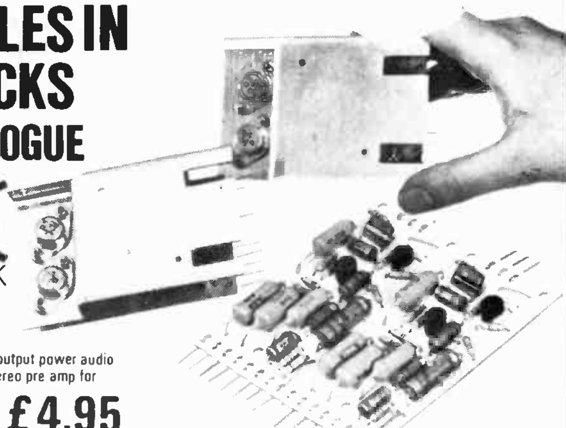

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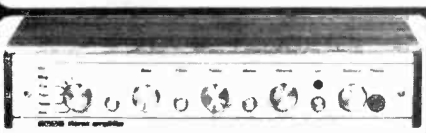

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computing today No 3

January 79

THE NEW MAGAZINE
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Personal Computing~ The Early Years

Softspot

Presented as a supplement to ETI.

computing today

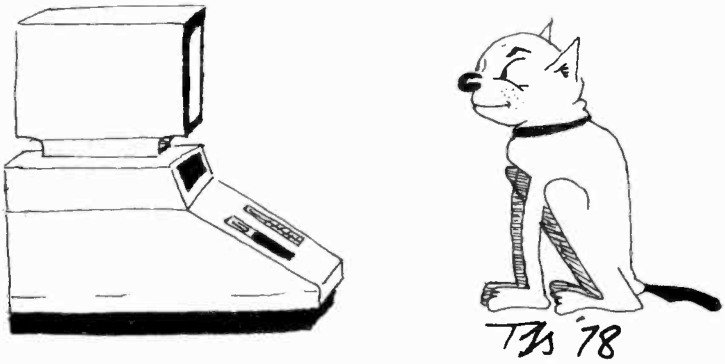
No.3 January 1979

Editor: Gary Evans
Production: Pete Howells
Advertising: Mark Strathern, David Sinfield, Joy Cheshire

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 by 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 Rl 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 Rl 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.

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 sped 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 OOOOH. 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
1605	—		03	PORT 3 (LED port)
1606	JMP	1600H	C3	Jump back to 1600H for next input
1607	—		00	from keyboard.
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 IAM INTERUPT 3
1619	—		1F	
161A	—		16	
161B	CALL	PSTRNG	CD	Print carriage return followed by string.
161C	—		2B	
161D	—		00	
161E	RET		C9	Return to main program.
161F	DATA	I	49	String data starts here and terminates with end of text marker 04.
1620	—	SPACE	20	
1621	—	A	41	
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 interupt 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 interupt should announce its presence. We hope that this simple example will show you that, contrary to popular belief, interupts 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 prints string
1604	—		2B	starting at address held in DE register pair.
1605	—		00	
1606	CALL	PCRLF	CD	Call sub-routine which prints out
1607	—		33	carriage return and line feed..
1608	—		00	
1609	CALL	INCH	CD	Call sub-routine which inputs data
160A	—		0B	from keyboard and holds this in
160B	—		00	accumulator.
160C	CALL	OUTCH	CD	Call sub-routine which prints out ASCII character from
160D	—		13	data in accumulator.
160E	—		00	
160F	JMP	1609H	C3	Jump back to address 1609H and wait
1610	—		09	for next character from keyboard
1611	—		16	
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 restart 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 alphabet is
160D	—		16	printed.
160E	CALL	PCRLF	CD	If alphabet is completed output carriage
160F	—		33	return and line feed.
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
1613	—		03	1603H and repeat.
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 restart instruction
1601	LXI H		21	Load HL register pair with address one less than start of
1602	—		FF	VDU RAM.
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
1614	—		29	increments H register by one
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
1619	—		06	1606H and repeat.
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
1620	—		13	clear of last alphabet).
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
1624	—		1F	last line of alphabet so jump back to
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.
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.
0013H	OUTCH	A CALL routine which outputs character to VDU.
0018H	RST3	Reacts to Interrupt 3 and re-vectors 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.
0020H	RST4	Reacts to Interrupt 4 and re-vectors to 1620H for user routine.
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.
0028H	RST5	Reacts to Interrupt 5 and re-vectors to 1628H for user routine.
002BH	PSTRNG	A CALL routine identical to PDATA except that it outputs Carriage Return/Line Feed prior to printing string.
0030H	RST6	Reacts to Interrupt 6 and re-vectors to 1630H for user routine.
0033H	PCRLF	A CALL routine which prints Carriage Return followed by Line Feed and then returns with the original contents of accumulator intact.
0038H	RST7	Reacts to Interrupt 7 and re-vectors to 1638H for user routine.

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 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!

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.
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.
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.
032CH	TPEOFF	When called switches the tape control relay off. Routine returns with 00H in accumulator.
03A1H	ACKA	Start address of string which prints INVALID. Use should be made of PSTRNG utility to insert Carriage Return and Line Feed.
03B5H	ACKB	Start address of string which prints START=. (Use via PSTRNG).
03C4H	ACKC	Start address of string which prints HEADER=. (Use via PSTRNG)
03CFH	ACKD	Start address of string which prints END. (Use via PSTRNG)
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.
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.

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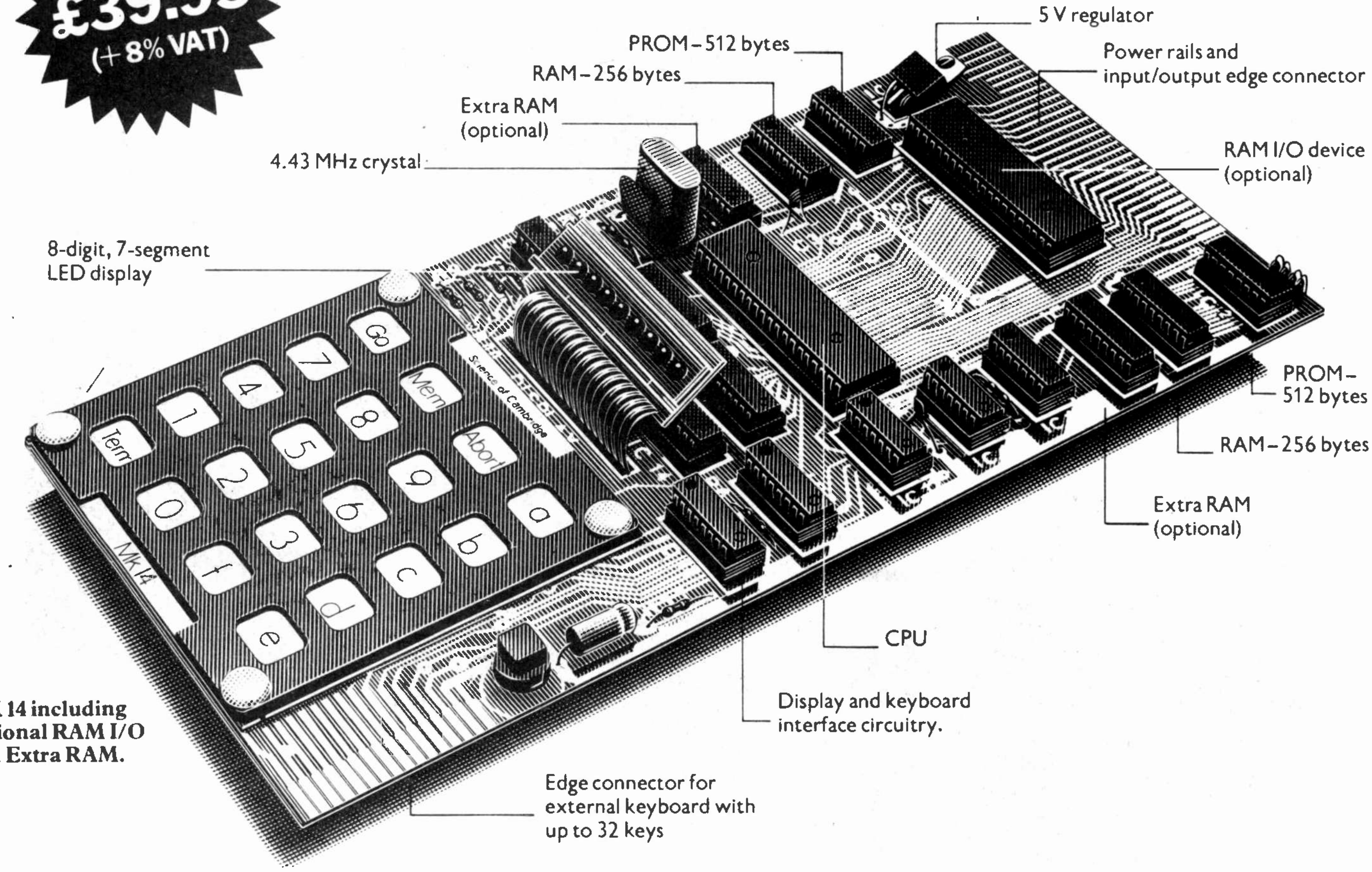

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SPECIFICATIONS

MK 14

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* 8 x 512 PROM, containing monitor program and interface instructions
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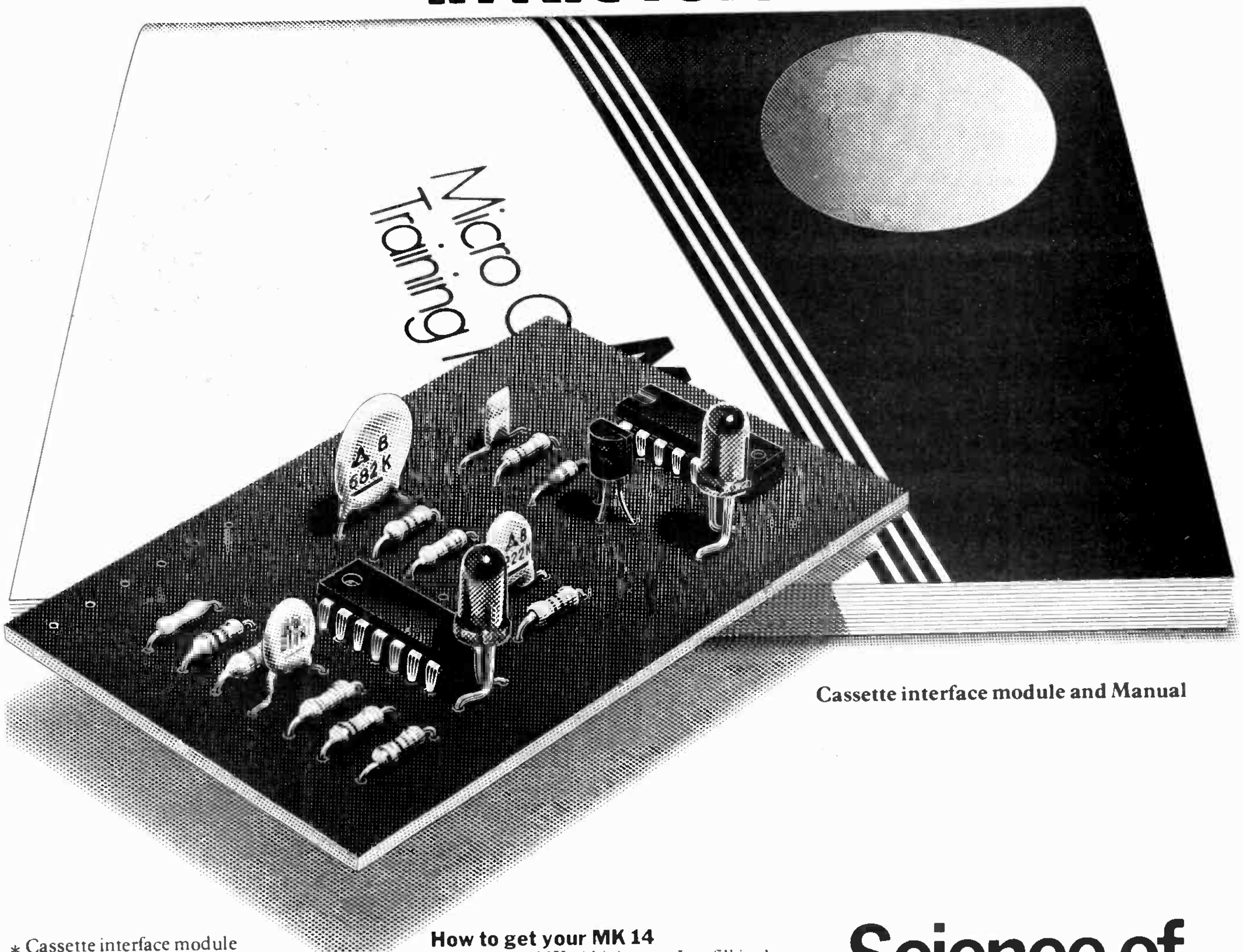

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computing

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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
```

Personal Computing — The Early Years

Tip toe through the early memories of the Personal Computing field

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 home-brewer.

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

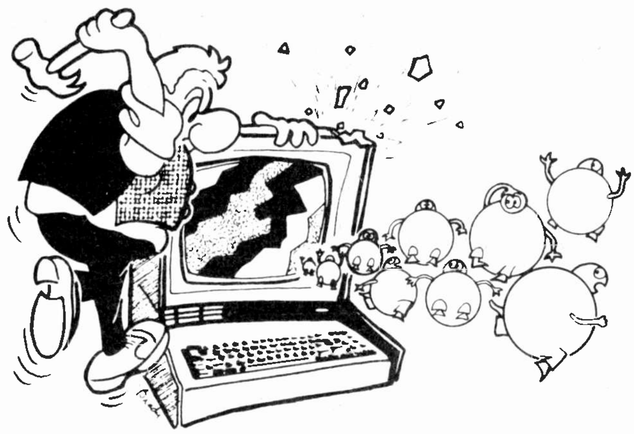
Ever since the tradition of stripping a discarded radio chassis was established by the pioneers of amateur radio, the humble junk box has been the hallmark of the truly worthy hobbyist. In much the same way as one may judge someone's social standing by the way he dresses, how neatly his garden is kept, 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 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 nutured 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 ot 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.

There are rumours of an Opto-Pneumatic Power Cue being evaluated by leading players. Integral Laser Theodolite system determines range and angles while Microprocessor backpack computes and controls shot dynamics.

TRS-80 Update

The August issue of ETI carried a reciew 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 occurance 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 Seperators," one can specify digit positions, cause automatic rounding off, concatentate (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 it's "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 concatented.

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 INKEYS$ 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 charact4er 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 interger), 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 oposite 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 l'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.

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.

THE MPU MAN

KEY

1 Teletype unit.
2 Punched paper tape reader.
3 Floppy disc 'player' unit.
4 Home-made floppy disc experimental unit.
5 Incompatible systems interface patch-board.
6 Skeleton keyboard for manual entry.
7 Modulator for feeding display material to domestic magic lantern.
8 Domestic magic lantern showing results of simulated World cup final.
9 Another advanced game in progress.
10 Working microprocessor module.
11 Well ventilated reprogrammable read only memory.
12 Interesting teleprintér graphics — genuine system check — no kid!
13 Early home-made 8-bit processor.
14 Power supply with outboard cooling and attractive economy housing.
15 Another development module. Seems to have undergone pre-frontal lobotomy. . . . Last Night of the Proms?
16 Junked cassette player with sprinkling of cassette programmes. Alternative to papertape or manual entry.
17 Primitive one-shot switch input unit.
18 Aerosol spray for de-bugging.
19 Mighty de-bugged noughts and crosses programme listing being triumphantly brandished.
20 Attempt to fabricate home brew floppy disc.
21 Another teletype unit.
22 Personalised low density punched tape storage system.

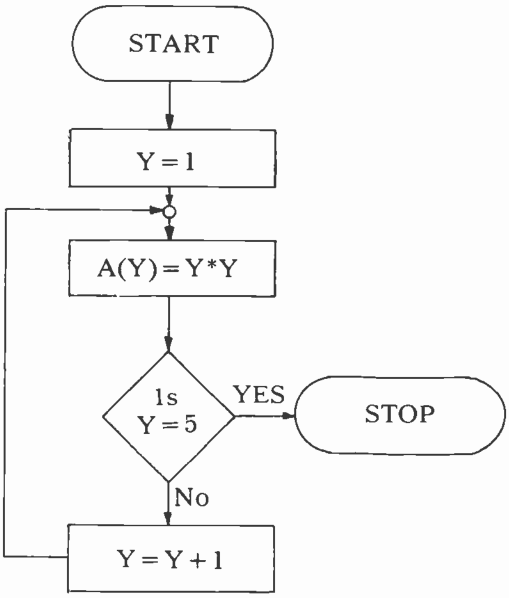
Beginning BASIC

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=5THEN 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=11)*(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 brackers 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.

CTI

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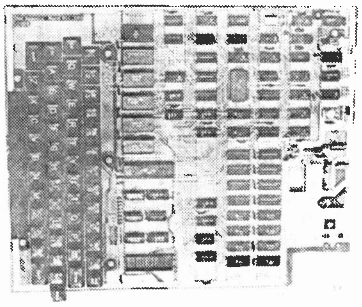

Ohio Scientific has made a major breakthrough in small computer technology which dramatically reduces the cost of personal computers. By use of custom LSI micro circuits, we have managed to put a complete ultra high performance computer and all necessary interfaces, including the keyboard and power supply, on a single printed circuit board. This new computer actually has more features and higher performance than some home or personal computers that are selling today for up to $2000. It is more powerful than computer systems which cost over $20,000 in the early 1970's.

This new machine can entertain your whole family with spectacular video games and cartoons, made possible by its ultra high resolution graphics and fast BASIC. It can help you with your personal finances and budget planning, made possible by its decimal arithmetic ability and cassette data storage capabilities. It can assist you in school or industry as an ultra powerful scientific calculator, made possible by its advanced scientific math functions and built-in "immediate" mode which allows complex problem solving without programming! This computer can actually entertain your children while it educates them in topics ranging from naming the President of the United States to tutoring trigonometry all possible by its fast extended BASIC graphics and data storage ability.

The machine can be economically expanded to assist in your business, remotely control your home, communicate with other computers and perform many of the other tasks via the broadest lines of expansion accessories in the microcomputer industry.

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- Full machine code monitor and I/O utilities in ROM
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Extras

- Available expander board features 24K static RAM (additional mini-floppy interface, port adapter for printer and modem and OSI 48 line expansion interface.
- Assembler/editor and extended machine code monitor available.

Commands

CONT	LIST	NEW	NULL	RUN	

Statements

CLEAR	DATA	DEF	DIM	END	FOR
GOTO	GOSUB	IF...GOTO	IF...THEN	INPUT	LET
NEXT	ON...GOTO	ON...GOSUB	POKE	PRINT	READ
REM	RESTORE	RETURN	STOP		

Expressions

Operators

—, +, *, /, ↑, NOT, AND, OR, >, <, <>, >=, <=, =

RANGE 10^{-32} to 10^{+32}

Functions

ABS(X)	ATN(X)	COS(X)	EXP(X)	FRE(X)	INT(X)
LOG(X)	PEEK(I)	POS(I)	RND(X)	SGN(X)	SIN(X)
SPC(I)	SQR(X)	TAB(I)	TAN(X)	USR(I)	

String Functions

ASC(X$)	CHR$(I)	FRE(X$)	LEFT$(X$,I)	LEN(X$)	MID$(X$,I,J).
RIGHT$(X$,I)			STR$(X)		VAL(X$)

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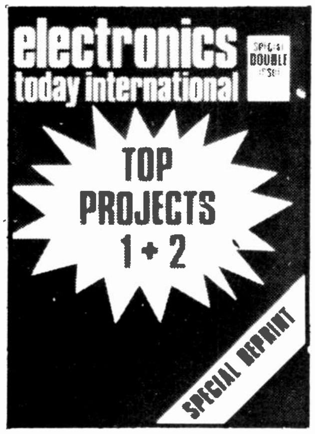

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ETI Top Projects 3. This issue was so popular that it is now sold out!

ETI Top Projects 4 includes:
Sweet sixteen stereo amp., waa-waa, audio level meter, expander/compressor, car theft alarm, headlight reminder, dual-tracking power supply, audio millivoltmeter, temperature meter, intruder alarm, touch switch, push-button dimmer, exposure meter, photo timer, electronic dice, high-power beacon, electronic one-armed bandit! . . .

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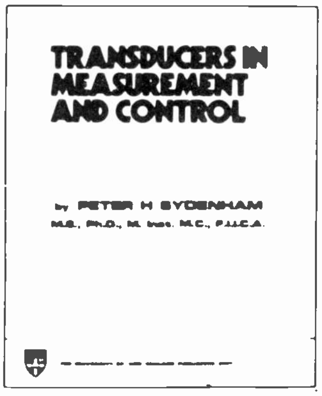
5 W stereo amp., stage mixer, disco mixer, touch organ, audio limiter, infra-red intruder alarm, model train controller, reaction tester, headphone radio, STD timer, double dice, gen.-purpose power supply, logic tester, power meter, digital voltmeter, universal timer, breakdown beacon, heart rate monitor, IB metal locator, temperature meter. . . .

ETI Top Projects 6, just published, includes:
Graphic equaliser, 50-100 W amp. modules, active crossover, flash trigger, "star and dot" game, burglar alarm, pink noise generator, sweep oscillator, marker generator, audio-visual metronime, LED dice, skeet game, lie detector, disco light show. . . .

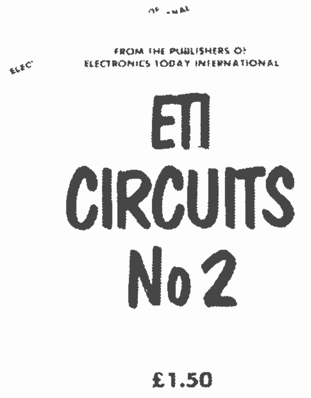
75p + 25p P&P

Comprised entirely of new material, the edition covers such diverse subjects as Star Wars and hi-fi! The magazine contains projects for everyone — none of which have appeared in ETI or Hobby Electronics and a look at the future of MPUs, Audio, Calculators and Video. How can you not read it?



£3.00 + 25p P&P

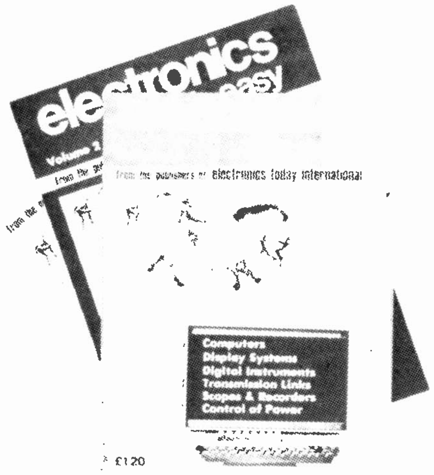
This book is rather an unusual reprint from the pages of ETI. The series appeared a couple of years ago in the magazine, and was so highly thought of by the University of New England that they have re-published the series splendidly for use as a standard textbook. Written by Peter Sydenham, M.E., Ph.D.,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



Each volume contains over 150 circuits, mainly drawn from the best of our Tech-Tips. The circuits are indexed for rapid selection and an additional section is included which gives transistor specs. and plenty of other useful data.

Sales of this publication have been phenomenal — hardly surprising when the circuits cost under 1p each! Each volume costs.

£1.50 + 25p P&P



ETI's successful beginners series came to an end some time ago now, and the whole series is available from us in reprint form. The three books between them contain all the information presented in the series (sometimes in more detail!) and together form an excellent starting point for anyone interested in learning the art of electronics. Each volume costs

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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 × 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_{stg} storage temperature
θ_h thermal resistance of heat sink. (Units. °C/W)
θ_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_{min} minimum capacitance (which occurs at the rated breakdown voltage)
C_o diode capacitance at zero bias
f_{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_{on} turn on time
t_{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} (h_{FB}, h_{FC}) current gain in the grounded emitter circuit (or in the grounded base or grounded collector circuit).
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 or I_E the steady base, collector or emitter current.
$I_{B(AV)}$, $I_{C(AV)}$ or $I_{E(AV)}$ the average value of the base, collector or emitter current.
I_{CEX} collector cut-off current in a specified circuit
I_{CM}, I_{BM} or I_{EM} peak value of collector, base or emitter current

I_b, I_c or I_e rms value of the alternating component of the current
I_{bm}, I_{cm} or I_{em} peak value of the alternating component of the current
i_C, i_B or i_E instantaneous value of the total current
i_c, i_b 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} 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_{gq} 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, Δf. 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.

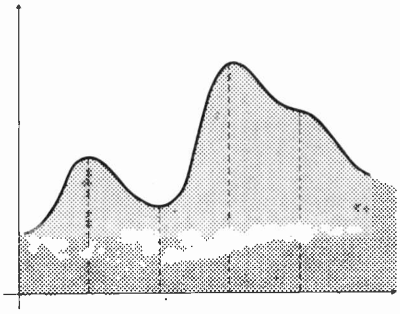
Thus i_E is the instantaneous value of the total emitter current, i_e the instantaneous value of the alternating component of the emitter current, and $I_{E(AV)}$ the average (DC) value of the total emitter current. Other subscripts can be used in a similar way, I_F being the forward DC current with no signal, i_F the instantaneous forward current and I_{FM} the peak forward current.

ETI

Hobby Electronics

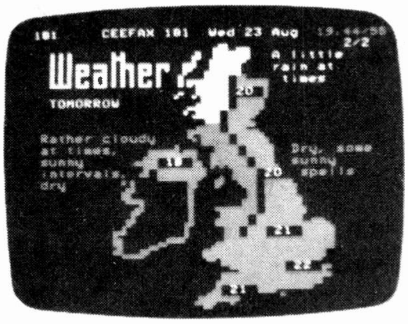
Next Month

4-Channel Equaliser



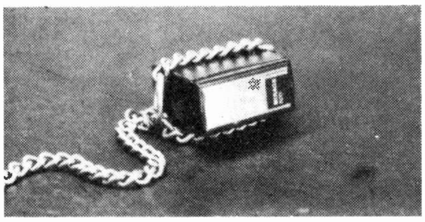
A fully-fledged graphic equaliser with four bands, allowing you to adjust the response of your Hi-Fi to suit the room it's in! Alternatively, this unit can be used as a really sophisticated tone control. This project was designed by a professional audio consultant especially for HE. We think it'll be a winner!

Viewdata



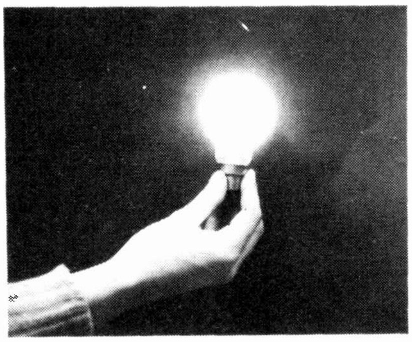
One of the most exciting developments in modern TV technology is the advent of data transmission and display. Viewdata is Britain's answer to advances which could mean shopping from the home, a computer terminal in every room or even the abolition of commuting!

Slave Flash



Using one flash gun is fairly straightforward — but how do you use two or more simultaneously?

Touch Switch

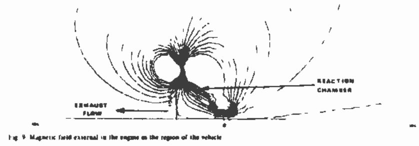


A switch with no moving parts! Just touch it and turn on the lights, motors or whatever turns you on. By the way, the above photo is not an illustration of the switch in action, but one of our staff having a bright idea.

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

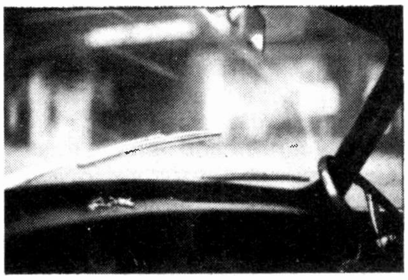


The British Interplanetary Society has just published a report which shows that interstellar flight by an un-manned vehicle is possible with modern technology. The report is nearly 200 pages of detailed drawings, calculations and specifications. We examine it clearly in detail.

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.

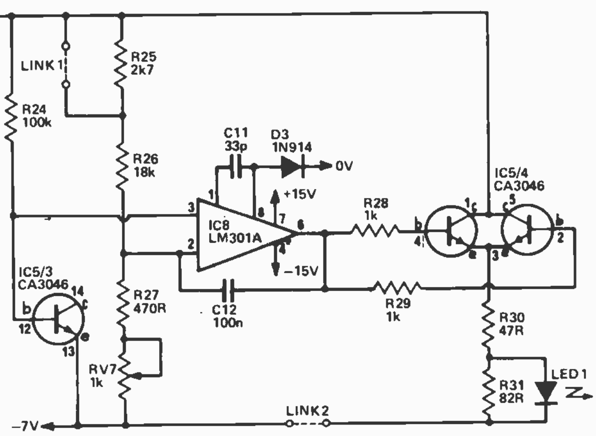
IN THE CONVENTIONAL musical scale, consecutive notes are not separated by the same frequency, but by the same ratio — the twelfth root of two. This is quite acceptable for most musical instrument manufacturers, except that in electronic music equipment it is easier to make oscillators which have an accurately 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.

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.

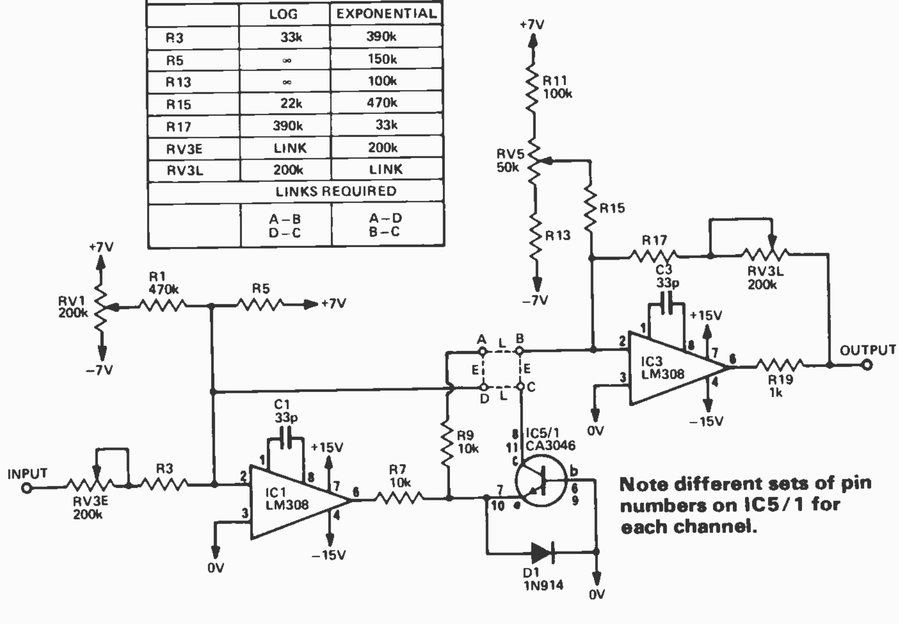
In the instrumentation field a lot of functions are displayed in dBs which are a logarithmic measurement. As this unit can be connected in either exp or log modes it is useful for this purpose also.

As the unit will normally be used with some other equipment, we have not described any mechanical housing.

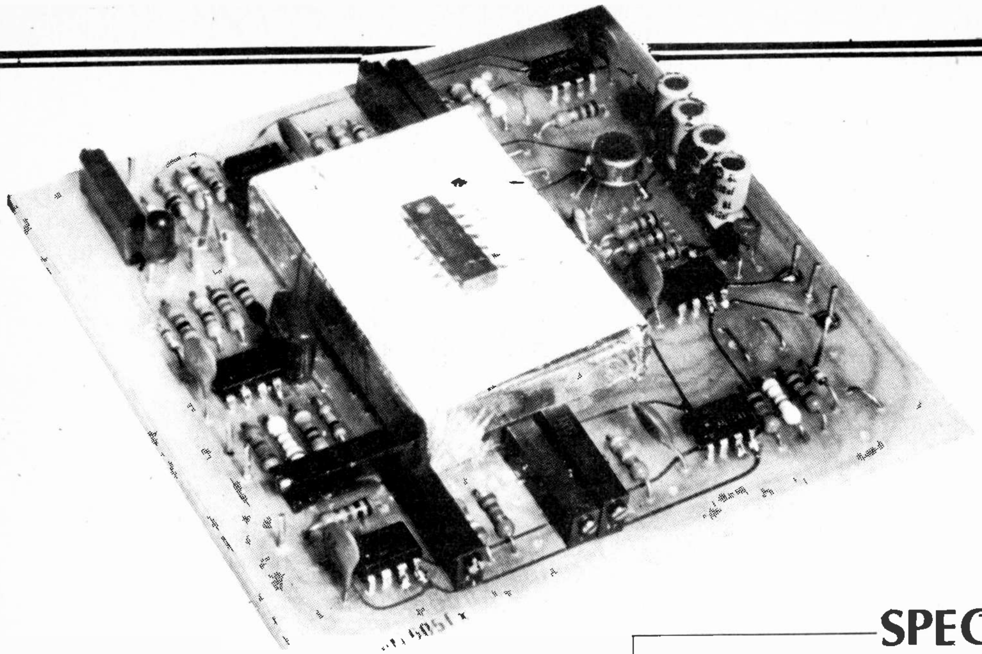


Below: the circuit diagram of the converter section. One channel only is shown here, the second — identical — uses the even components numbers. Above: the oven circuitry.

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 D–C	A–D 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

Transfer functions	
exponential	**V out = 0.15625 x 2Vin**
log.	**V out = Ln (Vin/0.15625)/Ln2**
Useful dynamic range	**50dB or 8 octaves**
Oven temperature	**approx. 55° C**
Warm up time	**about 2 minutes**
Power supply	**± 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 viltage. 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.

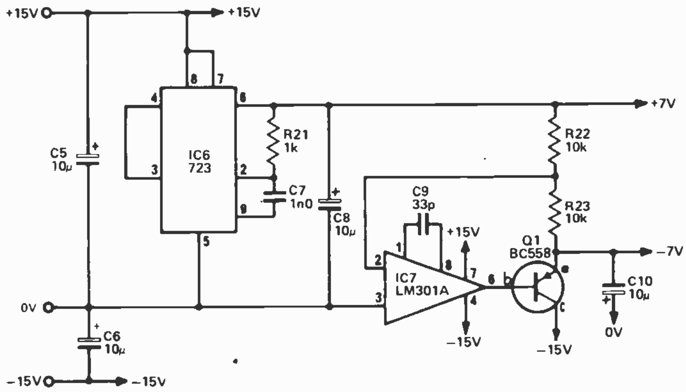
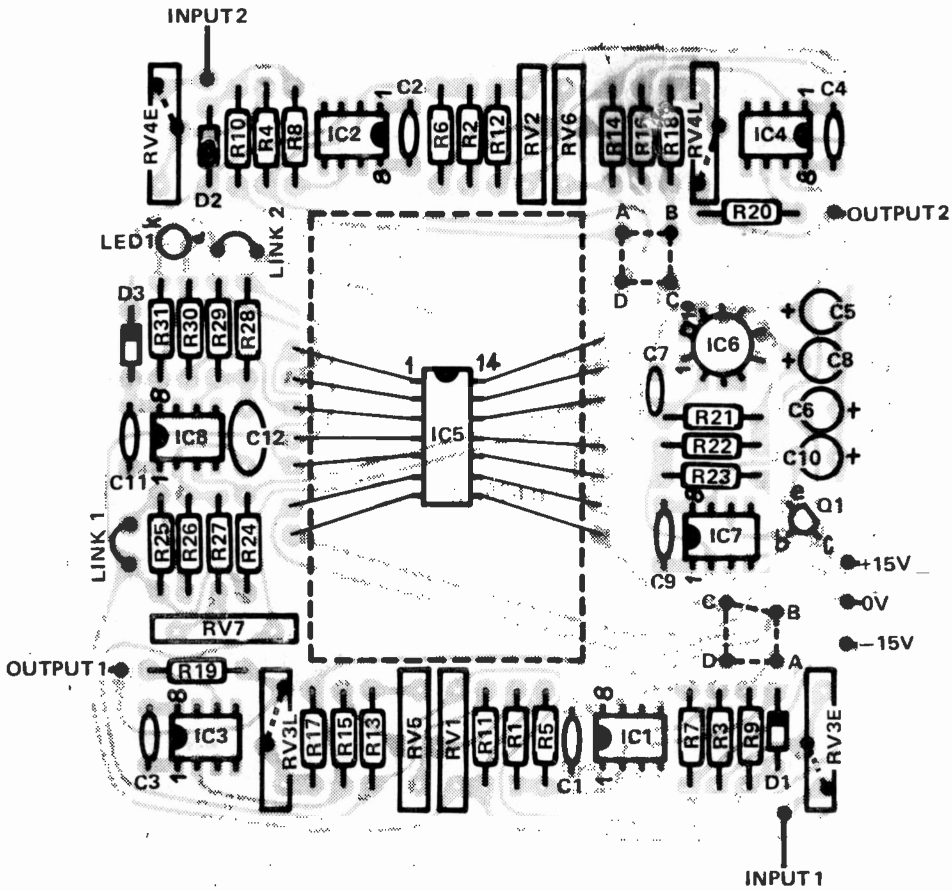


Fig. 1b. The power supply section which supplies the stable ± 7 V needed for the bias and adjustment controls.

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 ►



Component overlay for the complete log converter project.

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 multiturn trimmer
RV5, 6	50k multiturn trimmer
RV7	1k multiturn trimmer
CAPACITORS	
C1—C4	33p ceramic
C5, 6	10u 25 V electrolytic
C7	1n0 polyster
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	

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 valuves 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 mutli-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.

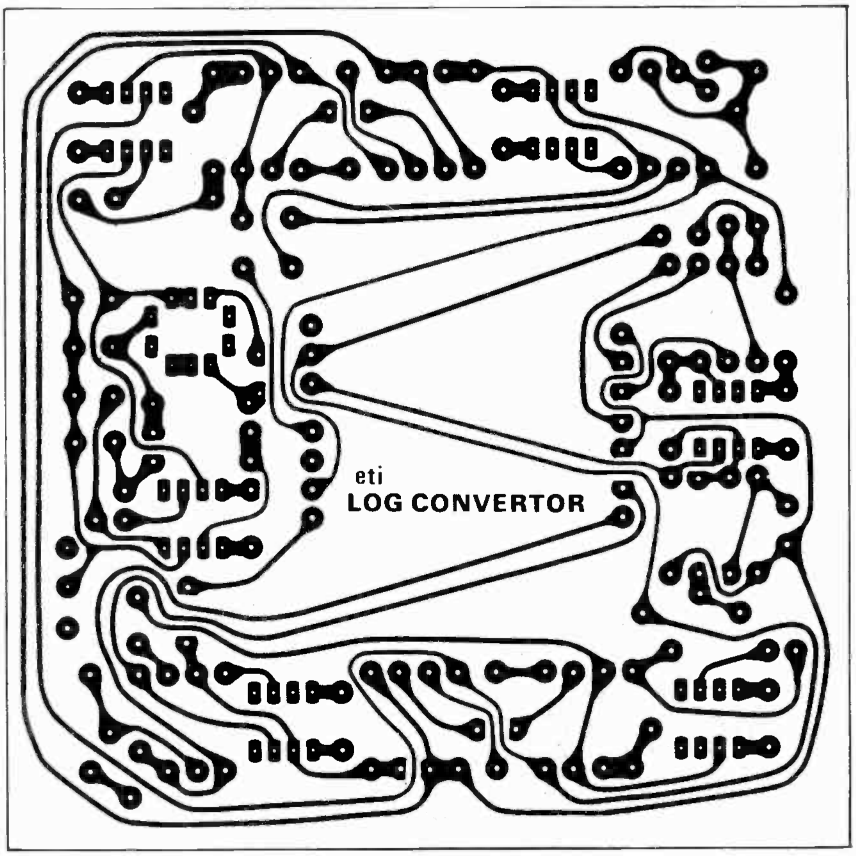
Calibration of Log Mode

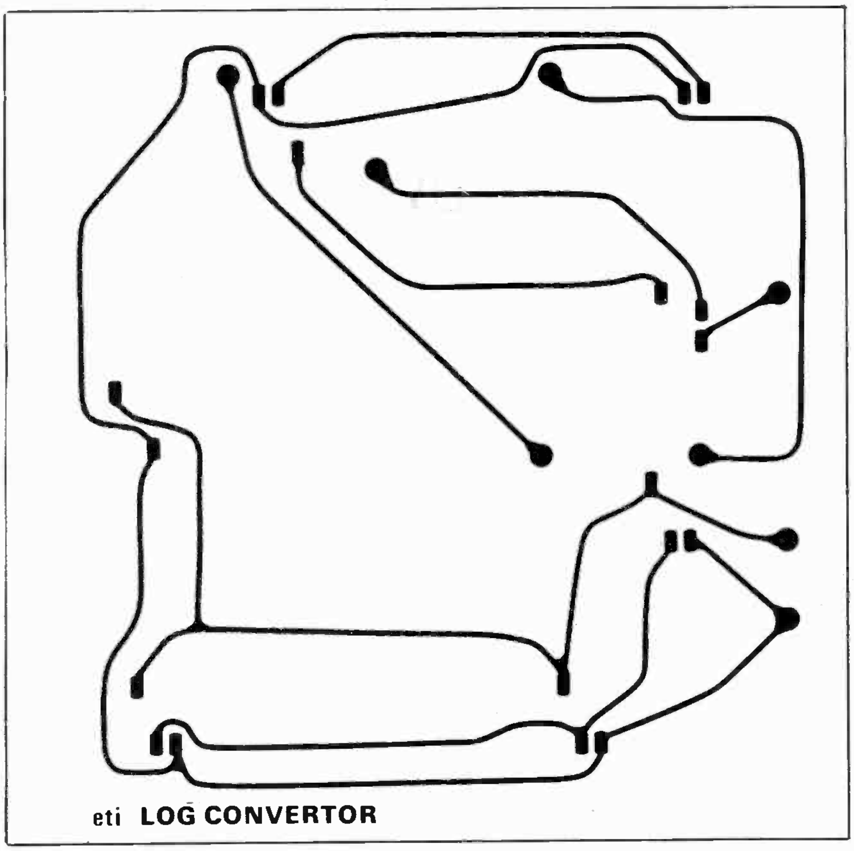
1. Set 0 V on the input.
2. Monitor the voltage on the junction. of R7 and R9.
3. Adjust RV1 to give a negative voltage on this point. Now adjust RV1 slowly until the voltage just switches positive.
4. Set 0.15625 V in the input.
5. Adjust RV5 to give 0 V output.
6. Set 5.00 V on the input.
7. Adjust 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. ETI





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.

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) greated 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 MoI has to charge its customers more than is reasonable! MoI 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 freshing 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 MoI 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.

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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 font 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 Interacot and it's rumoured, Atari are ready to launch something into this market.

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AF126	27p
AF127	27p
AF139	36p
AF186	54p
AF239	40p
ASY53	81p
ASY54	81p
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BC107	8p
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BC168	8p
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BC173	9p
BC182	10p
BC183	10p
BC184	10p
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BC328	15p
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BFX87	20p
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BSX20	21p
BU205	140p

BU208	160p
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OC28	108p
OC35	108p
OC71	19p
OC72	34p
OC84	46p
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4507	40p

4510	70p
4516	64p
4518	70p
4519	60p
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4528	55p
4578	27p
4583	82p
4585	105p
VOLTAGE REGULATORS	
7805	60p
7812	60p
7815	60p
7818	60p
7824	60p
7905	79p
7912	79p
7915	79p
7918	79p
7924	79p
THYRISTORS	
1A/50V	28p
1A/100V	30p
1A/200V	38p
1A/400V	40p
3A/100V	36p
3A/200V	38p
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CA3046	75p
CA3054	110p
CA3080	70p
CA3140E	70p
LM301AN	28p
LM308N	64p
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LM381N	120p
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DIODES	
BY127	16p
OA47	10p
OA91	15p
OA200	6p
OA202	9p
IN4148	4p
1N916	5p
1N4001	4p
1N4002	4p
1N4003	5p
1N4004	6p
1N4005	7p
1N4006	8p
1N4007	9p
1N5400	13p
1N5401	14p
1N5402	15p
1N5403	20p
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2A/50V	34p
2A/100V	36p
2A/200V	38p
2A/400V	40p
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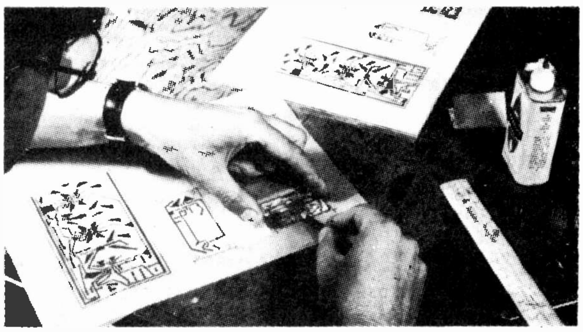

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CLICK ELIMINATOR

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 unnoticable — 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

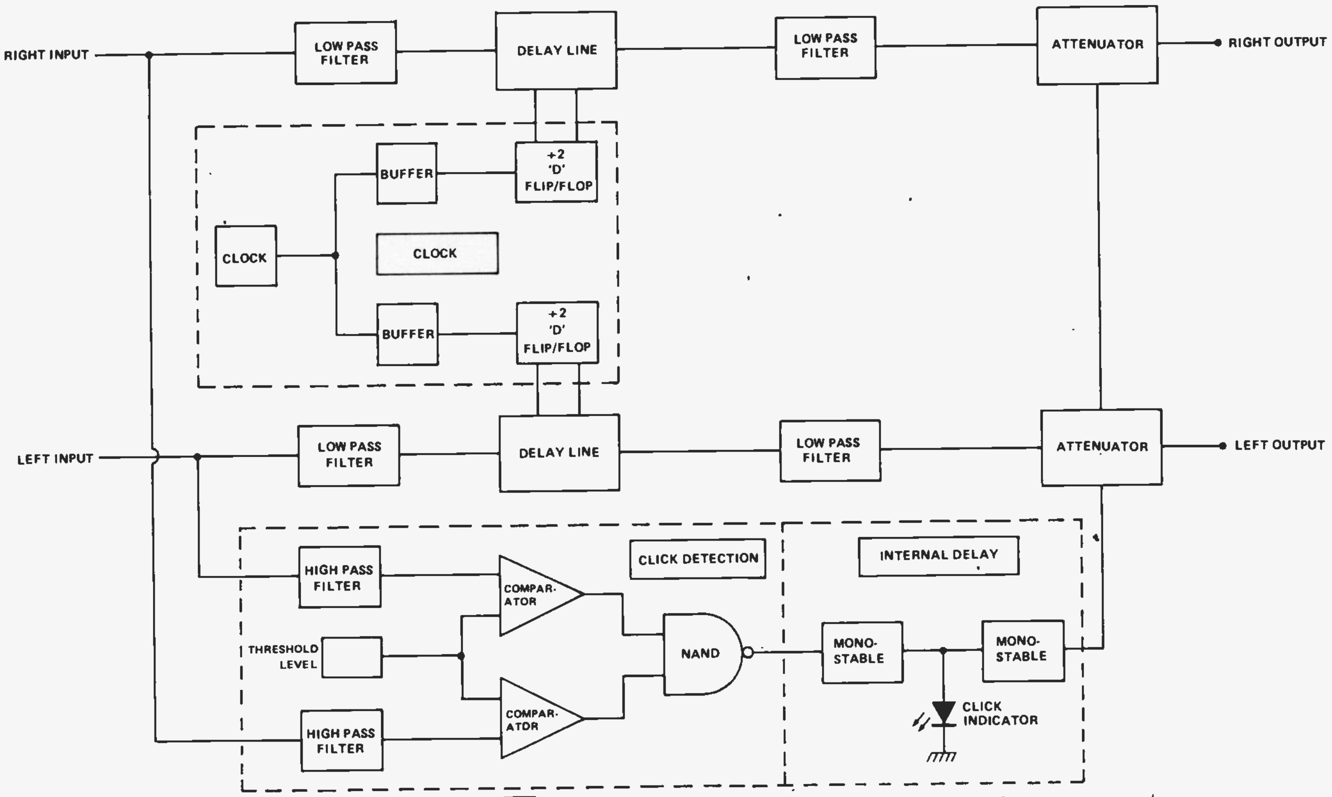


Fig. 1. Block diagram of the ETI click eliminator.

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 it's 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 it's 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 blicks now follows.

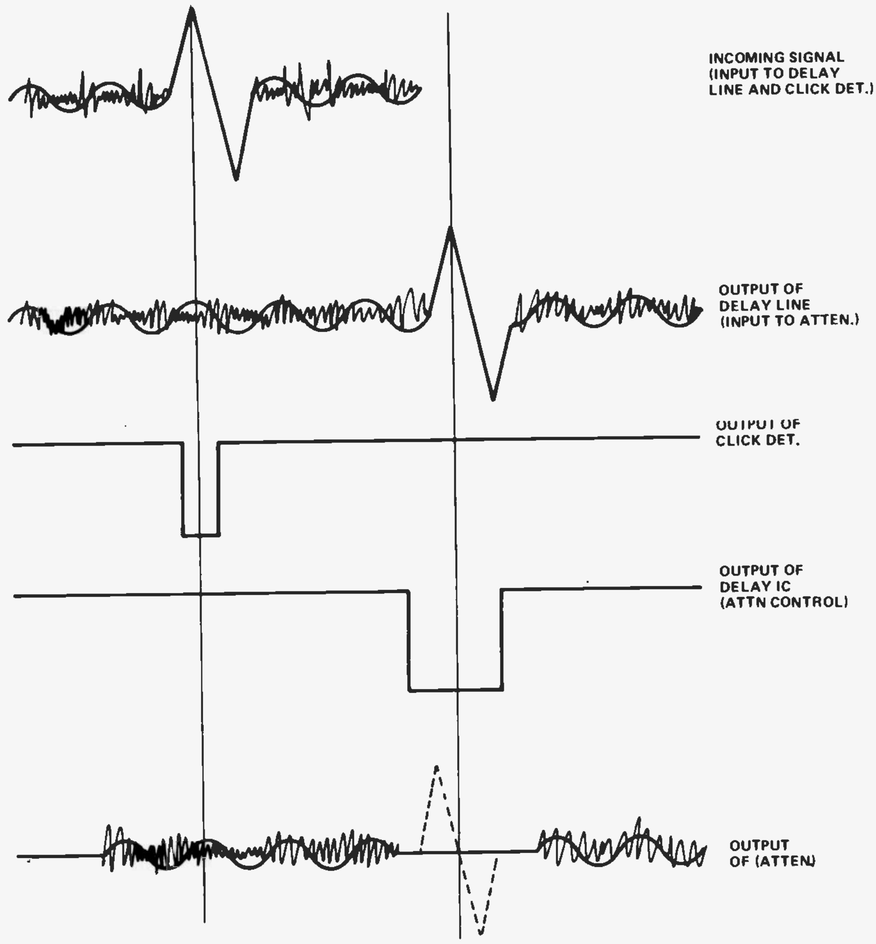
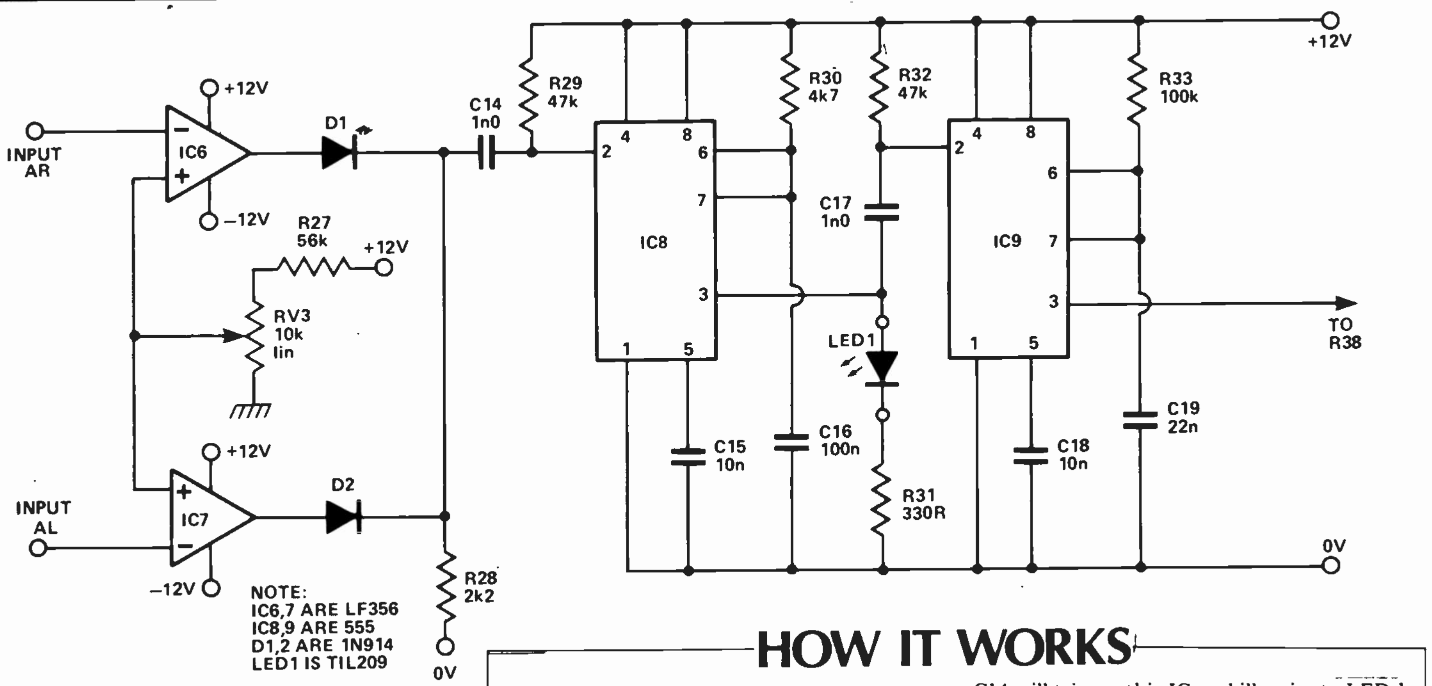
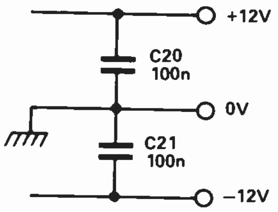


Fig. 2. Above are shown the waveforms that illustrate the action of the circuit when a click has been identified and is to be suppressed.





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.

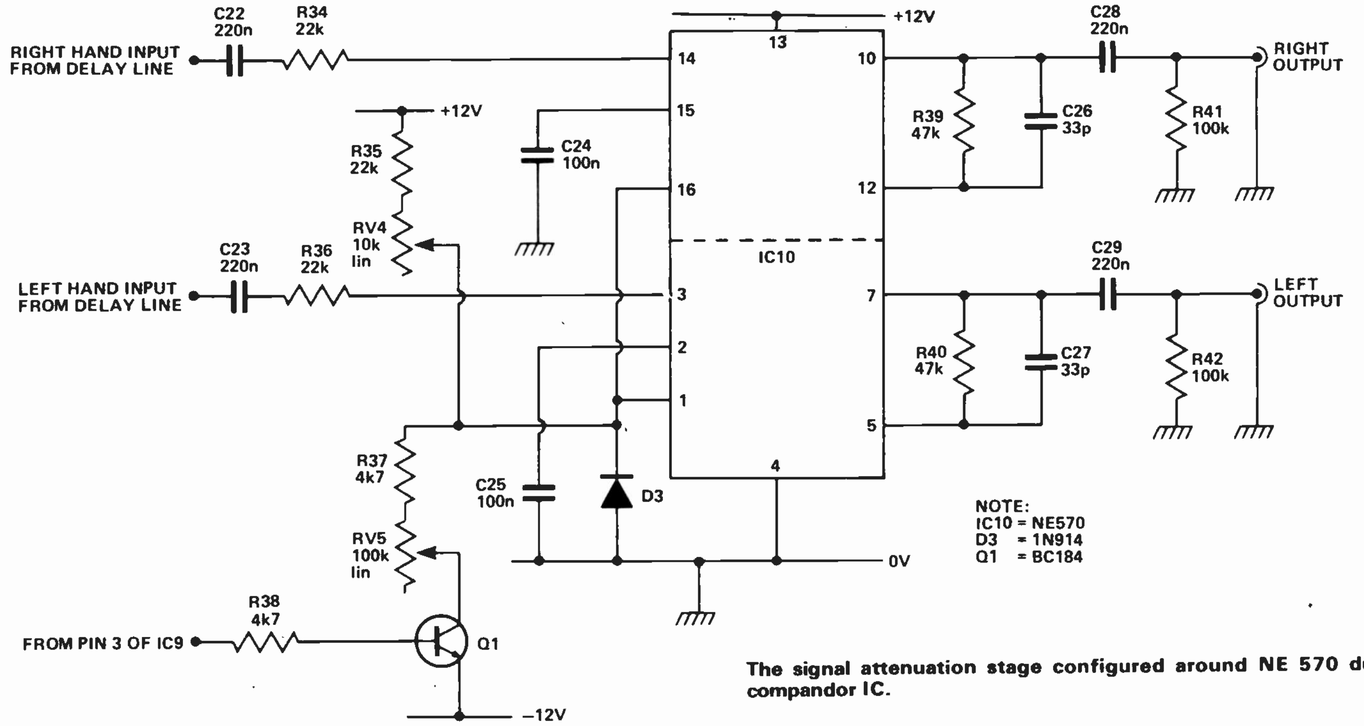
Another unique characteristic of a click is that it will appear on both channels simultaneously. We therefore pass the outputs of the comparator IC's to the NAND gate formed by D1, D2, and R28. The junction of these components and C14 will be high unless both the comparator outputs are low.

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

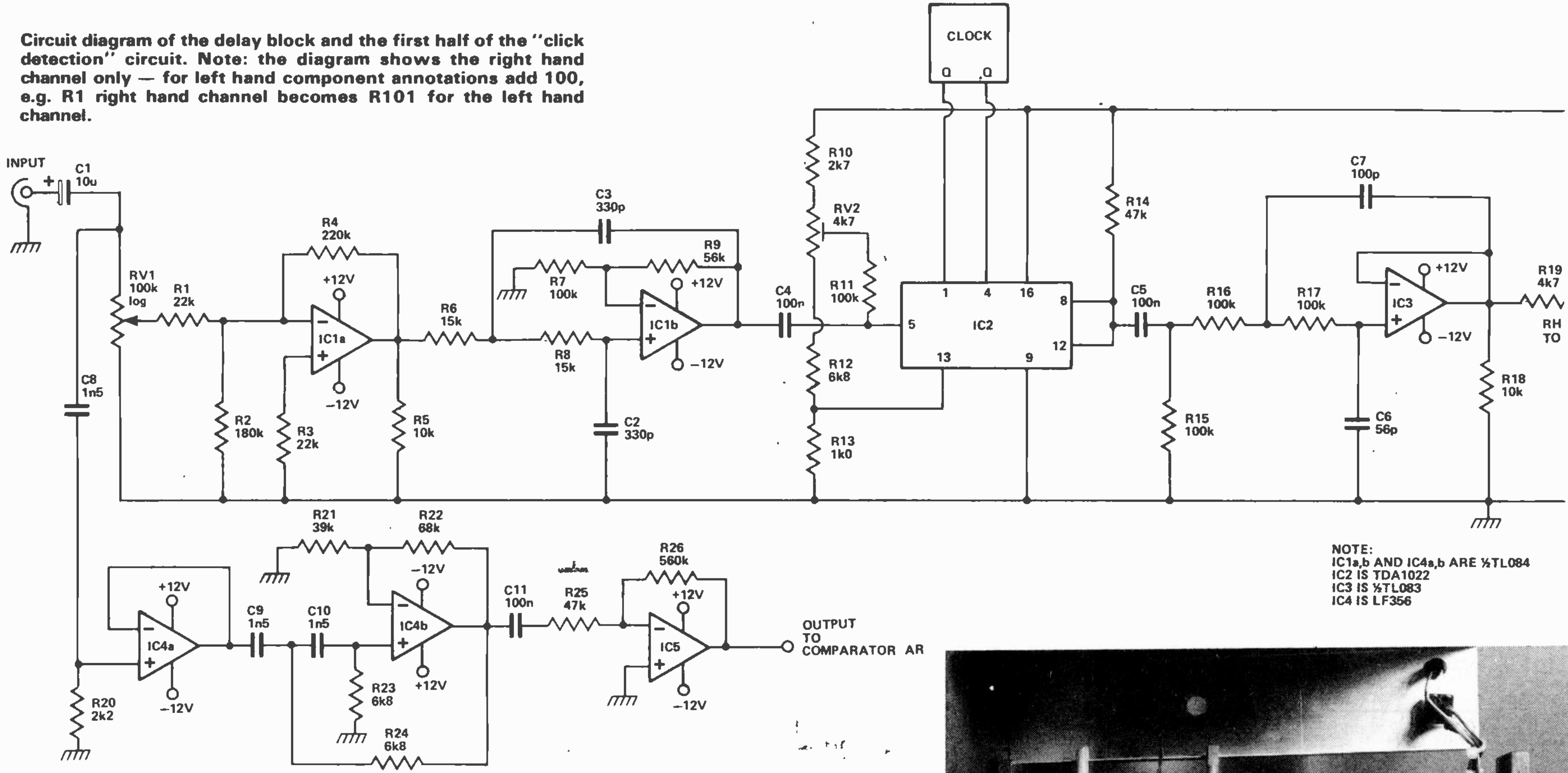
The attenuator is built around an NE570 dual compandor IC (see data sheet Oct 77 p.59). The inputs to the IC are at pins 14 and pin 3, the outputs — with suitable filters — are taken from pins 10 and 7. Gain control is achieved by robbing current from the NE570.

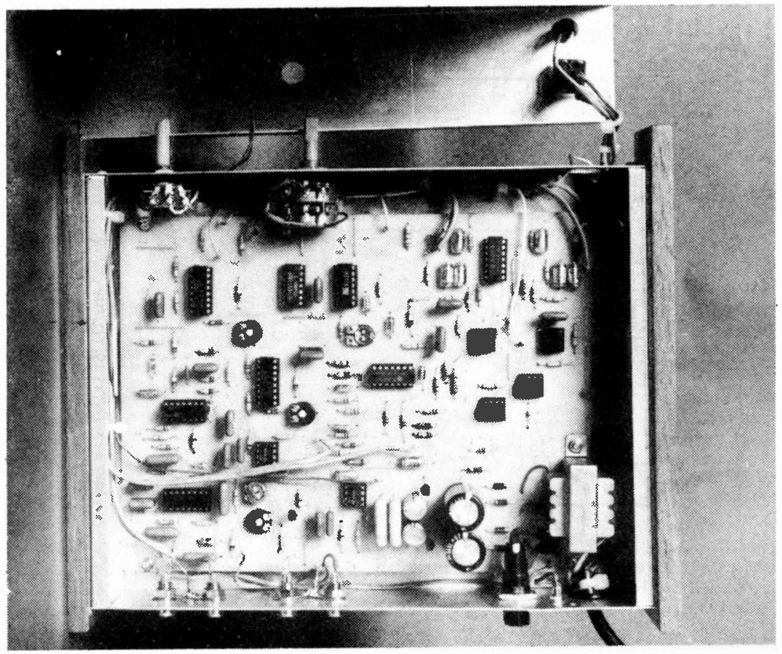
As the input to Q1 is taken high, the device will start to conduct and thus rob the NE570 of current, thus reducing the gain of the amplifier within the device. The control action is set up by RV4.



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 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 kis 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.

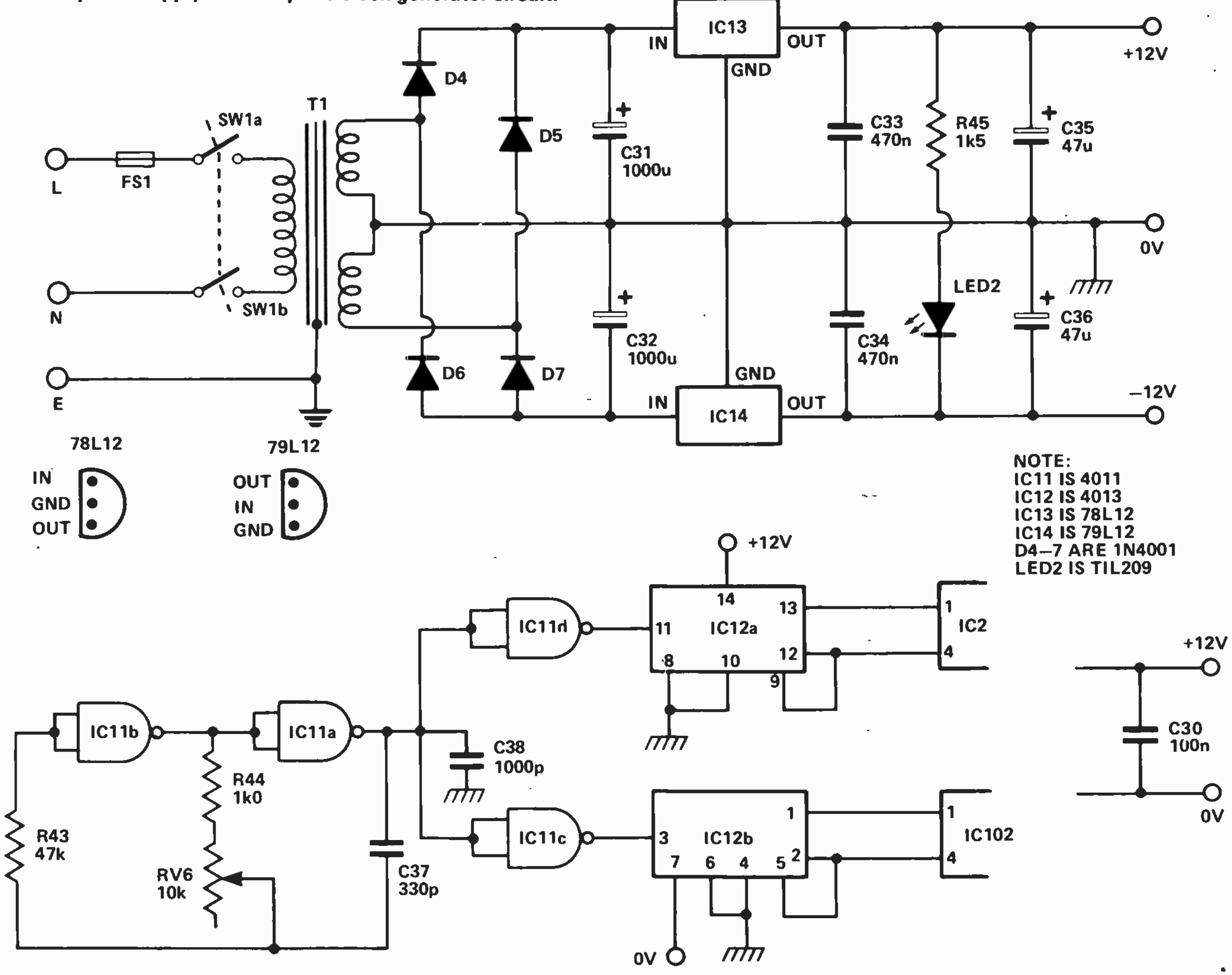
The output from the delay line is taken, via C5, to another Butterworth filter, this stage being used to remove any high frequency click detector described below.

CLOCK AND POWER SUPPLY

Pins 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.

The power supply and delay line clock generator circuit.



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 33, 38, 41, 42, 107, 111, 115, 116, 117	100k
R9, 27, 109	56k
R10, 110	2k7
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	T1L209

MISCELLANEOUS

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1N4007	£0.70	£6.00
1N4148		£2.20
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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.

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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 uncover 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!

Articles mentioned here are in an advanced state of preparation but circumstances may affect the final contents.

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?

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.

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

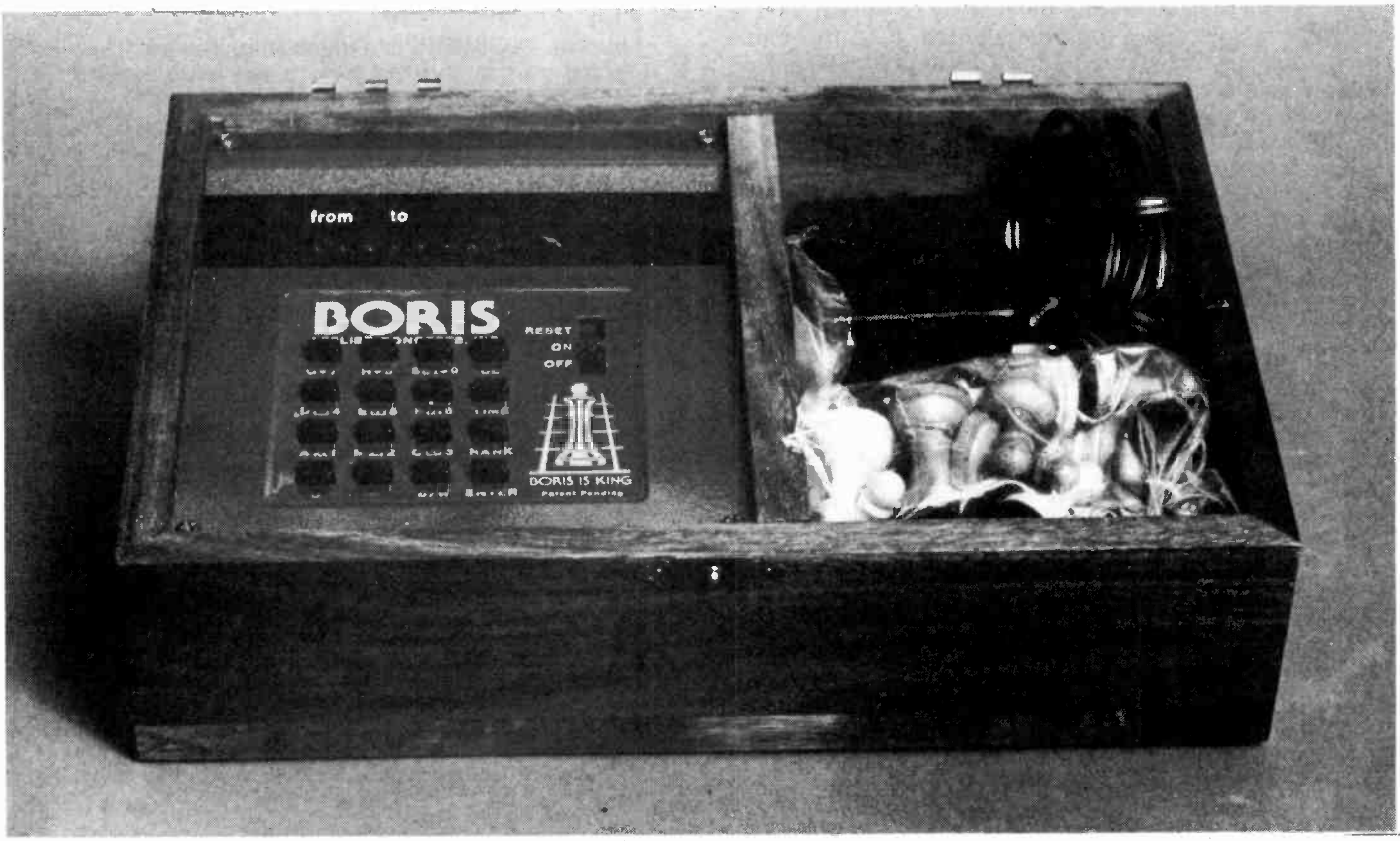
The presentation of the machine is excellent. The electronics consist of an F8 based system accessed by a 16 (multi-function) key array and interfaced to the outside world by a display consisting of eight alpha numeric devices. These are packed into a very smart wooden case which also holds the mains 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.

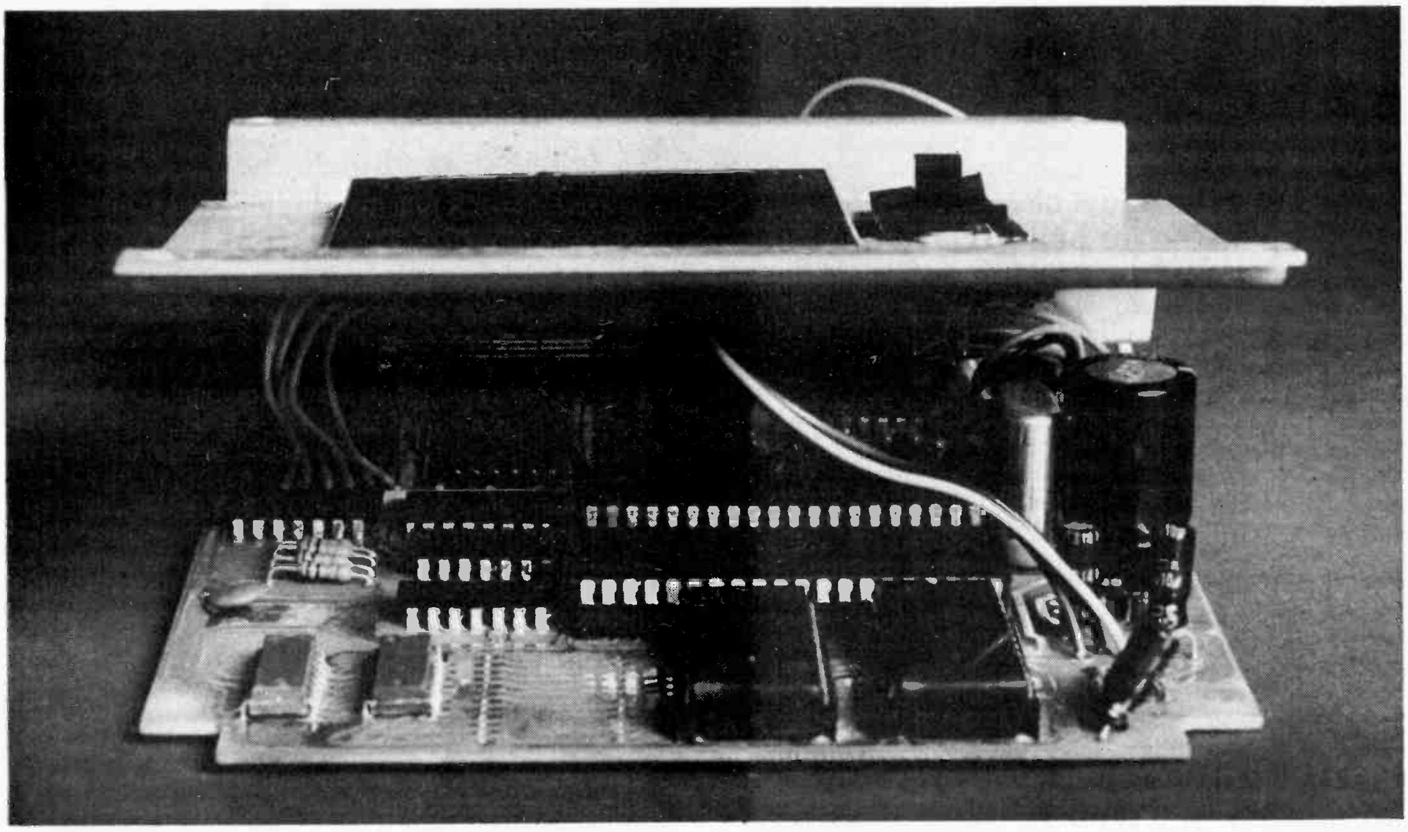
On the two units we were able to examine the mains adaptor terminates in a two pin American 'hi-fi' type of plug — which now fails BS of course. This is moulded into the adaptor body and makes life very awkward for the buyer. At first glance there is no way of getting mains into BORIS aside from wrapping 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

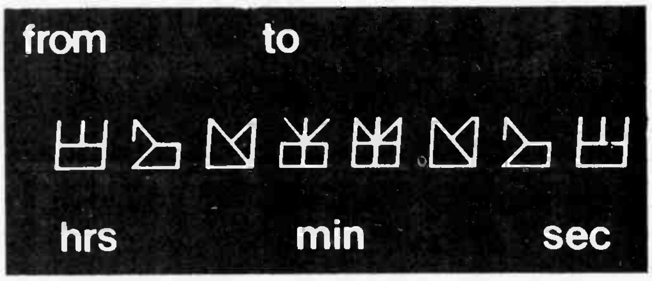
Undoubtedly the first thing to impress about BORIS has nothing to do with his chess abilities. It's his big mouth. Exactly how many comments his PROMs contains is anyone's guess — the importers Optimisation aren't saying — but we counted 47 in two evenings of chess, and I don't think we got them all!

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.

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 witn 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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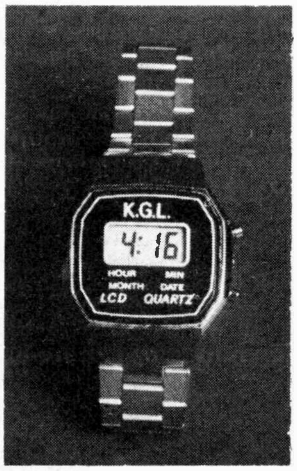
ETI

Ladies LCD Watch



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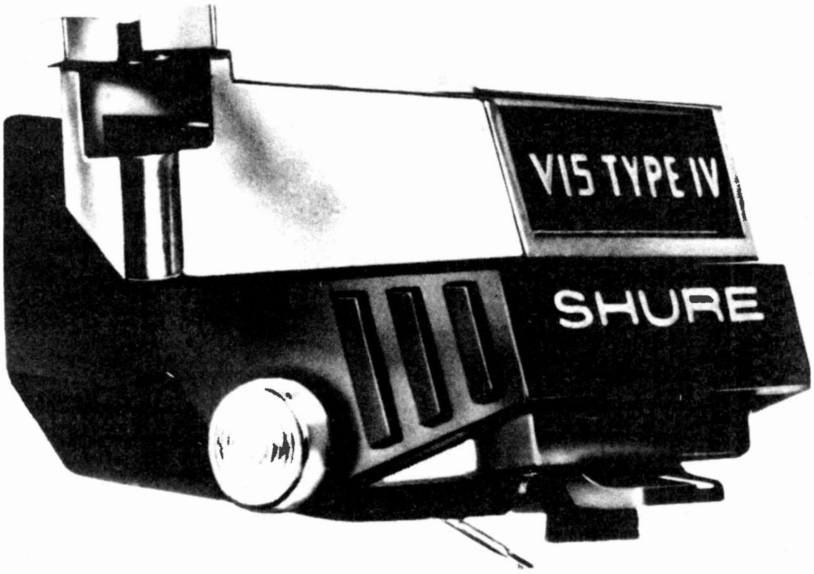
audiophile

What would you say if we told you about a cartridge which has a totally new stylus shape, a new improved magnet structure and revolutionary two part cantilever system — and a new radically different method of controlling operating conditions? It is all true, and its been around a few months too! Ron Harris took his time getting to the V15 Mk.4 — but found it worth the wait!



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 expressable 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.

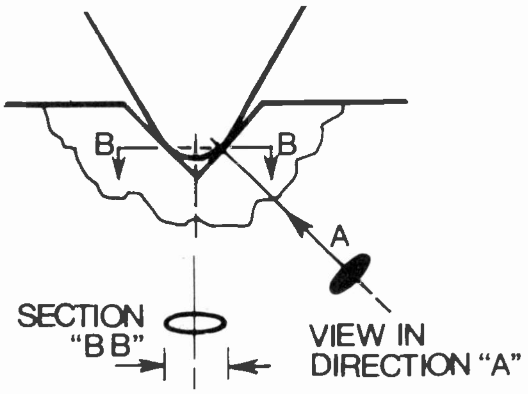
The new features to come out of of all this are a dynamic stabiliser — and it's *not* just a brush, a new cantilever assembly, a new stylus shape, and a static reduction system. In addition the effective mass of the dynamic system has been lowered significantly.

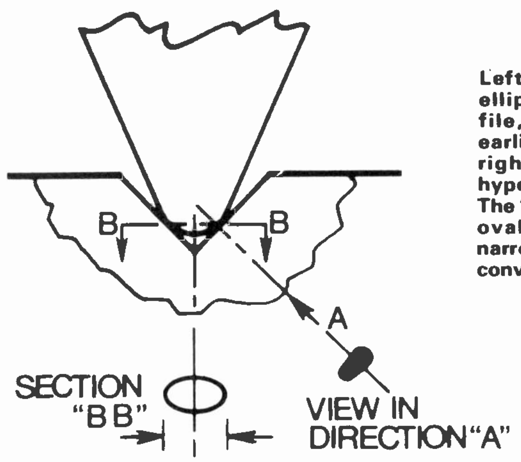
Tipped For Shape

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 prfile. 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 supress 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 cantilver 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 if worse by pumping ions at it.

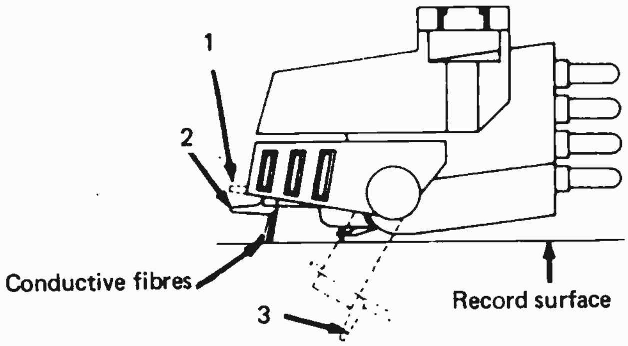
Another nasty well-known to LPs of all age groups is the warp. Warps come free with most records these days and provide such delights as variation in tracking angle, mis-tracking due to effective reduction of applied tracing force and overall disruption of the ideal conditions in which cartridges like 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.

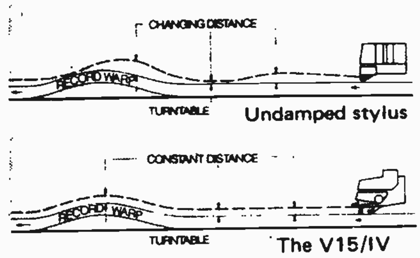
Bristling With Pride

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!

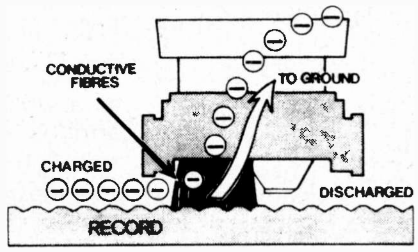
Sounds logical once someone tells you doesn't it? The brush does a good job shifting dust and muck out of the way too!



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.



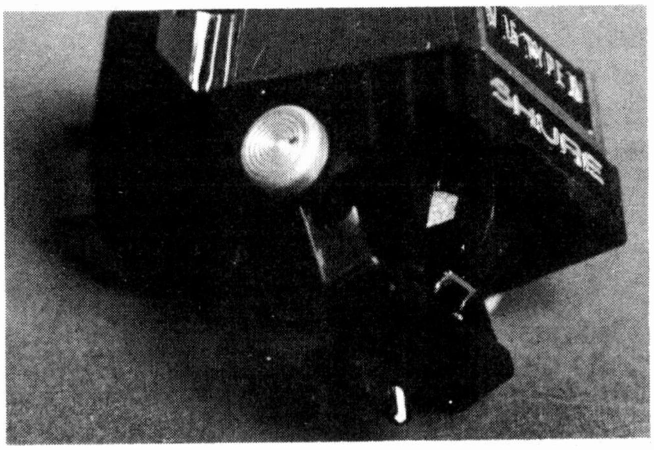
The V15 Type IV's brush with damped pivot is said to aid the tracking of warped discs by matching stylus movement more closely to the motion of the arm



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 reviewers 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 incredibibly detailed,a nd 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.

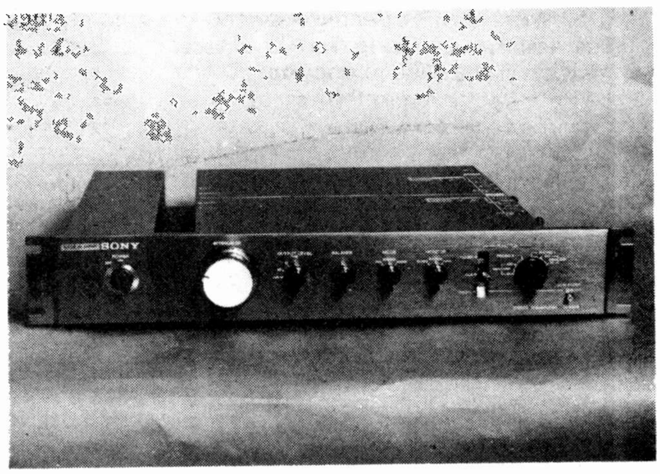
The cheapest such unit available is probably the RS mains suppressor. Your local component stockist should be able to order this for you, and fitting it is pretty simple. Its input comes from the mains, and its output feeds the hi-fi in question.

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 word 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 if 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

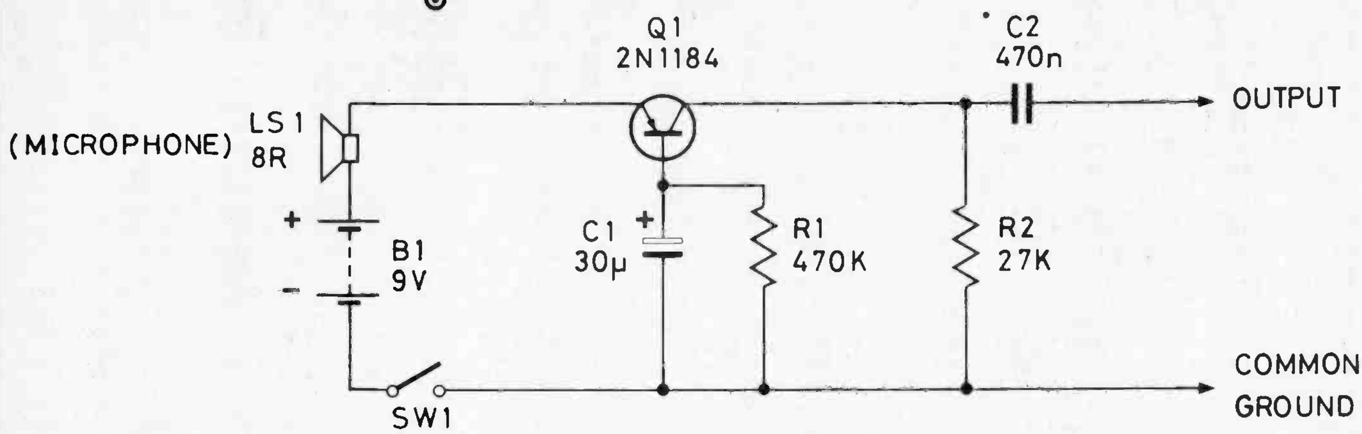
One major problem with SIDs is that of storage when they are not in use. Obviously they cannot be left to roam freely around the lab.! Normal work under these conditions is difficult. Even when they are stored in cupboards the voluble and plaintive cries of 'let me out' are disruptive.

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.

ETI



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

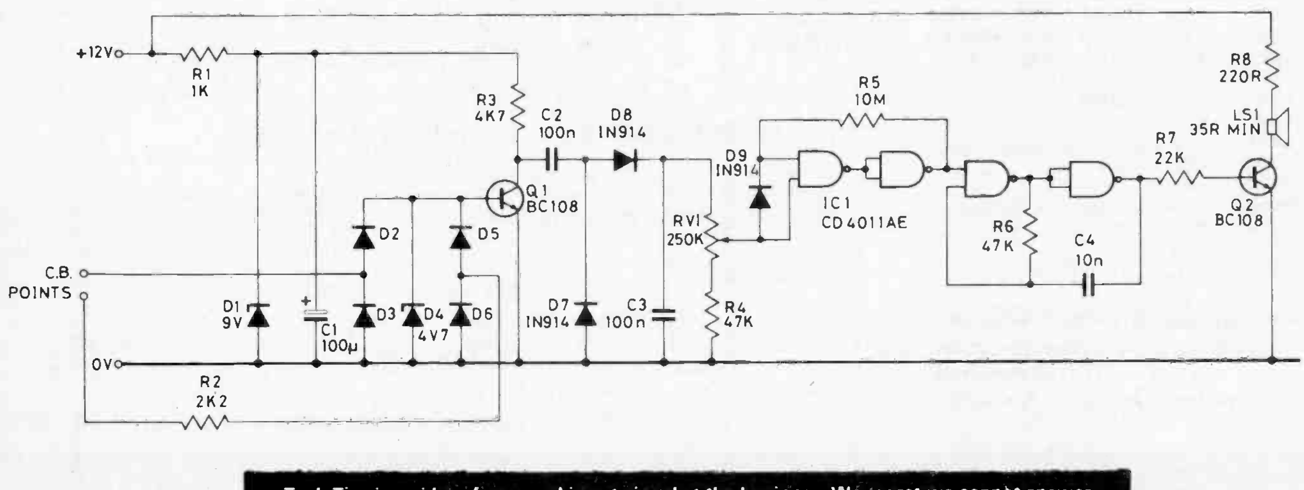
It is all too easy, during a long journey on a motorway, to allow one's speed to gradually creep beyond that point which the boys in blue take an unwelcome interest; this alarm gives an audible nudge whenever you drift over a pre-set speed.

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 = 133Hz 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.



7400	10p
7401	10p
7402	10p
7403	10p
7404	12p
7405	12p
7406	25p
7407	25p
7408	12p
7409	12p
7410	12p
7411	15p
7412	15p
7413	25p
7414	45p
7416	25p
7417	25p
7420	12p
7421	20p
7422	15p
7423	20p
7425	20p
7426	22p
7427	22p
7428	25p
7430	12p
7432	20p
7433	28p
7437	20p
7438	20p
7440	12p
7441	45p
7442	40p
7443	60p
7444	60p
7445	65p
7446	50p
7447	50p
7448	50p
7450	12p
7451	12p
7453	12p
7454	12p
7460	12p
7470	25p
7472	20p
7473	25p
7474	25p
7475	25p
7476	25p
7480	40p
7481	85p
7482	75p
7483	75p
7484	70p
7485	60p
7486	25p
7489	130p
7490	25p
7491	40p
7492	35p
7493	30p
7494	70p
7495	45p
7496	45p
7497	120p
74100	80p
74104	40p
74105	40p
74107	25p
74108	100p
74166	75p
74109	25p
74118	75p
74120	80p
74121	25p
74122	35p
74123	40p
74125	35p
74126	35p
74128	60p
74130	120p
74131	90p
74132	45p
74135	90p
74136	80p
74137	90p
74138	100p
74141	50p
74142	180p
74143	270p
74144	270p
74145	55p
74147	100p
74148	90p
74150	65p
74151	45p
74153	45p
74154	70p
74155	45p
74156	45p
74157	45p
74160	55p
74161	55p
74162	55p
74163	55p
74164	60p
74165	60p
74166	75p
74167	160p
74170	100p
74173	80p
74174	60p
74175	60p
74176	50p
74177	50p
74178	75p
74179	120p
74180	90p
74181	130p
74182	50p
74184	120p
74185	100p
74188	320p
74190	70p
74191	70p
74192	60p
74193	60p
74194	55p
74195	50p
74196	50p
74197	50p
74198	100p
74199	100p
74293	90p
74L500	18p
745112	80p

CMOS

4000	12p
4001	12p
4002	12p
4006	80p
4007	14p
4009	30p
4011	12p
4012	12p
4013	30p
4015	50p
4016	30p
4017	50p
4018	55p
4019	40p
4020	50p
4022	50p
4023	12p
4024	40p
4025	12p
4026	80p
4027	30p
4028	45p
4029	50p
4030	30p
4032	80p
4033	100p
4040	60p
4043	60p
4046	90p
4047	80p
4048	50p
4049	25p
4050	25p
4054	100p
4055	130p
4056	120p
4060	100p
4066	35p
4069	12p
4070	12p
4071	12p
4072	12p
4081	12p
4082	12p
4093	70p
4510	60p
4511	70p
4516	65p
4518	65p
4520	65p
4528	80p
4583	70p

LINEAR

AY3 8500	450p
CA 3039	70p
CA 3046	60p
CA 3060	225p
CA 3065	200p
CA 3076	250p
CA 3080	75p
CA 3084	250p
CA 3085	85p
CA 3086	60p
CA 3088	190p
CA 3089	160p
CA 3090AQ	360p
CA 3123 E	130p
CA 3130	100p
CA 3140	60p
LF 356	80p
LF 357	80p
LM 211 H	250p
LM 300 TR5	170p
LM 301 AN	30p
LM 304	200p
LM 307N	65p
LM 308 TO5	100p
LM 308 DIL	100p
LM 309 K	100p
LM 310 TO5	150p
LM 311 TO5	150p
LM 317 K	325p
LM 324	70p
LM 339	60p
LM 348 N	90p
LM 380	60p
LM 381 N	90p
LM 382	90p
LM 391	180p
LM 555	25p
LM 709 C	40p
LM 710 TO5	60p
LM 710 DIL	65p
LM 723 TO5	40p
LM 723 DIL	40p
LM 733	120p
LM 741	20p
LM 748	40p
LM 1303 N	100p
LM 1458	100p
LM 3080	75p
LM 3900	55p
LM 3909 N	65p
MC 1310 P	140p
MC 1312 P	150p
MC 1314 P	190p
MC 1315 P	230p
MK 50398	650p
MM 5314	380p
MM 5316	480p
NE 529 K	150p
NE 555	25p
NE 556	90p
NE 562 B	400p
SAD 1024	1500p
SL 917 B	650p
SN 76003 N	150p
SN 76013 N	110p
SN 76013 ND	125p
SN 76023 N	110p
SN 76023 ND	125p
SN 76033 N	150p
SN 7627 N	160p
SN 76228 N	180p
SN 76660 N	75p
TAA 300	100p
TAA 350	190p
TAA 550	35p
TAA 570	220p
TAA 661B	140p
TAA 700	350p
TAA 790	350p
TAD 100	150p
TAD 110	130p
TBA 120 S	60p
TBA 120 T	85p
TBA 480 Q	200p
TBA 520 Q	200p
TBA 530 Q	200p
TBA 540	200p
TBA 550 Q	250p
TBA 560 C	250p
TBA 641 A12	250p
TBA 700	180p
TBA 720 Q	225p
TBA 750 Q	200p
TBA 800	80p
TBA 810	100p
TBA 820	100p
TBA 920 Q	280p
TCA 270 Q	220p
TCA 270 S	220p
TCA 760	300p
TCA 4500 A	450p
TDA 1008	350p
TDA 1034	450p
TDA 2002	300p
TDA 2020	300p
TL 084	120p
XR 320	250p
XR 2206	450p
XR 2207	450p
XR 2208	600p
XR 2216	650p
XR 2567	250p
XR 4136	150p
XR 4202	150p
XR 4212	150p
XR 4739	150p
ZN 414	100p

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7410	11p
7413	22p
7414	36p
7420	11p
7430	11p
7441	45p
7442	32p
7447	40p
7474	22p
7475	25p
7486	20p
7490	24p
7493	24p
7496	36p
74121	24p
74123	32p
74141	45p
74151	36p
74153	36p
74154	60p
74157	36p
74160	45p
74164	45p
74190	45p
74192	45p
74193	45p
74196	48p

CMOS

4009	30p
4011	13p
4013	30p
4016	28p
4017	48p
4024	40p
4046	85p
4049	27p
4510	59p
4518	58p
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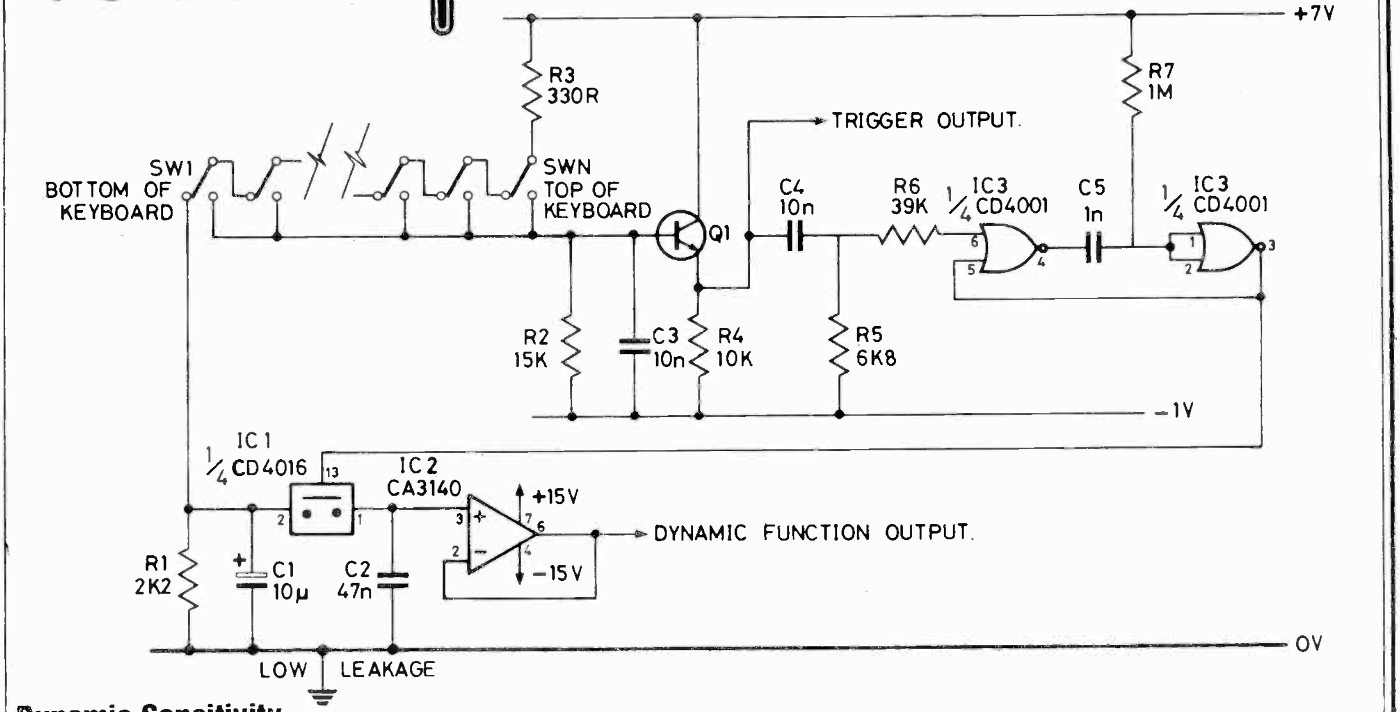


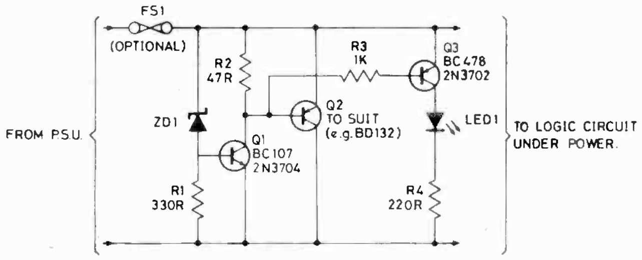
Dynamic Sensitivity

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, 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 TRQ1 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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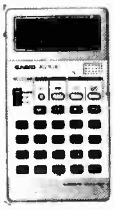

Hours, minutes, seconds, am/pm, 24 hour **Alarm** with sign. **Stopwatch:** Net times, lap times, 1st & 2nd place times from 1/10 sec. to 10 hrs. with ST & LAP signs. **Calculator:** 4 key memory, %, √, 1 year batteries. ± 20 secs/month. ¼ × 2⅜ × 4⅝in. RRP £26.95

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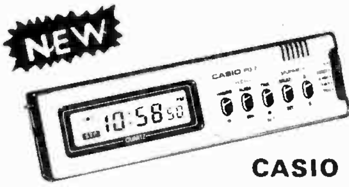

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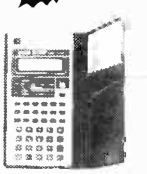

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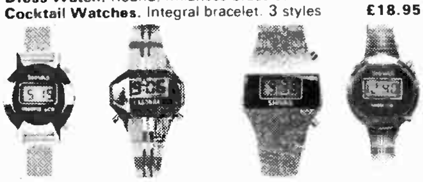

L1 L2 L3 L4

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54QS-16B Left, 6 digit (£49.95) **£39.95**
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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.

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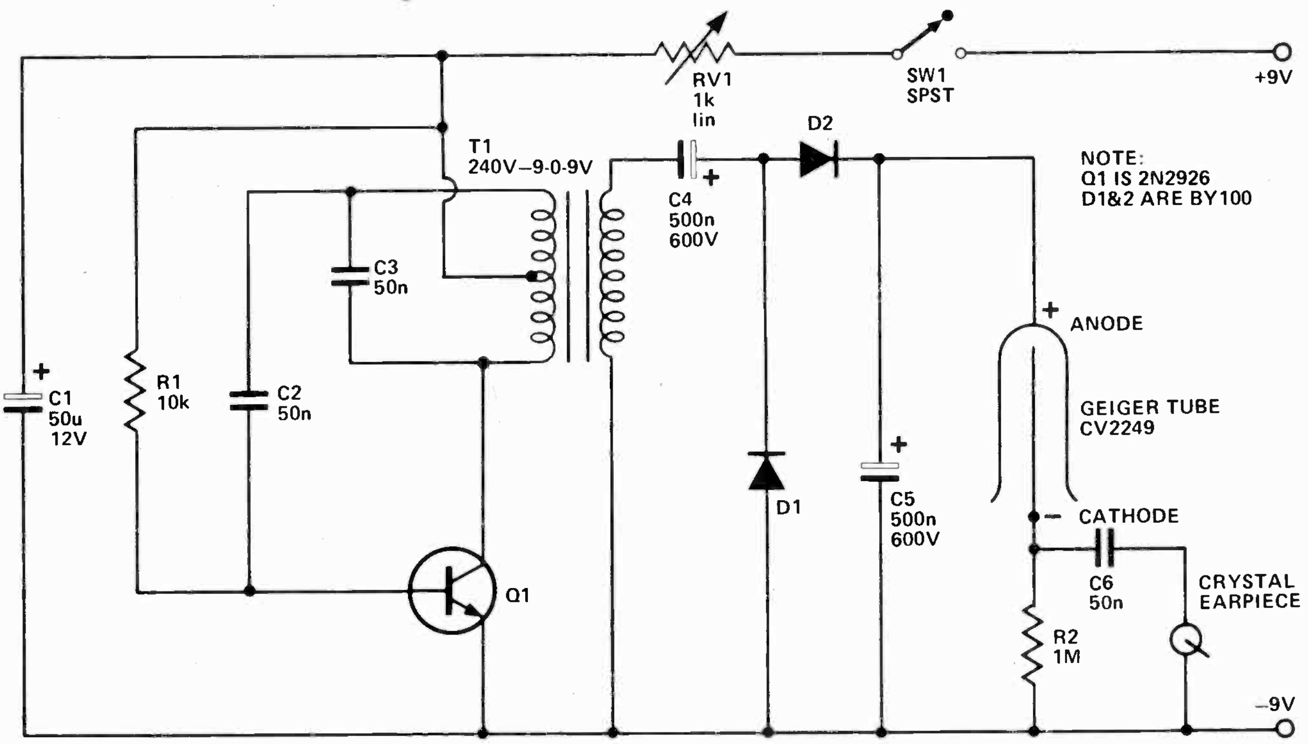
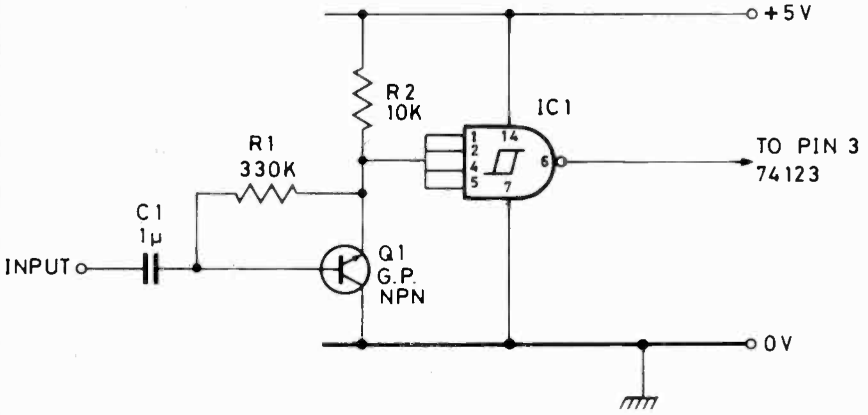


Geiger Counter

A. Wheatley

Although the circuit is imexpensive 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.

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25-27 Oxford Street
London W1R 1RF

No, she hasn't got it on backwards — the new ETI tee-shirt has ETI printed on it on **both** sides! Now you can say ETI in two directions at once!

TRANSISTORS

AC107	0.23	BC117	0.15	BC206	0.10	BC559B	0.11	BF184	0.20	BU205	1.30	2N1613	0.18
AC125	0.17	BC118	0.12	BC206B	0.11	BCY42	0.55	BF185	0.20	BU208	1.50	2N1671	1.10
AC126	0.17	BC119	0.25	BC207	0.10	BCY58	0.20	BF194	0.06	BU208-02	1.75	2N1671B	2.20
AC127	0.16	BC125	0.15	BC209B	0.09	BCY71	0.13	BF194A	0.07	BU406	3.60	2N1711	0.20
AC127K	0.23	BC125B	0.16	BC212A	0.10	BCY72	0.13	BF195	0.06	BUY69A	6.75	2N1893	0.25
AC128	0.14	BC126	0.15	BC213L	0.10	BD115	0.30	BF195D	0.07	BUY69B	2.00	2N1905	0.25
AC128K	0.25	BC136	0.15	BC214L	0.10	BD116	0.30	BF195G	0.07	BUY69C	7.00	2N1990	0.25
AC128/176	0.42	BC137	0.15	BC237	0.15	BD123	0.60	BF196	0.06	BUY70A	5.00	2N2060	1.00
AC142	0.18	BC138	0.30	BC237A	0.16	BD128	1.02	BF197	0.06	BUY71	4.50	2N2188	0.20
AC153	0.55	BC140	0.27	BC237C	0.21	BD131	0.35	BF198	0.06	MPS6517	0.48	2N2218A	0.22
AC158	0.50	BC141	0.29	BC238	0.15	BD133	0.40	BF224	0.10	MPS6523	0.27	2N2222	0.18
AC176	0.16	BC142	0.20	BC238B	0.16	BD135	0.30	BF253	0.10	MPSA06	0.90	2N2222A	0.20
AC187	0.50	BC147	0.06	BC238C	0.18	BD136	0.30	BF254	0.10	MV5053	0.72	2N2270	0.39
AC187K	0.55	BC147B	0.07	BC251A	0.15	BD137	0.30	BF255	0.10	MKT214	0.25	2N2368	0.10
AC188K	0.55	BC148	0.06	BC251B	0.17	BD138	0.30	BF257	0.16	MKT224	0.25	2N2484	0.18
ACY20	1.02	BC148A	0.07	BC252A	0.15	BD139	0.30	BF258	0.28	OC22	1.40	2N2904	0.18
ACY22	1.02	BC148B	0.07	BC252B	0.17	BD140	0.30	BF259	0.28	OC26	1.40	2N2906	0.18
AD142	0.87	BC149	0.06	BC252C	0.20	BD144	0.30	BF324	0.20	OC29	0.85	2N3053	0.15
AD143	0.87	BC157	0.06	BC258	0.20	BD168	0.50	BF335	0.25	OC35	1.00	2N3117	1.00
AD149	0.65	BC157A	0.07	BC261A	0.18	BD178	0.72	BF338	0.45	OC44	0.12	2N3440	0.70
AD161	0.35	BC158	0.07	BC262	0.20	BD181	1.32	BF457	0.60	OC45	0.12	2N3638	0.15
AD161/162	0.70	BC158A	0.08	BC267A	0.21	BD183	1.50	BF523	0.22	OC71	0.09	2N3638A	0.16
AD182	0.35	BC158V1	0.09	BC267B	0.22	BD232	0.60	BF594	0.10	OC74	0.10	2N3643	0.24
AD262	0.36	BC159	0.06	BC268	0.21	BD233	0.60	BFR91	5.00	OC75	0.10	2N3692	0.24
AD263	0.36	BC159A	0.07	BC304	0.25	BD234	0.60	BFT43	0.54	OC82	0.48	2N3705	0.06
ADY26	4.74	BC159B	0.07	BC307	0.15	BD235	0.40	BFX29	0.20	OC139	0.50	2N3706	0.06
ADZ11	4.05	BC161	0.25	BC307A	0.15	BD236	0.40	BFX34	0.70	OC203	2.50	2N3707	0.06
AF106	0.45	BC167	0.06	BC307B	0.15	BD237	0.40	BFX84	0.20	OC207	2.70	2N3711	0.06
AF109R	0.36	BC168	0.06	BC308	0.15	BD238	0.40	BFX85	0.20	OC1072	2.50	2N3819	0.20
AF124	0.25	BC169	0.06	BC309A	0.15	BD434	0.40	BFX88	0.20	OC1074	2.50	2N3899	3.00
AF125	0.25	BC170B	0.07	BC317B	0.15	BD507	0.50	BFY18	0.50	R2008B	2.10	2N3904	0.06
AF126	0.25	BC170C	0.07	BC322	0.10	BD508	0.50	BFY19	0.50	TIP30	0.35	2N3905	0.06
AF127	0.25	BC171	0.06	BC327	0.16	BD518	0.50	BFY33	0.50	TIP31	0.45	2N3906	0.06
AF139	0.32	BC171A	0.07	BC328	0.16	BD537	1.02	BFY34	0.50	TIP31A	0.45	2N4037	0.25
AF178	0.30	BC171B	0.07	BC337	0.16	BD587	1.40	BFY46	0.50	TIP32	0.45	2N4058	0.10
AF179	0.30	BC172	0.06	BC338	0.16	BDX32	1.90	BFY51	0.12	TIP33	0.60	2N4222A	0.65
AF200	0.36	BC172A	0.07	BC348A	0.15	BDY16	0.50	BFY52	0.12	TIP42	0.60	2N4348	2.00
AF201	0.39	BC172B	0.07	BC350A	0.17	BDY20	0.50	BFY81	4.00	TIP2955	0.65	2N4448	1.50
ASY73	0.38	BC172C	0.07	BC441	0.20	BF115	0.35	BRY39	0.35	TIS90	0.18	2N4914	3.50
ASZ15	0.60	BC173	0.06	BC461	0.24	BF121	0.20	BSX20	0.18	2N3448	0.30	2N5172	0.25
ASZ16	0.60	BC173B	0.07	BC546	0.10	BF123	0.20	BSX52	0.33	2N404	0.45	2N5245	0.30
ASZ17	0.60	BC174B	0.07	BC547	0.11	BF125	0.20	BSY20	0.21	2N524	0.48	2N5296	0.40
AU103	0.90	BC177A	0.12	BC547A	0.11	BF127	0.20	BSY25	0.30	2N526	0.48	2N5458	0.25
AU107	1.00	BC177B	0.12	BC547B	0.11	BF137	0.21	BSY26	0.30	2N527	0.48	2N5496	0.60
AU110	0.90	BC178B	0.12	BC547C	0.11	BF152	0.15	BSY27	0.30	2N685	3.50	2N5670	0.65
AU210	0.90	BC179	0.12	BC548A	0.11	BF154	0.15	BSY29	0.54	2N705	0.10	2N5926	0.55
BC107	0.06	BC182A	0.09	BC548B	0.11	BF157	0.37	BSY39	0.15	2N706	0.10	2N6123	0.65
BC107A	0.07	BC182B	0.09	BC548C	0.11	BF158	0.15	BSY52	0.33	2N706A	0.11	2S003	0.75
BC107B	0.07	BC183A	0.09	BC549A	0.11	BF167	0.25	BSY54	0.39	2N708	0.12	2S303	0.90
BC108	0.06	BC183LA	0.09	BC549B	0.11	BF173	0.20	BSY56	0.36	2N1039	0.15	2S304	0.90
BC108A	0.07	BC183LB	0.10	BC550	0.11	BF174	0.20	BSY60	0.36	2N1059	0.15	2S305	0.90
BC108B	0.07	BC184	0.08	BC557	0.11	BF177	0.25	BSY84	0.30	2N1101	0.15	2S323	1.00
BC109	0.08	BC184L	0.09	BC557A	0.11	BF178	0.25	BU105	1.08	2N1102	0.15	2S732	1.00
BC109B	0.07	BC184LB	0.10	BC557B	0.11	BF179	0.25	BU105-04	1.08	2N1132	0.20		
BC109C	0.07	BC186	0.19	BC557C	0.11	BF180	0.20	BU108	1.80	2N1304	0.50		
BC113	0.12	BC187	0.19	BC558	0.11	BF181	0.20	BU126	1.00	2N1305	0.50		
BC114	0.15	BC204	0.08	BC558A	0.11	BF182	0.20	BU133	1.75	2N1307	0.50		
BC116	0.13	BC204B	0.09	BC558B	0.11	BF183	0.20	BU204	1.30	2N1309	0.50		

DIODES

AA119	0.17	BA243	0.85	BY142	0.45	BY204-8	0.65	ITT827	2.35	OA86	0.20	1N5403	0.15
AA121	0.11	BAX13	0.06	BY164	0.50	BY204-10	0.75	ITT921	0.20	OA90	0.07	1N5404	0.16
AA129	0.08	BAX16	0.07	BY176	3.45	BY206	0.30	ITT923	0.35	OA91	0.06	1N5405	0.25
AA143	0.15	BAX17	0.10	BY179	0.90	BY210-400	0.45	ITT1075	0.25	OA95	0.06	1N5406	0.20
AA144	0.09	BB105B	0.35	BY182	1.85	BY210-600	0.50	ITT2001	0.25	OA202	0.07	1N5407	0.19
BA102	0.30	BB105G	0.35	BY184	0.70	BY210-800	0.55	ITT2002	0.20	S12	0.14	1N5408	0.20
BA111	0.98	BB110G	0.45	BY187	1.30	BYX10	0.35	MR502	0.75	1N4001	0.04	1N5450A	0.75
BA115	0.25	BB142	1.25	BY198	0.75	BYX55-350	0.45	MR813	0.90	1N4002	0.05	1N5761	0.60
BA145	0.15	BR100	0.20	BY199	0.55	BYX55-600	0.55	MR854	1.80	1N4003	0.05		
BA148	0.12	BR101	0.30	BY201-2	0.40	BYX71-350	0.90	MR856	2.10	1N4004	0.06		
BA154	0.10	BY100	0.20	BY201-3	0.40	BYX71-600	1.15	MR992A	1.55	1N4005	0.06		
BA155	0.12	BY103	0.35	BY201-4	0.40	BZX61 series		MV2203	1.60	1N4006	0.07		
BA156	0.12	BY118	1.45	BY201-5	0.55		0.18	MV5460	0.65	1N4007	0.08		
BA157	0.45	BY126	0.15	BY201-6	0.55	BZX88 series		OA47	0.07	1N4148	0.04		
BA158	0.65	BY127	0.10	BY203-12	0.60		0.08	OA70	0.07	1N4150	0.45		
BA159	0.75	BY130	0.15	BY203-16	0.65	DK13	0.45	OA71	0.35	1N4448	0.25		
BA182	0.45	BY133	0.10	BY203-20	1.00	ITT44	0.10	OA81	0.12	1N5401	0.12		
BA201	0.15	BY134	0.45	BY204-4	0.45	ITT210	1.35	OA85	0.12	1N5402	0.15		

LINEAR INTEGRATED CIRCUITS

CA3020	1.75	MC1358PQ	3.85	SN76023ND	2.15	TAA570	2.85	TBA400	2.25	TBA700	3.95	TCA270	3.00
CA3046	0.80	SAA570	4.20	SN76033N	2.48	TAA621	6.95	TBA510	2.40	TBA700Q	2.25	TCA270B	3.60
CA3048	2.50	SAA700B	10.15	SN76110N	1.50	TAA630	0.55	TBA510Q	2.50	TBA720	5.10	TCA270Q	3.60
CA3065	1.58	SAS560	2.75	SN76131N	2.00	TAA630S	5.10	TBA520	2.50	TBA720A	5.10	TCA270S	2.25
CA3089E	7.68	SAS570	2.75	SN76226N	3.15	TAA661A	1.70	TBA520Q	2.50	TBA720AQ	2.10	TCA270SQ	3.40
CA3090Q	4.50	SBA750B	0.75	SN76226ND	3.15	TAA661B	1.80	TBA530	2.50	TBA750	2.40	TCA800	5.40
ETT6016	4.95	SC9503P	2.00	SN76227N	2.50	TAA700	3.50	TBA530Q	2.50	TBA750Q	2.50	TCA800Q	12.40
ETTR6016	4.95	SC9504P	2.00	SN76532N	3.15	TAA840	4.50	TBA540	2.50	TBA800	0.80	TCA830	3.10
MC1303L	1.50	SL414A	4.85	SN76533N	2.25	TAD100	1.35	TBA540Q	2.25	TBA800Q	2.85	TCA940	6.75
MC1304P	2.00	SL415A	6.30	SN76544N	1.80	TBA120A	3.05	TBA550	3.50	TBA810A	3.40	TDA1327	2.85
MC1305	5.15	SL901B	8.50	SN76550N	1.80	TBA120AS	1.50	TBA550Q	3.80	TBA810S	1.10	TDA1327B	2.85
MC1307P	2.85	SL917B	10.70	SN76660N	0.80	TBA120S	2.70	TBA560	6.45	TBA820	0.80	TDA1330	1.60
MC1310P	1.00	SL1310	5.65	SN76666N	1.60	TBA120SB	1.60	TBA560C	4.50	TBA915	7.35	741	0.25
MC1327P	2.75	SL1327	2.75	TAA300	3.75	TBA120SQ	1.60	TBA560Q	7.35	TBA920	3.00		
MC1327PQ	2.50	SL3046	2.60	TAA310	3.15	TBA281	4.70	TBA560CQ	3.00	TBA920Q	3.50		
MC1330P	1.25	SN76003N	2.50	TAA320	2.60	TBA350A	3.00	TBA570	2.00	TBA950-2	5.40		
MC1339P	3.95	SN76003ND	2.15	TAA350A	3.00	TBA396	1.80	TBA570Q	2.00	TBA950-2X	5.04		
MC1349	3.35	SN76013N	1.50	TAA435	3.40	TBA440	3.60	TBA641A12	6.20	TBA990	4.95		
MCx351P	1.25	SN76013ND	2.15	TAA550	0.50	TBA440G	3.95	TBA641B11	5.65	TBA990Q	3.75		
MC1352P	1.45	SN76023N	1.50	TAA550B	0.40	TBA480Q	2.50	TBA673	5.00	TCA160	5.10		

BRIDGE RECTIFIERS

CURRENT	VOLTAGE	ORDER CODE	PRICE
1A	50V	B1/50	0.25
1A	100V	B1/100	0.26
1A	200V	B1/200	0.28
1A	400V	B1/400	0.30
1A	800V	B1/800	0.34
2A	50V	B2/50	0.40
2A	100V	B2/100	0.45
2A	200V	B2/200	0.55
2A	400V	B2/400	0.65
2A	800V	B2/800	0.70
3A	200V	B3/200	0.70
3A	600V	B3/600	0.80
4A	100V	B4/100	0.90
4A	400V	B4/400	0.95
6A	50V	B6/50	0.95
6A	200V	B6/200	1.10
6A	400V	B6/400	1.20
10A	400V	B10/400	2.50
25A	50V	B25/50	4.00
25A	200V	B25/200	4.20
25A	400V	B25/400	4.30

THYRISTORS

CURRENT	VOLTAGE	CASE	ORDER CODE	PRICE
80mA	30V	TO18	S08/30	0.22
80mA	60V	TO18	S08/60	0.24
80mA	200V	TO18	S08/200	0.25
1A	50V	TO220	S1/50	0.25
1A	100V	TO220	S1/100	0.26
1A	200V	TO220	S1/200	0.28
1A	400V	TO220	S1/400	0.35
3A	50V	TO220	S3/50	0.25
3A	100V	TO220	S3/100	0.26
3A	200V	TO220	S3/200	0.30
3A	400V	TO220	S3/400	0.40
4A	50V	TO220	S4/50	0.35
4A	100V	TO220	S4/100	0.40
4A	200V	TO220	S4/200	0.50
4A	400V	TO220	S4/400	0.55
5A	400V	TO220	S5/400	0.55
7A	50V	TO220	S7/50	0.45
7A	100V	TO220	S7/100	0.50
7A	200V	TO220	S7/200	0.55
7A	400V	TO220	S7/400	0.60
8A	400V	TO220	S8/400	0.70

I. C. SOCKETS

NO. OF PINS	ORDER CODE	PRICE
8	D8	0.10
14	D14	0.11
16	D16	0.13
20	D20	0.30
22	D22	0.35
24	D24	0.40
28	D28	0.45
40	D40	0.60

TRIACS

CURRENT	VOLTAGE	CASE	ORDER CODE	PRICE
3A	100V	TO220	T3/100	0.75
3A	200V	TO220	T3/200	0.80
3A	400V	TO220	T3/400	0.85
6A	200V	TO220	T6/200	1.00
6A	400V	TO220	T6/400	1.05
8A	400V	TO220	T8/400	1.35
10A	400V	TO220	T10/400	1.40
15A	400V	TO220	T15/400	2.00

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	.90
7402	.12	7428	.34	7473	.26	74110	.46	74151	.60	74178	1.20
7403	.12	7430	.13	7474	.20	74111	.70	74153	.60	74179	1.10
7404	.13	7432	.24	7475	.28	74116	1.60	74154	1.06	74180	.70
7405	.13	7433	.32	7476	.13	74118	.82	74155	.63	74181	1.95
7406	.29	7437	.24	7483	.75	74119	1.30	74156	.63	74182	.75
7407	.29	7438	.24	7484	.90	74120	.82	74157	.63	74184	1.20
7408	.14	7440	.13	7485	.90	74121	.26	74158	1.70	74185	1.20
7409	.14	7441	.52	7486	.26	74122	.40	74160	.80	74186	7.20
7410	.13	7442	.55	7489	2.00	74123	.55	74161	.80	74188	5.40
7411	.18	7444	.90	7490	.35	74125	.45	74163	.80	74190	1.10
7412	.21	7445	.70	7491	.65	74126	.46	74164	.90	74191	1.00
7413	.25	7446	.70	7492	.45	74128	.62	74165	.90	74192	1.00
7414	.54	7447	.66	7493	.36	74132	.70	74166	1.00	74193	1.10
7416	.27	7448	.60	7494	.80	74141	.58	74167	2.70	74194	.92
7417	.27	7450	.13	7495	.55	74142	2.02	74170	1.70	74195	.85
7420	.13	7451	.13	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	.95	74145	.65	74174	.90	74198	1.60
7425	.22	7460	.13	74105	.40	74147	1.35	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	.20	4016	.45	4027	.35	4049	.28	4072	.20	4511	.70
3006	.95	4017	.55	4028	.70	4050	.45	4073	.20	4512	.95
4007	.20	4018	.90	4029	.90	4051	.88	4075	.20	4516	.70
4008	.94	4019	.45	4030	.50	4052	.88	4076	1.10	4518	.65
4009	.46	4020	.60	4033	1.40	4053	.88	4078	.20	4520	1.10
4010	.50	4021	.85	4035	1.10	4055	1.00	4081	.20		
4011	.15	4022	.85	4040	.90	4060	1.00	4082	.20		
4012	.15	4023	.20	4041	.90	4066	.35	4502	.90		
4013	.35	4024	.68	4042	.75	4068	.20	4507	.52		

RESISTORS

¼W Values available in E12 series from 10R to 1M. Price 0.03 each.
½W Values available in E12 series from 1R0 to 10M. Price 0.03 each.
1W Values available in E12 series from 2R2 to 10M. Price 0.06 each.
2W Values available in E12 series from 10R to 10M. Prices 0.11 each.
5W Values available in E6 series from 1R0 to 6K8.
Prices 1R0 to 1Ks 0.19 each.
1K5 to 3K3 0.22 each.
4K7 to 6K8 0.24 each.
7W Values available in E12 series from R47 to 22K.
Prices R47 to R82 0.25 each.
1R0 to 1K0 0.26 each.
1K2 to 12K 0.27 each.
15K to 22K 0.28 each.
11W Values available in E6 series from 1R0 to 22K.
Prices 1R0 to 1K0 0.29 each.
1K5 to 12K 0.30 each.
15K to 22K 0.35 each.

17W Values available to E6 series from 1R0 to 22K.
Prices 1R0 to 4K7 0.39 each.
6K8 to 22K 0.41 each.

½W Single turn cermet potentiometer. Values available: 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 50K, 100K, 200K, 500K, 1M.
Price 0.97 each.

¾W Multiturn cermet potentiometer. Values available: 20R, 50R, 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 100K, 500K.
Price 1.40 each.

1W Potentiometer with 2" spindle. Values available: 10R, 25R, 50R, 100R, 250R, 500R, 1K0, 2K0, 5K0, 10K, 20K.
Prices 10R to 5K0 1.51 each.
10K & 20K 1.62 each.

1.5W Convergence preset potentiometer. Values available: 5R0, 7R0, 10R, 15R, 20R, 100R, 500R.
Price 0.50 each.

2W 10 Turn potentiometer. Values available: 100R, 200R, 500R, 1K0, 2K0, 5K0, 10K, 20K, 50K, 100K.
Price 7.34 each.

CAPACITORS

Tantalum Bead

6 3V	47uF	0.32 each
	100uF	0.50 each
16V	10uF	0.24 each
	22uF	0.30 each
	47uF	0.50 each
25V	22uF	0.41 each
35V	0 1uF	0.22 each
	0 22uF	0.22 each
	0 47uF	0.22 each
	1 0uF	0.22 each
	2 2uF	0.22 each
	4 7uF	0.24 each

Disc Ceramic

8kV	150pF	0.27 each
	180pF	0.27 each
	200pF	0.27 each
	220pF	0.27 each
	250pF	0.40 each
	270pF	0.40 each
	300pF	0.40 each

Mixed Dielectric

600V	1uF	1.01 each
1kV	0 01uF	0.26 each
	0.033uF	0.32 each
	0 047uF	0.35 each
	0 1uF	0.39 each
	0 22uF	0.58 each
	0 47uF	0.89 each
1 25kV	0 1uF	0.50 each
1 5kV	0 001uF	0.24 each
	0 0022uF	0.24 each
	0 0047uF	0.24 each
	0 22uF	0.28 each

Single Ended Electrolytic

16V	10uF	0.11 each
	22uF	0.11 each
	47uF	0.11 each
	100uF	0.11 each
	220uF	0.14 each
	470uF	0.28 each
	1000uF	0.32 each
63V	1uF	0.11 each
	2 2uF	0.11 each
	4 7uF	0.11 each
	10uF	0.13 each
	22uF	0.16 each
	47uF	0.22 each
	100uF	0.32 each
	220uF	0.46 each

Double Ended Electrolytic

10V	22uF	0.14 each
	100uF	0.14 each
	220uF	0.17 each
	470uF	0.36 each
	1000uF	0.40 each

25V	10uF	0.14 each
	22uF	0.14 each
	47uF	0.17 each
	100uF	0.17 each
	220uF	0.36 each
	470uF	0.47 each
	1000uF	0.72 each
63V	1uF	0.14 each
	2 2uF	0.14 each
	4.7uF	0.14 each
	10uF	0.17 each
	22uF	0.17 each
	47uF	0.29 each
	100uF	0.40 each
	220uF	0.65 each
	470uF	0.66 each
	1000uF	1.01 each
	2200uF	1.44 each
100V	10uF	0.20 each
	22uF	0.25 each
	47uF	0.36 each
	100uF	0.61 each
	220uF	0.68 each
450V	1uF	0.27 each
	4 7uF	0.45 each
	10uF	0.53 each
	22uF	1.07 each
	33uF	1.22 each

Silvered Mica

500V	3.3pF	0.18 each
	5pF	0.18 each
	10pF	0.18 each
	39pF	0.18 each
	100pF	0.18 each
	150pF	0.18 each
	180pF	0.18 each
	220pF	0.18 each
	330pF	0.36 each
	470pF	0.36 each
	680pF	0.36 each
	820pF	0.36 each
	1000pF	0.42 each
	2200pF	0.50 each
	8200pF	1.58 each
	10000pF	1.62 each

Multi-sectional Electrolytic

30V	2500/2500uF	1.94 each
70V	2500/2500uF	2.70 each
300V	150/150/100uF	2.81 each
350V	200/300uF	2.46 each
	200/200/100/32uF	3.89 each
	150/100/100/100/150uF	4.75 each
	400/400uF	4.75 each
	300/300/150/100/50uF	5.18 each

PANEL METERS

Size 2 × 2 × 1⅜ , requires 1¾ cut-out

F.S.O.	ORDER CODE	PRICE
1mA	M1	6.50
500mA	M500	6.50

ORDERING

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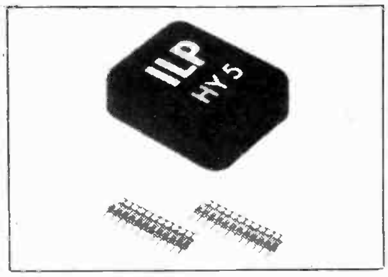
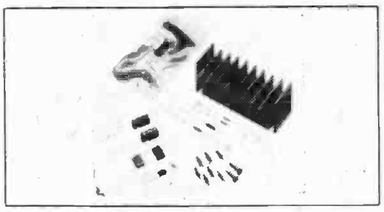
15—240 Watts!

HY5
Preamplifier



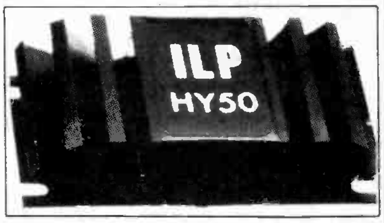
The HY5 is a mono hybrid amplifier ideally suited for all applications. All common input functions (mag Cartridge, tuner, etc.), are catered for internally, the desired function is achieved either by a multi-way switch or direct connection to the appropriate pins. The internal volume and tone circuits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

HY30
15 Watts into 8Ω



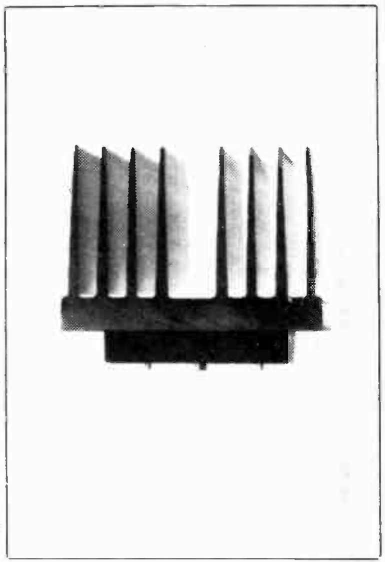
The HY30 is an exciting New kit from I.L.P. it features a virtually indestructible I.C. with short circuit and thermal protection. The kit consists of I.C., heatsink, P.C. board, 4 resistors, 6 capacitors, mounting kit, together with easy to follow construction and operating instructions. This amplifier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

HY50
25 Watts into 8Ω



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

HY120
60 Watts into 8Ω

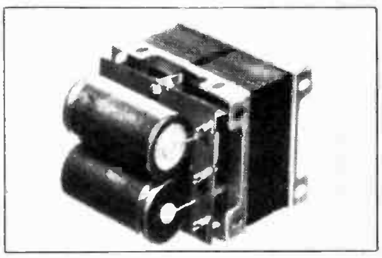


The HY120 is the baby of I.L.P.'s new high power range, designed to meet the most exacting requirements including load line and thermal protection; this amplifier sets a new standard in modular design.
FEATURES: Very low distortion — Integral Heatsink — Load line protection — Thermal protection — Five connections — No external components
APPLICATIONS: Hi-Fi — High quality disco — Public address — Monitor amplifier — Guitar and organ
SPECIFICATIONS:
INPUT SENSITIVITY 500mV
OUTPUT POWER 60W RMS into 8Ω; LOAD IMPEDANCE 4-16Ω; DISTORTION 0.04% at 60W at 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 8Ω

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

HY400
240 Watts into 4Ω



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

POWER SUPPLIES

PSU36 suitable for two HY30's **£6.44** + 81p VAT
PSU50 suitable for two HY50's **£8.18** + £1.02 VAT
PSU70 suitable for two HY120's **£14.58** + £1.17 VAT
PSU90 suitable for one HY200 **£15.19** + £1.21 VAT
PSU180 suitable for two HY200's or one HY400 **£25.42** + £2.03 VAT

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AD INDEX

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Introducing the personal computer you've waited for. The Exidy Sorcerer.

I didn't buy my personal computer until I found the one that had all the features I was looking for.
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It isn't magic. Exidy started with the best features of other computers, added some tricks of their own, and put it all together with more flexibility than ever before available. Presto! My reasons for waiting just disappeared.

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Software on inexpensive cassette tapes for the Sorcerer is available from Exidy and many other software makers.

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*Altair is a trademark of Pertec Computer Corp.

I wanted Graphics, and the Sorcerer is super. Its 256 character set – more than any other personal computer – includes 128 graphic symbols that I can define.

I wanted high resolution video.
With 122,880 points in a 512 x 240 format, I get the most detailed illustrations.

I wanted to display more information.
The Sorcerer displays 1920 characters in 30 lines of 64 characters – equal to a double-spaced typed page.

I wanted a full, professional keyboard.
The Sorcerer's 79-key data processing keyboard provides designated graphics, the complete ASCII character set in upper and lower case, and a 16-key numeric pad.

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