electronics today

INTERNATIONAL

JANUARY 1979

50p

Take out the scratches with our

CLICK ELIMINATOR

Digital Tacho

Bo[illegible] Check

Power [illegible]pplies

Loudspeaker Principles

Inside: computing today no3

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

TRANSCENDENT 2000
SINGLE BOARD SYNTHESIZER

LIVE PERFORMANCE SYNTHESIZER DESIGNED BY CONSULTANT TIM ORR (FORMERLY SYNTHESIZER DESIGNER FOR EMS LIMITED) AND FEATURED AS A CONSTRUCTIONAL ARTICLE IN ELECTRONICS TODAY INTERNATIONAL.
The TRANSCENDENT 2000 is a 3 octave instrument transposable 2 octaves up or down giving an effective 7 octave range. There is portamento, pitch bending, a VCO with shape and pitch modulation, a VCF with both low and high pass outputs and a separate dynamic sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features.

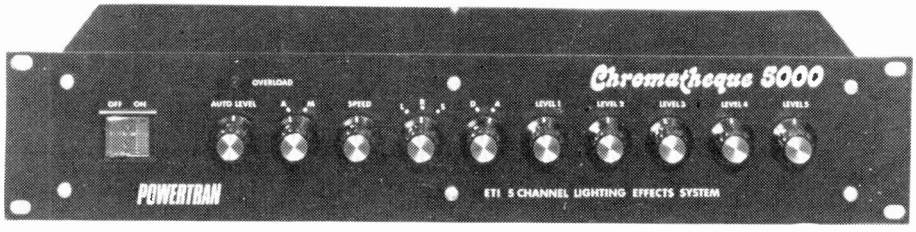
The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or ½% metal film!) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibre glass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready built units selling for between £500 and £700!

COMPLETE KIT ONLY £172.00 + VAT!

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

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

LAST MONTH'S FRONT COVER FEATURE!



COMPLETE KIT ONLY £49.50 + VAT!

PSI 4002 STUDIO MODEL

cabinet size 17.2" x 17.2" x 6.7"

COMPLETE KIT ONLY £196.90 + VAT

200 + 200 watt AMPLIFIER

As featured in Electronics Today International

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

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

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

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

EXPORT ORDERS: No VAT. Postage charged at actual cost plus 50p handling and documentation.
U.K. ORDERS. Subject to 12% surcharge for VAT* (i.e. add ⅛ to the price). No charge is made for carriage. *or at current rate if changed.
SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.
SALES COUNTER: If you prefer to collect your kit from the factory, call at Sales Counter (at rear of factory). Open 9 a.m.-4.30 p.m. Monday-Thursday.

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

POWERTRAN ELECTRONICS

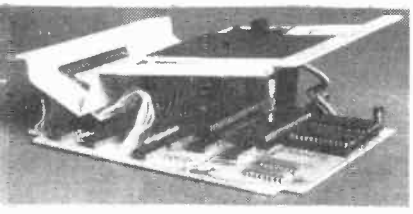
PORTWAY INDUSTRIAL ESTATE
ANDOVER, HANTS SP10 3NM

ANDOVER
(STD 0264) 64455

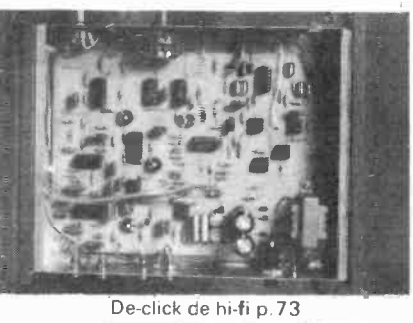
electronics today

JANUARY 1979 VOL 8 NO 1 INTERNATIONAL

Time we did this p.84



Check it out p.81



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FEATURES

PROJECTS

INFORMATION

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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.

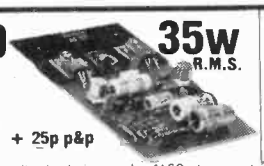
£4.55 + 25p p&p
+ 12½ % VAT

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

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

AL30A
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 1. TAPE	100 mV/100 K ohms) For an
INPUTS 1. RADIO TUNER	100 mV/100K ohms) output
3. MAGNETIC P.U.	3.5 mV/50 K ohms) 250mV
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
BASS CONTROL RANGE	± 15 dBs at 75 Hz
TREBLE CONTROL RANGE	+ 10—20 dBs at 15 kHz
SIGNAL/NOISE RATIO	Better than 65 dBs (All inputs)
INPUT OVERLOAD	Better than 26 dBs (All inputs)
SUPPLY	20 to 40 V
DIMENSIONS	300x90x33mm (less controls)

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.

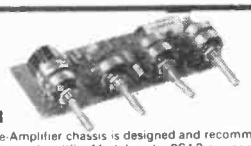
MPA30
MAGNETIC CARTRIDGE PRE-AMPLIFIER

£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. 60x43x26 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 + 12½% VAT

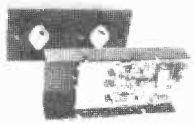
BI-PAK

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

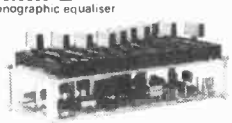
NEW

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 ⅛" (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

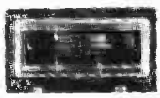
TEAK 30 designed mainly for use with our stereo 30 Audio System but has proved very helpful to home constructors. Fitted with solid uncut front and back. o/n 139. **£5.45** +12½% VAT. P&P 70p.

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".

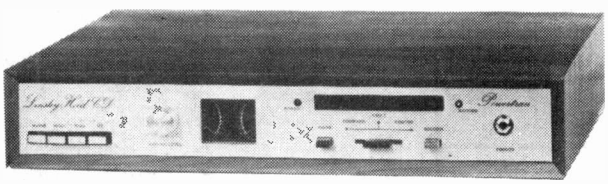
DE LUXE EASY TO BUILD LINSLEY-HOOD 75W AMPLIFIER £99.30 + VAT

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".



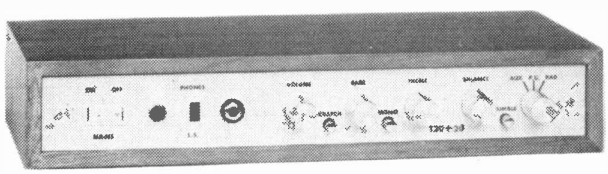
cabinet size 18.3" × 12.7" × 3.1".

LINSLEY-HOOD CASSETTE DECK £79.60 + VAT

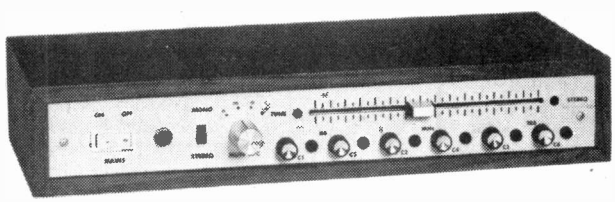
This design, published in Wireless World, although straightforward and relatively low cost provides a very high standard of performance There are separate record and replay amplifiers and switchable equalisation together with a choice of bias levels are also provided. The mechanism is the Goldring-Lenco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



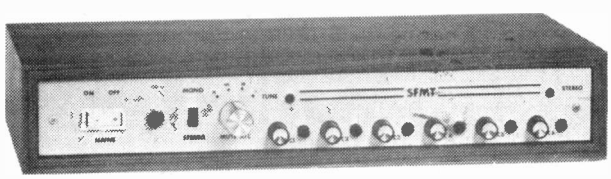
cabinet size 15.5" × 6.7" × 2.8".

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

PRICE STABILITY: Order with confidence! irrespective of any price changes. We will honour all prices in this advertisement until February 28th, 1979 If ETI January, 1979 issue is mentioned with your order Errors and VAT rate changes excluded
EXPORT ORDERS: No VAT Postage charged at actual cost plus 50p handling and documentation
U.K. ORDERS: Subject to 12½% surcharge for VAT* (i e. add ⅛ to the price). No charge is made for carrier, *or at current rate if changed.
SECURICOR DELIVERY. For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit
SALES COUNTER: If you prefer to collect your kit from the factory, Call at Sales Counter (at rear of factory) Open 9 a m.-4 30 p m. Monday-Thursday

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!

POWERTRAN ELECTRONICS

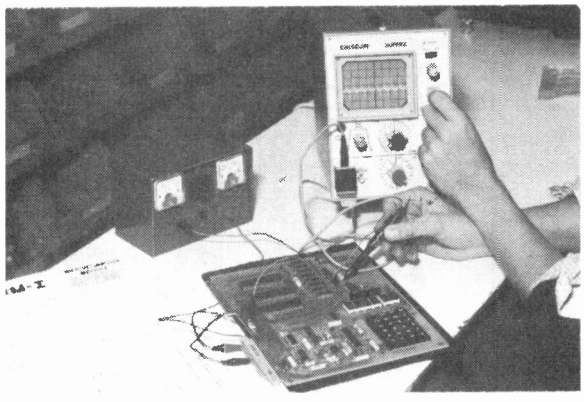
PORTWAY INDUSTRIAL ESTATE
ANDOVER HANTS SP10 3NM

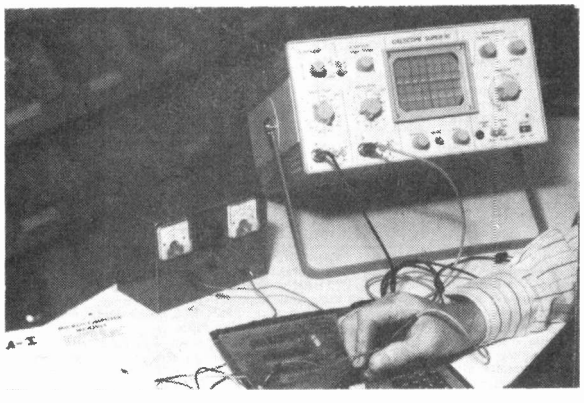
ANDOVER
(0264) 64455

news digest.....

FLEET OF FOOT?

For all us kiddies (anyone who isn't — please leave now) this is a good idea. Those nasty sneaky MPUs have invaded our nice little game of Battleships. Based on a TMS 1000 the unit contains enough RAM to hold the board as seen by both players, and make appropriate noises at time of defeat or victory or whatever. Nice explosion sound effects etc too. And what's more it's British designed — which is a distinct recommendation and selling well in America — which isn't. Price £29 or thereabouts. AID, 10 RATHBONE PLACE, LONDON W1P 2DN.





NOT A TRACE OF GREED

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

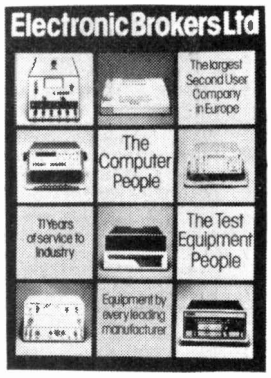
Calscope 6: — single trace: sensitivity range 50mV to 50V per cm/in 12 ranges: Bandwidth 6MHz: time base range 1 and to 100 ms per cm. Time base triggering is claimed to be particularly good. Price £162.

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

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

PEDIGREE CATS

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



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

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

PUT THESE TO GOOD USE

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

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

ambit international ®

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

DKI frequency counter ICs: details in cat2

MSM5523	for CA LEDs with RHDP such as FND507	£14 inc xtal
MSM5525	for 3½ digit LCD AM/FM with direct segment drive. no clock or timers	£11 inc xtal

Other types for fluorescent displays etc OA

Other new semiconductor additions:

KB4437	pilot cancel mpx decoder	4.35
KB4438	muting stereo preamp	2.22
HA1370	supercedes TDA2020	2.99
TDA1090	HiFi AM/FM	3.35
TDA1220	low cost AM/FM	1.45

PRICES DOWN ON VMOS: as expected, this new technology in power transistors is getting cheaper. 120v comp pairs /100W for £10.00

Price reduction on CA3189E ....now £2.20

New varicaps: to add to the biggest range.....

KV1211 2:9v bias to tune MW, like the KV1210, but a double diode £1.75

New pilot tone filters from TOKO.....

208BLR series, individual per channel with a 26/38kHz version for pilot cancel decoder applications. Flat to 15kHz £0.90

New crystal filter for amateur NBFM.....

TOYO 10M4B1 with over 90dB adjacent ch. rejection for 2m NBFM. 10.7MHz £14

New ceramic IF filters for 455kHz.....

CFM455H 6kHz/6dB, 15kHz max /60dB ideal for MC3357 etc. £10

A brief summary of some of our range of ICs:

TDA1062/1.95; TDA1083/1.95; HA1197/£1.40 CA3123E/£1.40; TBA651/£1.81; CA3089/1.94 HA1137/£2.20; MC1310/£2.20; HA1196/£3.95 KB4424/£2.75; KB4423/£2.53;SD6000/£3.75 KB4412/£2.55; KB4413/£2.75; KB4417/£2.55 MC1495L/£6.86*; MC1496P/£1.25 LM381N/£1.81; LM1303/£0.99; ULN2283B/ £1.00; LM380N/£1; TBA810AS/£1.09 TCA940E/£1.80; TDA2002/£1.95; ICL8038CC/£4.50*; NE566/£2.50*; NE567/ £2.50*; NE560B/£3.50; NE561B/£3.50; NE562B/£3.50*; NE568A/£2.50*

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

Some transistors for RF specifically:

BF256L8/0.34; 40822/0.43*; 40823/0.51 * 40673/0.55* ; BF900/961/0.80*; BF960/1.60* BF224/0.22, BF274/0.18; BF195/0.18; BF240/0.22, BF241/0.22; BF362/0.70; BF479/0.86; BF679S/0.70; BFY90/0.90*

PIN and other Varicap diodes:

BA102/0.30; BA121/0.30; ITT210/0.30 BB104B/0.40; MVAM2/£1.48; MVAM115/ £1.05; MVAM125/1.05, KV1210/£2.75 BA479/0.35; TDA1061/0.95; BA182/0.21

METER MADE low cost panel meters : 3 x 930 series with blanks and dry transfer sheet of scales and ledgends for £12.5 *

TERMS etc: CWD please, VAT on Ambit Items is generally 12½%, except where marked (*). Catalogue part 1:45p, part 2 50p all inclusive. Postage 25p per order, carriage on tuner kits £3. Phone Brentwood (0277) 216029/227050 9am-7pm. Callers welcome inc. Saturdays .

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

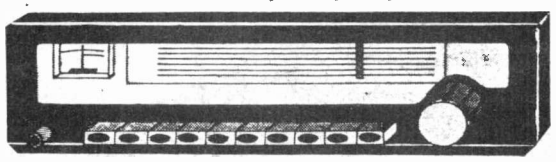
That's not to say it doesn't look like HiFi - just that it doesn't look like the usual sort of thing you have come to associate with DIY HiFi. The Mk3 outstrips and outperforms all British made HiFi tuners, and most imported ones too. Certainly at the price, there isn't one near it. But more than that,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

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

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

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

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



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

The tuner board - with "on board" PCB mounted switching, all components etc : **£33.00**
The case/cabinet with PSU, meter and mechanics etc **£25.00**
An SAE for full details please. See the feature article in Practical Wireless (Dec/Jan)

2 Gresham Road, Brentwood, Essex.

OSTS

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

SEE THE AMBIT AD TOO!

CD4000 CMOS

4000	17p	4059	563p	4522	149p
4001	17p	4060	115p	4527	157p
4002	17p	4063	109p	4528	102p
4006	109p	4066	53p	4529	141p
4007	18p	4067	400p	4530	90p
4008	80p	4068	25p	4531	141p
4009	58p	4069	20p	4532	125p
4010	58p	4070	20p	4534	614p
4011	17p	4071	20p	4536	380p
4012	17p	4072	20p	4538	150p
4013	55p	4073	20p	4539	110p
4016	52p	4075	20p	4541	141p
4017	80p	4076	90p	4543	174p
4018	80p	4077	20p	4549	399p
4019	60p	4078	20p	4553	440p
4020	93p	4081	20p	4554	153p
4021	82p	4082	20p	4556	77p
4022	90p	4085	82p	4557	386p
4023	17p	4086	82p	4558	117p
4024	76p	4089	150p	4559	388p
4025	17p	4093	50p	4560	218p
4026	180p	4094	190p	4561	65p
4027	55p	4096	105p	4562	530p
4028	72p	4097	372p	4566	159p
4029	100p	4098	110p	4568	281p
4030	58p	4099	122p	4569	303p
4031	260p	4160	90p	4572	25p
4032	100p	4161	90p	4580	600p
4033	145p	4162	90p	4581	319p
4034	200p	4163	90p	4582	164p
4035	120p	4174	104p	4583	84p
4036	250p	4175	95p	4584	63p
4037	100p	4194	95p	4585	100p
4038	105p	4501	23p		
4039	250p	4502	91p		
4040	83p	4503	69p		
4041	90p	4506	51p		
4042	85p	4507	55p		
4043	85p	4508	248p		
4044	80p	4510	99p		
4045	150p	4511	149p		
4046	130p	4512	98p		
4047	99p	4513	206p		
4048	60p	4514	260p		
4049	55p	4515	300p		
4050	55p	4516	125p		
4051	65p	4517	382p		
4052	65p	4518	103p		
4053	65p	4519	57p		
4054	120p	4520	109p		
4055	135p	4521	236p		

Micromarket PRICES SLASHED

6800 series

6800P	6.50
6820P	£6
6850P	2.75
6810P	£4
6852	3.65

8080 series

8080	6.30
8212	2.30
8216	1.95
8224	3.50
8228	4.78
8251	6.25
8255	5.40

MEMORIES

2102	£1.70
2112	£3.40
2513	£5.34
4027	£5.78
2114	£10
2708	£10.55

Development

MEK6800 £220
TK80 £306
AMI, Signetics TI, Intersil, Harris etc. OA

Voltage Regs

NEW LOW PRICES

7800 series UC TO220 package 1A	all 95p
7900 series UC TO220 package 1A	all £1
78MUC series TO220 package ½A	all 90p
78LCP series TO92 100mA	all 35p
L200 up to 3A/adjustable V&A	195p
78MGT2C ½amp adjustable volts	175p
79MGT2C ½amp adjustable volts	175p
723C precision controller	66p

MAINS FILTERS FOR NOISE/RFI etc

1 amp in IEC connector	£4.83
5 amp in 'wire in' case	£3.87

NE550A 73p

LINEARS non-consumer

BIMOS

CA3130E	84p
CA3130T	90p
CA3140E	35p
CA3140T	72p
CA3160E	90p
CA3160T	99p

Op amps

LM301AH	67p
LM301AN	30p
LM308H	121p
LM308N	97p
LM318H	279p
LM318N	224p
LM339N	66p
LM348N	186p
LM3900N	60p
709HC to5	64p
709PC dil	36p
710HC to5	65p
710PC dil	59p
723CN	65p
741CH to5	66p
741CN 8dil	27p
747CN	70p
748CN	36p
NE531T	12Cp
NE531N	105p

OPTO 7 seg displays

0.43" High Efficiency HP:

5082-7650	red CA	233p
5082-7653	red CC	
5082-7660	yellow CA	
5082-7663	yellow CC	
5082-7670	green CA	
5082-7673	green CC	

0.3" Standard HP

5082-7730	red CA	147p
5082-7740	red CC	

0.5" Fairchild

FND500 red CC	150p
FND507 red CA	150p

TERMS: CWO pse., VAT to be added at 8% (inland), pp 25p per order. When ordering from the OSTS and Ambit - a single combined remittance and pp charge is sufficient. Account details OA.

2 Gresham Road, Brentwood, Essex.

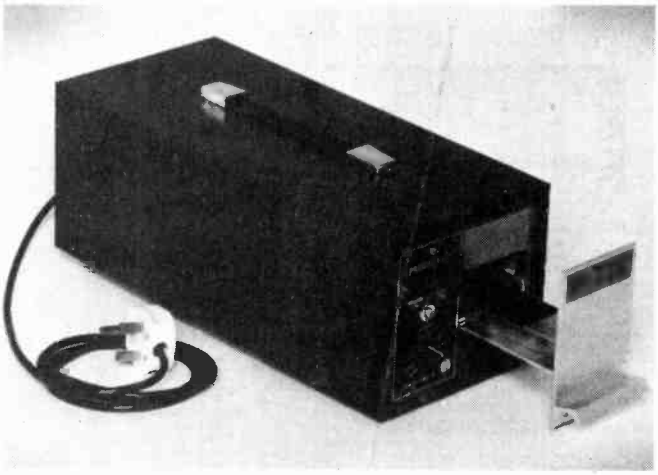
TTL : Standard AND LP Schottky

	'N'	'LSN'		'N'	'LSN'		'N'	'LSN'		'N'	'LSN'		LSN
7400	13	20	7455	35	24	74126	57	44	74185	134		74377	124
7401	13	20	7460	17		74128	74		74188	275		74378	93
7402	14	20	7463			74132	73	78	74190	115	92	74379	130
7403	14	20	7470	28		74133		29	74191			74386	37
7404	14	24	7472	28		74136		40	74192	105	180	74390	140
7405	18	26	7473	32		74138		60	74193	105	180	74395	139
7406	38		7474	27	38	74139		60	74194	105	187	74396	133
7407	38		7475	38	40	74141	56		74195	95	137	74398	180
7408	17	24	7476	37		74142	265		74196	99	110	74399	150
7409	17	24	7478			74143	312		74197	85	110	74445	92
7410	15	24	7480	48		74144	312		74198	150		74447	90
7411	20	24	7481	86		74145	65		74199	160		74490	140
7412	17	24	7482	69		74147	175		74248		90	74668	110
7413	30	52	7483A			74148	109		74249		93	74670	249
7414	51	130	7484	97		74150	99		74251		90	**MISCELLENY**	
7415		24	7485	104	99	74151	64	84	74253		105	NE555	30p
7416	30		7486		40	74153	64	54	74257		108	NE556	78p
7417	30		7489	205		74154	96		74258		153	NE558	180p
7420	16	24	7490	33	90	74155	54	110	74259		420	ICM7217	950p
7421	29	24	7491	76	110	74156	80	110	74260		153	ICM7208	1495p
7422	24	24	7492	38	78	74157	67	55	74261		353	ICL7106CP -	
7423	27		7493	32	99	74158		60	74266		40	LCD DVM IC	
7425	27		7494	78		74159	210		74273		124		955p
7426	36	27	7495A	65	99	74160	82	130	74275		312	LCD DVM KIT	
7427	27	29	7496	58	120	74161	92	78	74279		52		2480p
7428	35	32	7497	185		74162	92	130	74283		120	3½ digit LCD	
7430	17	24	74100	119		74163	92	78	74290		90	display	1150p
7432	25	24	74104	63		74164	104		74293		95	ICL7107 LED	
7433	40	32	74105	62		74165	105		74295		120	DVM kit	2065p
7437	40	24	74107	32	38	74166			74298		100	ICM7216 - 8 digit	
7438	33	24	74109	63	38	74167	20		74324		157	10MHz DFM/	
7440	17	24	74110	54		74168			74325		242	timer	£19.82
7441	74		74111	68		74169		200	74326		247	(for LED C.Cath)	
7442	70	99	74112	88		74170	230	200	74327		237	SCALAR ICs	
7443	115		74113		38	74172	625		74352		100	8629 150MHz	
7444	112		74114		38	74173	170		74353		100	divide by 100	
7445	94		74116	198		74174	87	120	74362		715		420p
7446	94		74118	83		74175	87	110	74365		49	95H90DC	780p
7447	82		74119	119		74176	75		74366		49	11C90DC	1400p
7448	56	99	74120	115		74177	78		74367		43	8618 -new-divide	
7449		99	74121	25		74180	85		74368		49	by 100 or 10	
7450	17		74122	46		74181	165	350	74373		77	for 120/60MHz	
7451	17	24	74123	48		74182	160		74374		77		450p
7453	17		74124			74183		210	74375		60		
7454	17	24	74125	38	44	74184	135						

The ICL7216BIPI is still the cheapest way to make a full 8 digit/ 10MHz frequency counter/timer, and with 10 external components + display - it is also one of the simplest. For £19.82, it takes a lot of beating. The mains filters have been extended now to include a 6amp IEC version at £5.10, and with the amount of electronic noise on the average supply (next door's fridge, for instance) it is a really worthwhile addition to any sensitive equipment. LPSN TTL now includes many more of latest types, all - of course - are absolutely prime first quality types. And don t forget our range of OPTO displays includes Hewlett Package high efficiency 0.43" types in all colours - renowned as the finest quality in the market. For other types of component - discrete LEDs, radio and audio devices, tuner modules, kits etc., see our other advertisement for more details - or send for the AMBIT catalogue system. Part one (45p) includes details of our background 'standard' items, and the new part two includes all the latest introductions and developments, plus a rundown on OSTS.

..... 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.

WATFORD ELECTRONICS

33/35 CARDIFF ROAD, WATFORD, HERTS, ENGLAND
MAIL ORDER, CALLERS WELCOME.
Tel. Watford 40588/9.

ALL DEVICES BRAND NEW, FULL SPEC. AND FULLY GUARANTEED. ORDERS DESPATCHED BY RETURN OF POST. TERMS OF BUSINESS: CASH/CHEQUE/P.Os OR BANKERS DRAFT WITH ORDER. GOVERNMENT AND EDUCATIONAL INSTITUTIONS' OFFICIAL ORDERS ACCEPTED. TRADE AND EXPORT INQUIRY WELCOME. P&P ADD 30p TO ALL ORDERS UNDER £10. OVERSEAS ORDERS POSTAGE AT COST. AIR/SURFACE. SEND 50p FOR OUR CATALOGUE.

VAT Export orders no VAT. Applicable to U.K. Customers only. Unless stated otherwise, all prices are exclusive of VAT. Please add 8% to devices marked *. To the rest add 12½%.

We stock thousands more items. It pays to visit us. We are situated behind Watford Football Ground. Nearest Underground/BR Station: Watford High Street. Open Monday to Saturday. Ample Free Car Parking space available.

POLYESTER CAPACITORS: Axial lead type. (Values are in µF).
400V: 0-001, 0-0015, 0-0022, 0-0033 **7p;** 0-0047, 0-0068, 0-01, 0-015, 0-018 **9p;** 0-022, 0-033, **10p;** 0-047, 0-068 **14p;** 0-1, **15p;** 0-15, 0-22, **22p;** 0-33, 0-47 **39p;** 0-68 **45p.**
160V: 0-039, 0-15, 0-22 **11p;** 0-33, 0-47 **19p;** 0-68, 1-0 **22p;** 1-5 **29p;** 2-2 **32p.** 4-7 **48p.**
DUBILIER: 1000V: 0-01, 0-015 **20p;** 0-022 **22p;** 0-047 **26p;** 0-1 **38p;** 0-47 **48p.**

POLYESTER RADIAL LEAD (Values in µF). **250V:**
0-01, 0-015, 0-022, 0-027 **5p;** 0-033, 0-047, 0-068, 0-1 **7p;** 0-15 **11p;** 0-22, 0-33 **13p;** 0-47 **15p;** 0-68 **18p;** 1-0 **24p;** 1-5 **27p;** 2-2 **31p.**

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

ELECTROLYTIC CAPACITORS: Axial lead type (Values are in µF).
63V: 0-47, 1-0, 1-5, 2-2, 2-5, 3-3, 4-7, 6-8, 8, 10, 15, 22, **8p;** 47, 32, 50, **11p;** 63, 100, **27p; 50V:** 50, 100, 220, **25p;** 470, **50p;** 1000, **68p; 40V:** 22, 33, **7p;** 100, **11p;** 2200, 3300, **62p;** 4700, **64p; 35V:** 10, 33, **7p;** 330, 470, **32p;** 1000, **49p; 25V:** 10, 22, 47, **6p;** 80, 100, 160, **8p;** 220, 250, **13p;** 470, 640, **25p;** 1000, **27p;** 1500, **30p;** 2000, **34p;** 3300, **58p;** 4700 **64p; 16V:** 10, 40, 47, 68, **7p;** 100, 125, **8p;** 220, 330, **14p;** 470, **16p;** 1000, 1500, **20p;** 2200, **34p; 10V:** 100, **6p;** 640, **10p;** 1000, **14p.**
TAG-END TYPE: 70V: 2000, **98p;** 4700, **121p; 50V:** 10,000, **255p; 40V:** 2500, **65p;** 3300, 4700, **70p;** 15,000 **450p. 25V:** 4700 **48p;** 2200 **37p; 325V:** 200+100+50+100 **190p.**

TANTALUM BEAD CAPACITORS
35V: 0.1µF, 0-22, 0-33, 0-47, 0-68, 1-0, 2.2µF, 3-3, 4-7, 6-8. **25V:** 1-5, 10. **20V:** 1-5, **16V:** 10µF **13p** each.
16V: 22 **25p.** 47µF, 100 **40p.**
10V: 22µF, 33. **6V:** 47, 68, 100. **3V:** 68, 100µF. **20p** each.

MYLAR FILM CAPACITORS
100V: 0-001, 0-002, 0-005, 0-01µF **6p**
0-015, 0-02, 0-04, 0-05, 0-056µF **7p**
0.1µF, 0-2 **9p. 50V:** 0.47µF **11p**

CERAMIC CAPACITORS 50V
Range: 0-5pF to 10,000pF **3p**
0-015µF, 0-022µF, 0-033µF **4p**
0.047µF **4p**; 0.1µF **6p.**

SILVER MICA (Values in pF) 3-3, 4-7, 6-8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 220 **9p** each
250, 300, 330, 360, 390, 600, 820 **16p** each
1000, 1800, 2000, 2200 **20p** each

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

MINIATURE TYPE TRIMMERS
2.5-6pF; 2 10pF; 10-40pF **22p**
5-25pF; 5-45pF; 60pF; 88pF; **30p**

COMPRESSION TRIMMERS
3-40pF; 10-80pF; 25-190pF **25p**
100-500pF; **45p**

GAS & SMOKE Detectors*
TGS 812 & 813 **415p***

POTENTIOMETERS (AB or EGEN)
Carbon Track, ¼W Log & ½W Linear values
500Ω 1KΩ & 2KΩ (lin. only) Single gang **27p**
5KΩ-2MΩ single gang **27p**
5KΩ-2MΩ single gang D/P switch **60p**
5KΩ-2MΩ dual gang stereo **70p**

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm
5KΩ-500KΩ single gang **70p**
10KΩ-500KΩ dual gang **80p**
Self Stick Graduated Bezels **22p**

PRESET POTENTIOMETERS
0 1W 50Ω—5MΩ Miniature Vertical & Horizontal **8p**
0-25W 100Ω—3-3MΩ horiz. larger **10p**
0-25W 200Ω—4 7MΩ Vert. **10p**

RESISTORS — Erie make 5% Carbon Miniature High Stability, Low noise

	RANGE	VAL	1-99	100+
¼W	2.2Ω 4.7M	E24	1.5p	1p
½W	2.2Ω-4.7M	E12	2p	1.5p
1W	2.2Ω-10M	E12	5p	4p
2% Metal Film 10Ω-1MΩ			6p	4p
1% 0.5W 51Ω-1M		E24	10p	8p

100+ price applies to Resistors of each type not mixed values.

THERMISTORS: VA1034, 1039, 1040, 1055, 1056, 1058, 1066, 1067, 1098, 1100 **20p** each.

OPTO ELECTRONICS *
LEDs plus Clips
TIL209 Red **13p**
TIL211 Grn **18p**
TIL212 Yellow **22p**
.2 Red **15p**
.2 Amber Green Yellow **19p**
Spare Clips **2p**
LS400 **255p**
OCP71 **110p**
DRP61 **84p**
ORP12 **63p**
2N5777 **45p**
7 Segment Displays
TIL307 **675p**
TIL312 .3 CA **105p**
TIL313 .3 CC **105p**
TIL321 .5 CA **115p**
TIL322 .5 CC **115p**
DL704 .3 CC **99p**
DL707 .3 CA **99p**
DL747 .6 CA **180p**
FND357 **120p**
MAN3640 **175p**
XAN351 3 Grn **180p**
HP5082-7730 **160p**
Liquid Crystal Display 3½ or 4 Digit **915p**
OPTO ISOLATORS
TIL 111/2 **85p**
TIL114 **95p**
TIL117 **110p**

Ferrites
FX3008 25p
FX1089 25p

JACKSONS VARIABLE CAPACITORS

Dielectric
100/300pF **140p**
500pF **165p**
6 1 Ball Drive 4511/DAF **115p***
Dial Drive 4183 6 1/36 1 **650p***
Drum 54mm **30p***
0-1-365pF **245p**
00 2 365pF **275p**
0 2 365pF with slow motion Drive **325p**
00 208/176 **285p**
.. with slow motion drive **325p**
C804-5pF 10 15 25 50pF **175p***
100, 150pF **215p***
'L' 3x310pF **495p**
00-3x25pF **430p**

DENCO COILS

'DP' VALVE TYPE
Range 1-5 B.Y.R.W **86p**
6-7 B.Y.R **75p**
1-5 Green **92p**
'T' 1-5 B.Y.R.W **93p**
B9A Valve Holder **25p**
RDT2 **92p**
RFC 5 chokes **91p**
RFC 7 (19mH) **96p**
1FT 13/14/15/16/17 **85p**
1FT 18/1.6 **99p**
1FT 18/465 **105p**
TOC1 **86p**
MW5FR **82p**
MW/LW 5FR **103p**

RF CHOKES

1µH, 4.7, 10, 22, 33, 47, 100, 200, 470, 750, 1mH, 2.5, 5, 10 **35p each**
43mH, 100 **60p each**

VEROBOARD*

	0.1 (copper clad)	0.15	0.15 (plain)
2½ x 3¼	41p	33p	22p
2½ x 5	49p	45p	28p
3¾ x 3¾	49p	45p	—
3¾ x 5	58p	60p	39p
2½ x 17	152p	121p	79p
3¾ x 17	195p	163p	107p
4¾ x 17	252p	—	165p

Pkt of 35 pins **30p**
Spot face cutter **85p**
Pin insertion tool **99p**

VERO WIRING PEN*
Plus Spool **325p**
Spare spool (wire) **80p*** Combs **7p** each

FERRIC CHLORIDE*
1lb bag Anhydrous **65p + 30p p. & p.**

DALO ETCH RESIST PEN* + spare tip **75p**

COPPER CLAD BOARDS*

Fibre Glass	Single-sided	Double-sided	SRBP 7.5 x 7.5
6 x 6	75p	90p	60p
6 x 12	130p	175p	

DIL SOCKETS* Low Profile (TEXAS)
8 pin **10p;** 14 pin **12p;** 16 pin **13p;** 18 pin **20p;** 20 pin **27p;** 22 pin **30p;** 24 pin **30p;** 28 pin **42p;** 40 pin **55p.** 60 pin **245p.**

SOLDERCON PINS*
100 pins **50p;** 1000 pins **400p**

DIODES

	p
AA119	15
AAZ15	15
BY100	24
BY126	14
BY127	14
CRO33	157
OA9	75
OA47	12
OA70	12
OA79	12
OA81	15
OA85	12
OA90	6
OA91	6
OA95	8
OA200	9
OA202	8
IN914	4
IN916	5
IN4001/2*	5
IN4003*	6
IN4004/5*	6
IN4006/7*	7
IN4148	4
IS44	20
3A/100V*	18
3A/400V*	20
3A/600V*	27
3A/1000V*	30
6A/600V	50

NOISE
Z5J **160**

VARICAPS
MVAM2 **135**
MVAM115 **120**
BA102 **25**
BB104 **40**
BB105B **40**
BB106 **40**

TRIACS*

3A100V	48
3A200V	49
3A400V	50
8A100V	54
8A400V	64
8A800V	108
12A100V	60
12A400V	70
16A100V	95
16A400V	105
16A500V	150
25A800V	295
40669	95

*BRIDGE RECTIFIERS

(plastic case)

	p
1A/50V	20
1A/100V	22
1A/200V	25
1A/400V	29
1A/600V	34
2A/50V	35
2A/100V	44
2A/200V	46
2A/400V	53
2A/600V	65
4A/100V	72
4A/200V	75
4A/400V	79
4A/600V	105
4A/800V	120
6A/100V	73
6A/200V	78
6A/400V	85
BY164	56
VM18 DIL	40

ZENERS
Range 2V7 to 39V 400mW **9p each**
Range 3V3 to 33V 1 3W **17p each**

SCRs* Thyristors

1A50V	38
1A100V	42
1A200V	47
1A400V	52
1A600V	70
5A100V	32
7A300V	35
8A300V	48
8A600V	43
8A500V	58
8A600V	85
12A300V	59
12A500V	92
BT106	150
C106D	38
TIC44	25
TIC45	45
2N4444	140
2N5060	28
2N5062	30
2N5064	35

DIAC*
ST2 **25**

TRANSISTORS

	p
AC107*	23
AC117*	35
AC125*	20
AC126*	20
AC127*	20
AC128*	20
AC141*	24
AC141K*	38
AC142*	24
AC142K*	38
AC176*	18
AC187*	20
AC188*	20
ACY17	35
ACY18	40
ACY19	40
ACY20	40
ACY21	35
ACY22	40
ACY28	40
ACY39	78
ACY41	39
ACY44	39
AD149*	70
AD161*	42
AD162*	42
AF106*	70
AF114*	25
AF115*	25
AF116*	25
AF117*	25
AF118*	55
AF121*	48
AF124*	55
AF125*	35
AF126*	55
AF127*	35
AF139*	35
AF178*	70
AF180*	70
AF186*	50
AF239*	42
AFZ11	128
ASY26*	40
ASY27*	45
ASY50*	95
ASY76*	95
ASZ21	60
BC107*	9
BC107B*	10
BC108*	9
BC108B*	12
BC108C*	12
BC109*	9
BC109B*	12
BC109C*	12
BC113	17
BC114	19
BC115	19
BC116	19
BC117	15
BC118	19
BC119*	28
BC134	19
BC135	20
BC136	18
BC137	20
BC140*	28
BC142*	25
BC143*	25
BC147	7
BC147B	10
BC148	7
BC148B	10
BC148C	10
BC149	8
BC149C	10
BC153	14
BC154	14
BC157	10
BC158	11
BC159	11
BC160*	27
BC167A	11

	p
BC168C	12
BC169C	10
BC170	17
BC171	11
BC172	10
BC177*	17
BC178*	17
BC179*	17
BC182	9
BC183	9
BC184	9
BC182L	10
BC183L	10
BC184L	10
BC186	21
BC187*	28
BC212	9
BC212L	10
BC213	9
BC213L	11
BC214	9
BC214K	14
BC214L	10
BC307B	14
BC308	13
BC327	15
BC328	13
BC338	12
BC441*	30
BC461*	30
BC477*	25
BC547	11
BC548	11
BC549C	13
BC557	13
BC558	12
BC559	20
BCY30*	57
BCY34*	75
BCY39*	80
BCY40*	78
BCY42*	48
BCY43*	75
BCY58*	22
BCY59*	22
BCY70*	15
BCY71*	17
BCY72*	17
BCY78*	20
BCZ11	145
BD112	95
BD115*	62
BD121*	95
BD123*	98
BD124*	115
BD131*	38
BD132*	38
BD133*	43
BD135*	36
BD136*	37
BD137*	36
BD138*	36
BD139*	45
BD140*	50
BD142*	59
BD144*	198
BD145*	198
BD181*	85
BD205*	110
BD378*	65
BD434	42
BD517*	65
BD695A*	75
BD696A*	75
BDY11	220
BDY17*	195
BDY60*	110
BDY61*	165
BF115*	22
BF154*	25
BF158*	29
BF160	30
BF161	60
BF167	25

	p
BF173*	25
BF177*	24
BF178*	25
BF179*	30
BF180*	20
BF181*	30
BF182*	30
BF183*	30
BF184*	30
BF194	10
BF195	10
BF196	10
BF197	10
BF198	18
BF199	18
BF200*	32
BF224A	18
BF244	24
BF244B	30
BF256*	50
BF257*	26
BF258*	30
BF259*	32
BF336	30
BF394	22
BF594	40
BF595	38
BFR39	25
BFR40	25
BFR41	28
BFR79	28
BFR80	28
BFR81	28
BFR98	105
BFX29*	26
BFX81*	130
BFX84*	24
BFX85*	24
BFX86*	28
BFX87*	23
BFX88*	24
BFY18*	50
BFY50*	20
BFY51*	20
BFY52*	20
BFY53*	28
BFY55*	45
BFY64*	40
BFY71*	20
BSX20*	18
BSX26*	75
BSX29*	43
BSX78*	55
BSY95A*	25
BU105*	140
BU205	190
BU208	228
E421	96
E5567	65
MD8001*	158
ME1120	25
ME4102	10
ME6002	14
MJ400*	90
MJ491*	190
MJ2955*	99
MJE340*	50
MJE370*	55
MJE371*	60
MJE520*	45
MJE521*	65
MJE2955*	99
MJE3055*	70
MPF102	30
MPF103	36
MPF104	36
MPF105	36
MPF106	50
MPF107	50
MPS3904	40
MPSA05	24
MPSA06	24
MPSA12	42
MPSA55	24

	p
MPSA56	24
MPSA70	34
MPSU02	58
MPSU05	48
MPSU06	54
MPSU52	65
MPSU55	53
MPSU56	56
MPU131*	39
OC23*	150
OC25*	120
OC26*	150
OC28*	99
OC29*	160
OC35*	80
OC36*	99
OC41*	48
OC42*	32
OC43*	55
OC44*	31
OC45*	20
OC46*	28
OC70*	19
OC71*	25
OC72*	30
OC74*	45
OC75*	45
OC76*	36
OC77*	76
OC79*	76
OC81D*	28
OC82D*	48
OC83*	48
OC84*	44
OC122*	48
OC123*	48
OC139*	85
OC140*	85
OC141*	85
OC170*	40
OC171*	40
OC200*	48
OC201*	75
OC203*	85
OC204*	85
SJE5039*	95
TIP29	43
TIP29A	44
TIP29B	56
TIP29C	60
TIP30	47
TIP30A	47
TIP30B	64
TIP30C	65
TIP31*	40
TIP31A*	40
TIP31B*	40
TIP31C*	66
TIP32*	45
TIP32A*	49
TIP32B*	70
TIP32C*	70
TIP33*	80
TIP33A*	80
TIP33B*	100
TIP33C*	105
TIP34*	85
TIP34A*	85
TIP34B*	110
TIP34C*	110
TIP35*	219
TIP35A	225
TIP35B*	240
TIP35C*	270
TIP36*	260
TIP36A*	265
TIP36B*	300
TIP36C*	325
TIP41A*	63
TIP41B*	73
TIP42A*	64
TIP42B*	82
TIP2955*	63
TIP3055*	60

	p
TIS43	36
TIS44	45
TIS45	45
TIS46	45
TIS47	50
TIS48	50
TIS49	50
TIS50	47
TIS74	47
TIS90	18
TIS91	22
ZTX107	11
ZTX108	11
ZTX109	11
ZTX212	28
ZTX300	13
ZTX301	16
ZTX302	18
ZTX303	21
ZTX304	24
ZTX311	17
ZTX314	24
ZTX320	30
ZTX326	40
ZTX341	20
ZTX500	13
ZTX501	14
ZTX502	19
ZTX503	15
ZTX504	25
ZTX531	25
ZTX550	25
40250*	85
40251*	97
40311*	50
40313*	125
40315*	55
40316*	85
40317*	52
40319*	71
40320*	56
40323*	60
40324*	85
40326*	52
40327*	62
40347*	80
40348*	101
40360*	43
40361*	45
40362*	48
40406*	65
40407*	50
40408*	75
40411*	285
40412*	63
40467*	95
40594*	80
40495*	90
40603*	58
40636*	125
40673*	68
2N697*	21
2N698*	39
2N699*	39
2N706A*	19
2N707*	50
2N708*	19
2N914*	32
2N916*	27
2N918*	30
2N920*	51
2N930*	18
2N1131*	22
2N1132*	22
2N1303*	50
2N1304*	50
2N1305*	28
2N1306*	35
2N1307*	50
2N1308*	46
2N1613*	23
2N1670*	150
2N1671B*	195
2N2160*	105

	p
2N2217*	48
2N2218A*	31
2N2219A*	22
2N2220A*	20
2N2221A*	23
2N2222A*	20
2N2303*	45
2N2368*	21
2N2369A*	15
2N2483*	28
2N2484*	30
2N2646*	48
2N2784	55
2N2904*	22
2N2905A*	20
2N2906*	18
2N2907*	20
2N2907A*	22
2N2926G	10
2N3011*	24
2N3053*	20
2N3054*	49
2N3055*	55
2N3108	39
2N3442*	131
2N3563	20
2N3614*	169
2N3615*	135
2N3663*	24
2N3702	10
2N3703	11
2N3704	10
2N3705	11
2N3706	10
2N3707	10
2N3708	10
2N3709	10
2N3710	16
2N3711	10
2N3772*	170
2N3773*	288
2N3813	22
2N3820	32
2N3823*	65
2N3824*	70
2N3866*	90
2N3903	18
2N3904	18
2N3905	18
2N3906	17
2N4037*	52
2N4041*	80
2N4058*	17
2N4061	17
2N4062	13
2N4064*	120
2N4069	45
2N4236	145
2N4286	20
2N4289	20
2N4859	65
2N4922*	55
2N5135	42
2N5136	42
2N5138	20
2N5172	24
2N5179*	60
2N5180*	60
2N5191*	65
2N5305*	24
2N5457	32
2N5458	32
2N5459	32
2N5485	32
2N5777*	45
2N6027	40
2N6109	45
2SD234*	50
3N128*	85
3N140*	85

Matched Pair 10p extra

LINEAR ICs

702	75
709C 8 pin	35
709C 14 pin	49
709C TO5	35
723* 14 pin	45
741* 8 pin	22
741* 14 pin	32
747C* 14 pin	70
748C* 8 pin	36
753 8 pin	150
810	159
AY-1-0212	580
AY-1-1313A	660
AY-1-1320	305
AY-1-5050	180
AY-1-5051	145
AY-1-6721/6	195
AY-3-1015*	560
AY-3-8500*	390
AY-3-8550*	450
AY-3-8710*	850
AY-5-1013*	450
AY-5-1224A*	260
AY-5-1230*	450
AY-5-1315	560
AY-5-1317A	630
AY-5-3500*	510
AY-5-3507*	415
AY-5-4007	650
AY-5-8100*	735
CA3011*	82
CA3012*	150
CA3014*	137
CA3018*	68
CA3020	170
CA3023	170
CA3028A*	80
CA3035	240
CA3036	110
CA3043	190
CA3045	140
CA3046	71
CA3048	200
CA3075	175
CA3080E*	70
CA3081	190
CA3089E	210
CA3090AQ	375
CA3123E	200
CA3130*	85
CA3140*	70
F944DC	00
ICL7106*	752
ICL7107*	975

ICL8038CC*	335
ICM7205*	1150
LD130*	452
LM300H	170
LM301AP*	30
LM308T	110
LM311*	120
LM318H*	205
LM319S*	195
LM324A	79
LM327*	125
LM339*	80
LM348*	95
LM349*	00
LM379*	375
LM380	95
LM381N	145
LM381AN	248
LM382	125
LM1458*	50
LM3900*	60
LM3909N*	70
LM3911*	125
M252AA*	750
M253AA*	795
MC663	275
MC724*	175
MC1303	88
MC1304P	260
MC1310P	149
MC1312PQ	195
MC1488*	85
MC1489*	90
MC14433L	1250
MC1495*	395
MC1496L	92
MC1710CG	79
MC3340P*	150
MC3360P	120
MC3401	70
MEM780	205
MFC40008	85
MFC6040*	97
MK50253*	650
MK50362*	650
MK50398*	635
MM307AA	00
MM57160*	620
NE350	160
NE515	80
NE543K	210
NE544	185
NE555*	29
NE55608*	60
NE560*	325

NE561*	395
NE562B*	410
NE564*	425
NE565A*	120
NE566*	160
NE567V*	155
NE571	420
RAM2102-2*	170
RC4136D	120
SAS560	240
SAS570	240
SG3402*	295
SL437A	560
SL414	275
SN72710*	43
SN72733*	99
SN76003N	175
SN76013	140
SN76018*	148
SN76023	140
SN76033N	175
SN76115N	215
SN76131*	110
SN76227N	115
SN76477*	225
SN76810*	150
TAA550	50
TAA621AX1	228
TAA661A	155
TAA700	353
TAA960	300
TAD100	150
TBA120S	70
TBA540	215
TBA540Q	220
TBA550Q	330
TBA641-A12 BX or BX11	250
TBA651	180
TBA800	90
TBA810S	99
TBA820	70
TBA920Q	260
TBA990Q	395
TCA270Q	220
TDA1022*	575
TDA2020	320
TL071*	60
TL081CP*	52
TL082CP*	96
TL084CP*	130
UAA170	198
ZN414	90
ZN424E	130
ZN425E*	410

TTL 74* (TEXAS)

7400	13
7401	13
7402	14
7403	14
7404	14
7405	18
7406	38
7407	38
7408	17
7409	17
7410	15
7411	20
7412	17
7413	30
7414	51
7416	30
7417	30
7420	16
7421	29
7422	24
7423	27
7425	27
7426	36
7427	27
7428	35
7430	17
7432	25
7433	40
7437	30
7438	33
7440	17
7441	74
7442	68
7443	115
7444	112
7445	94
7446	94
7447	82
7448	56
7450	17
7451	17
7453	17
7454	17
7460	17
7470	28
7472	25
7473	32
7474	27
7475	38
7476	36
7480	48
7481	86

7482	69
7483	72
7484	95
7485	106
7486	31
7489	210
7490	33
7491	75
7492	38
7493	32
7494	78
7495	65
7496	57
7497	189
74100	119
74104	62
74105	62
74107	29
74109	54
74110	54
74111	68
74116	198
74118	83
74120	115
74121	25
74122	46
74123	48
74125	38
74126	57
74128	74
74132	73
74141	56
74142	269
74143	314
74144	314
74145	65
74147	175
74148	109
74150	99
74151	64
74153	64
74154	96
74155	53
74156	80
74159	210
74160	82
74161	92
74163	92
74164	105
74165	105
74166	161
74167	198
74172	625
74173	170
74174	87

74175	87
74176	75
74177	78
74180	85
74181	165
74182	90
74184	135
74185	135
74188	275
74190	115
74192	105
74193	105
74194	105
74195	95
74196	99
74197	85
74198	150
74279	110
74283	160
74365	132
74366	132
74367	99
74368	132
74393	173
75150	120
75450	84
75491	00
75492	00

74LS*

00	14
01	14
02	16
03	16
04	16
05	20
08	22
09	22
10	20
11	22
12	23
13	38
14	75
15	30
20	20
21	22
26	48
27	28
28	48
30	22
32	27
33	39
37	39
38	39
40	28

42	98
47	90
48	120
49	120
51	24
54	28
55	30
63	150
73	46
74	41
75	48
76	40
78	40
83	115
85	118
86	43
90	60
91	104
92	89
93	89
95	116
96	116
107	44
109	55
112	55
113	50
114	50
122	70
123	70
124	180
125	60
126	60
132	95
136	55
138	85
139	85
145	108
147	170
148	173
151	96
153	76
155	96
156	96
157	76
158	96
160	128
161	98
162	138
163	118
164	114
165	75
166	226
170	288
173	105
174	106

175	110
181	398
183	298
190	140
191	140
192	130
193	130
194	166
195	136
196	100
197	140
221	96
240	236
241	232
242	232
243	232
245	270
247	190
248	190
249	190
251	134
253	142
257	110
258	146
259	160
261	450
266	52
273	244
275	250
279	66
283	192
290	128
293	128
295	185
298	168
324	240
325	290
326	294
327	286
347	148
348	186
352	228
353	228
365	65
366	65
367	65
368	66
373	180
375	160
377	212
378	184
379	215
384	86
386	86
390	230

.....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.

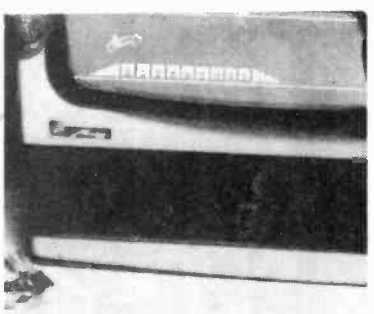
SHORTS

● 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 phenominal 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.



TTLs by TEXAS

7400	13p
7401	14p
7402	14p
7403	14p
7404	17p
74S04	90p
7405	18p
7406	32p
7407	32p
7408	19p
7409	19p
7410	15p
7411	24p
7412	20p
7413	30p
7414	60p
7416	27p
7417	27p
7420	17p
7421	40p
7422	22p
7423	34p
7425	30p
7426	40p
7427	34p
7428	36p
7430	17p
7432	30p
7433	40p
7437	35p
7438	35p
7440	17p
7441	70p
7442A	60p
7443	112p
7444	112p
7445	100p
7446A	93p
7447A	60p
7448	80p
7450	17p
7451	17p
7453	17p
7454	17p
7460	17p
7470	36p
7472	30p
7473	34p
7474	30p
7475	36p
7476	35p
7480	50p
7481	100p
7482	84p
7483A	90p
7484	100p
7485	110p
7486	34p
7489	210p
7490A	33p
7491	80p
7492A	46p
7493A	33p
7494	84p
7495A	70p
7496	65p
7497	180p
74100	130p
74104	65p
74105	65p
74107	34p
74109	55p
74110	55p
74111	70p
74116	200p
74118	130p
74119	210p
74120	110p
74121	28p
74122	48p
74123	55p
74125	55p
74126	60p
74128	75p
74132	75p
74136	75p
74141	70p
74142	200p
74145	90p
74147	190p
74148	150p
74510	100p
74151A	70p
74153	70p
74154	100p
74155	90p
74156	90p
74157	70p
74159	190p
74160	100p
74161	100p
74162	100p
74163	100p
74164	120p
74165	130p
74166	140p
74167	200p
74170	240p
74172	720p
74173	120p
74174	93p
74175	85p
74176	90p
74177	90p
74178	160p
74180	93p
74181	200p
74182	90p
74184A	150p
74185	150p

74186	700p
74190	100p
74191	100p
74192	100p
74193	100p
74194	100p
74195	95p
74196	95p
74197	80p
74198	150p
74199	150p
74200	£10
74221	160p
74251	140p
74259	250p
74265	90p
74278	290p
74279	140p
74283	190p
74284	400p
74285	400p
74290	150p
74293	150p
74294	200p
74298	200p
74365	150p
74366	150p
74367	120p
74368	150p
74390	200p
74393	200p
74490	225p

74LS SERIES

74LS00	18p
74LS02	18p
74LS04	20p
74LS05	25p
74LS08	25p
74LS10	20p
74LS11	40p
74LS13	45p
74LS14	90p
74LS20	22p
74LS21	40p
74LS22	28p
74LS27	38p
74LS30	22p
74LS32	40p
74LS42	95p
74LS47	90p
74LS55	30p
74LS72	
74LS73	50p
74LS74	40p
74LS75	50p
74LS83	110p
74LS85	100p
74LS86	40p
74LS90	90p
74LS92	72p
74LS93	90p
74LS107	45p
74LS112	100p
75LS123	75p
74LS124	180p
74LS125	80p
74LS132	120p
74LS133	60p
74LS138	60p
74LS139	60p
74LS148	140p
74LS151	100p
74LS153	60p
74LS154	140p
74LS157	60p
74LS158	120p
74LS160	130p
74LS161	100p
74LS162	140p
74LS163	110p
74LS164	120p
74LS165	180p
74LS166	180p
74LS173	110p
74LS174	110p
74LS175	110p
74LS181	320p
74LS190	100p
74LS191	100p
74LS192	140p
74LS193	140p
74LS195	140p
74LS196	120p
74LS221	140p
74LS240	175p
74LS241	175p
74LS242	170p
74LS243	170p
74LS244	170p
74LS245	170p
74LS251	200p
74LS253	140p
74LS257	120p
74LS258	250p
74LS259	175p
74LS266	50p
74LS273	130p
74LS279	140p
74LS298	249p
74LS324	200p
74LS365	160p
74LS367	160p
74LS368	160p
74LS373	200p
74LS374	195p
74LS378	200p

4000 SERIES

4000	15p
4001	17p
4002	17p
4006	95p
4007	18p
4008	80p
4009	40p
4010	50p
4011	17p
4012	18p
4013	50p
4014	84p
4015	84p
4016	45p
4017	80p
4018	80p
4019	45p
4020	100p
4021	110p
4022	100p
4023	22p
4024	50p
4025	20p
4026	130p
4027	50p
4028	84p
4029	100p
4030	55p
4031	200p
4033	180p
4034	200p
4035	110p
4040	100p
4041	80p
4042	80p
4043	90p
4044	90p
4046	110p
4047	100p
4048	55p
4049	32p
4050	49p
4051	80p
4052	80p
4053	80p
4054	150p
4055	125p
4056	135p
4059	600p
4060	115p
4063	120p
4066	55p
4067	450p
4068	22p
4069	20p
4070	30p
4071	22p
4072	22p
4073	22p
4075	22p
4076	107p
4081	22p
4082	22p
4093	80p
4094	175p
4098	107p
4411	£11
4502	120p
4503	70p
4507	55p
4510	99p
4511	150p
4514	250p
4516	110p
4518	100p
4520	90p
4528	100p
4543	180p
4553	450p
4560	250p
4583	90p
4584	90p
40014	90p
40085	200p
40097	90p
14411	£11
14412V	£11
14433	£11

INTERFACE ICs

MC1488	100p
MC1489	100p
75107	160p
75150	175p
75182	230p
75324	375p
75325	375p
75451	72p
75491 2	96p
8T25	140p
8T26	250p
8T28	300p
8T95	160p
8T97	160p
81LS95	120p
81LS96	140p
81LS97	120p
81LS98	140p
9601	100p
9602	220p
9603	60p

93 SERIES

9301	160p
9302	175p
9308	316p
9310	275p
9311	275p
9312	160p
9314	165p
9316	225p
9321	225p
9322	150p
9334	225p
9368	200p
9370	200p
9374	200p

VEROBOARD

	0.1	0.15 (copper clad)
2½ x 3¾	41p	33p
2½ x 5	49p	45p
3¾ x 3¾	49p	45p
3¾ x 5	56p	60p
2½ x 17	152p	121p
3¾ x 17	195p	163p
4¾ x 17	252p	—

Pkt of 35 pins 30p
Spot face cutter 85p
Pin insertion tool 99p

VERO WIRING PEN

Plus Spool 325p
Spare spool (wire) 80p
Combs 7p each

LINEAR ICs

*AY1-0212	600p
*AY1-1313	668p
*AY1-1320	320p
*AY1-5050	200p
*AY5-1315	600p
*AY5-1317	636p
*CA3019	80p
*CA3046	70p
*CA3048	225p
CA3080E	72p
CA3086	48p
*CA3089E	225p
*CA3090AQ	375p
CA3130S	100p
CA3140E	70p
CA3160E	100p
FX209	750p
ICL7106	850p
ICL8038	340p
LM301A	36p
LM311	120p
LM318	200p
LM324	70p
LM339	75p
LM348	95p
*LM377	175p
LM380	75p
*LM381AN	160p
*LM389N	140p
LM709	36p
LM710	50p
LM725	350p
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news digest.....

WHEN THE COMPUTING and Control department of Imperial College decided that they needed a logic hardware teaching lab, they were faced with several alternatives. One was to teach all the students in each year to solder and then let them loose on a 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.

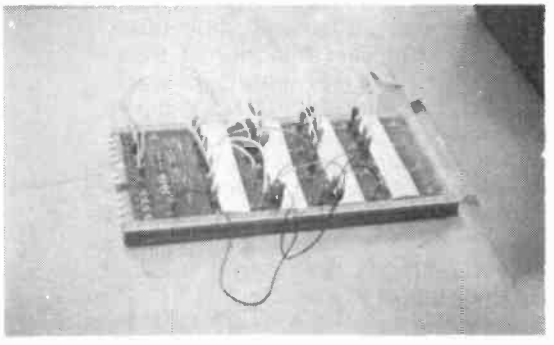
The setup works roughly like this: A computer terminal is situated in the centre of the 'lab' and is surrounded by 16 benches, each provided with an oscilloscope, a signal generator and other relevant test equipment and peripherals. Each bench also has a perspex case with several dozen sockets and LEDs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

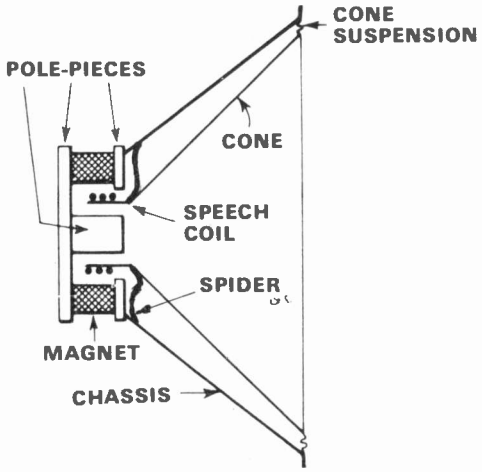
$$F = B.I.k \qquad k = \text{a const.}$$

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.

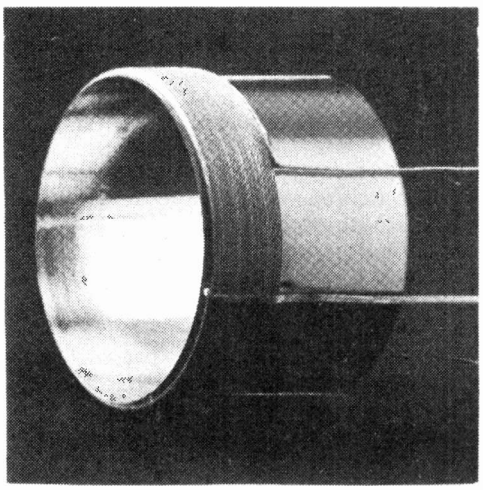


Basic schematic of moving coil loudspeaker. In practice the coil winding would be longer relative to the magnets, so that it did not move out of the field.

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.

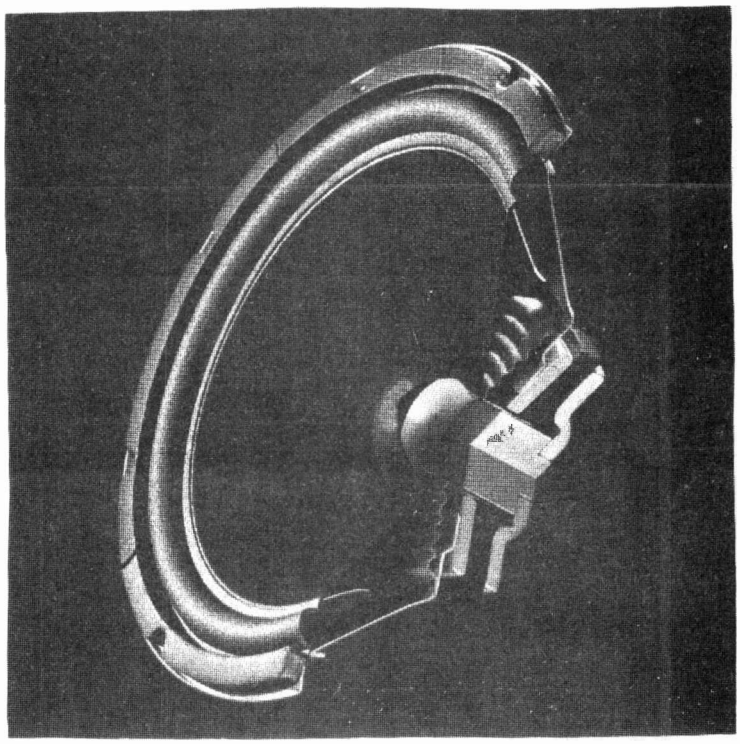


Close-up of a voice coil. This is a machine wound unit belonging to a Bose driver. Note the winding is butted very close to the edge of the paper former, and the precise nature of the winding necessary for linearity.

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!

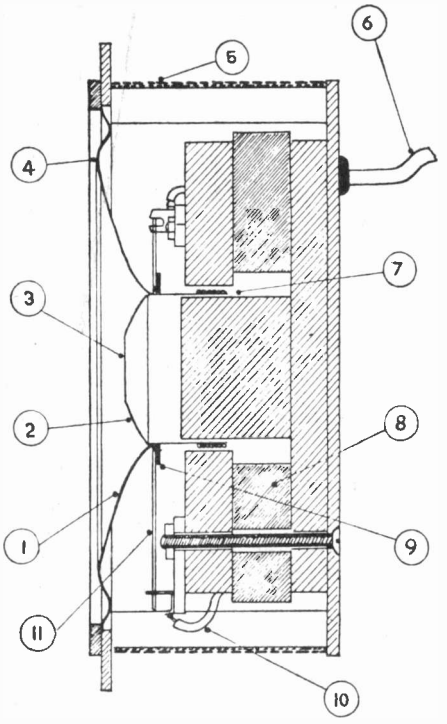
Sinclair marketed a finite baffle speaker some years ago but this seems to have ceased to be.

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 beryllium copper suspension cantilevers.



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

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

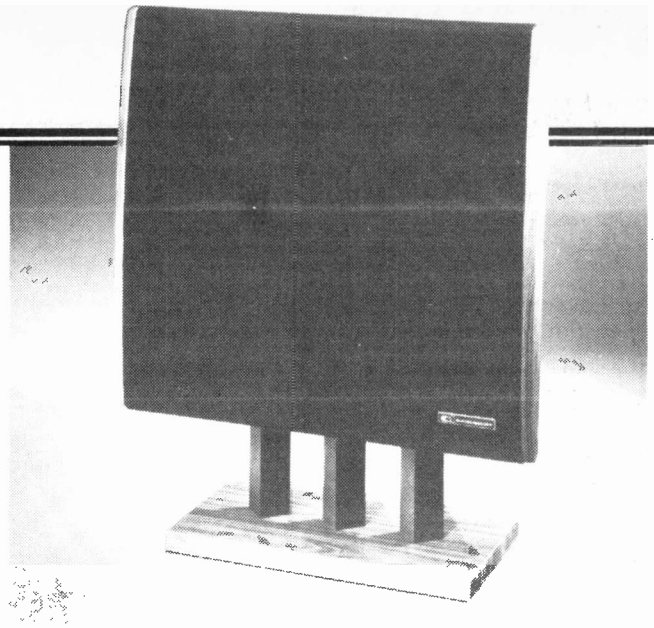
Bass Reflex

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

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

Auxiliary Bass Radiator

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



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

Transmission Lines

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

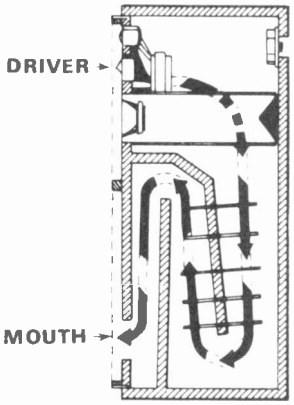
If the far end of the column is open then help is afforded to the bass performance in much the same way as bass reflex cabinets.

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

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

IMF have championed this technique for long time passing now, and as 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!

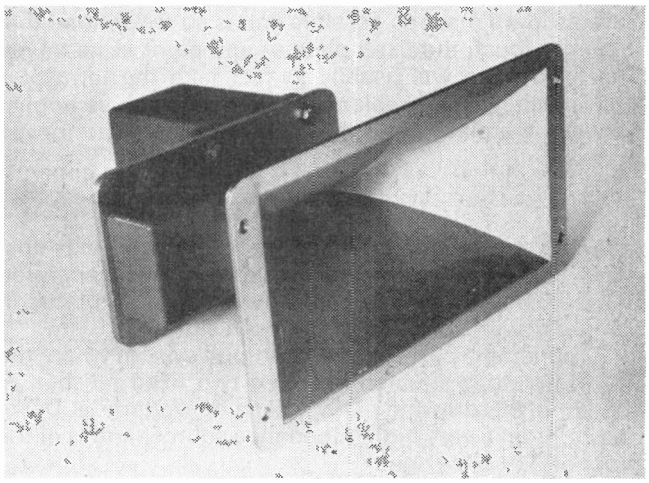


The basic principle behind the transmission line speaker enclosure. The air from the rear of the cone gets 'lost' down the line.

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.

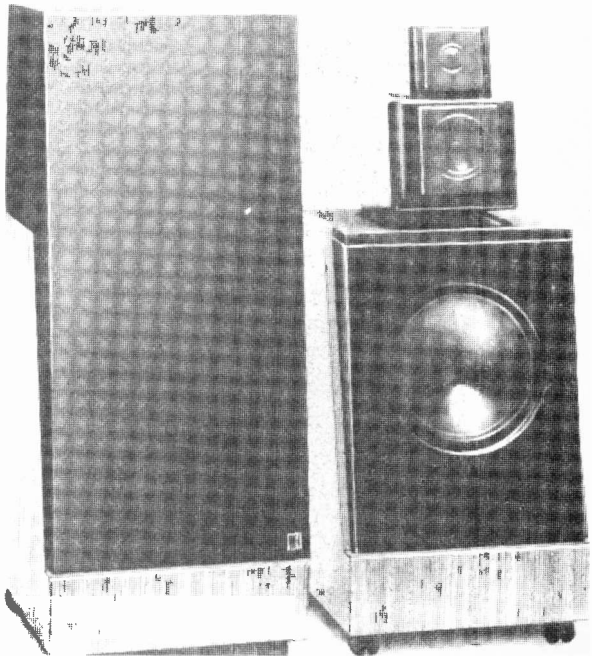
The horn converts the high pressure, low velocity sound energy present in the region of the driver into low pressure high velocity waves for propogation. The advantages of this type of loading are good damping of the driver, low distortion but a limited frequency response.



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 ≈ 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

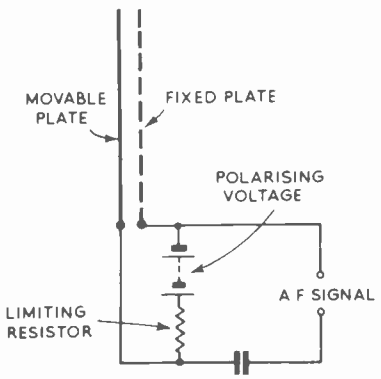
As we have seen the moving coil design suffers because the cone area is unevenly driven by the electrical music signal. The electrostatic principle, developed by both David Tombs and Peter Walker (of the Acoustical Manufacturing Company) is an attempt to produce a unit in which the entire surface of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

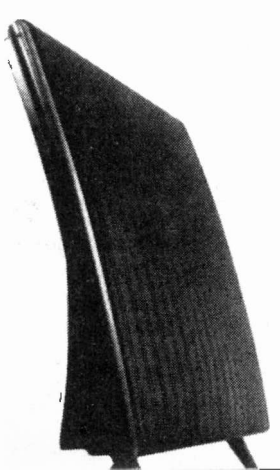
KLH made a brave attempt to reach the theoretical size of plate for good bass response with their superb KLH9 full range units. These are almost exactly door sized—and you need **two** per channel! And they cost £2000 a pair. And they are probably unbeatable by any speaker on the market for sheer accuracy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

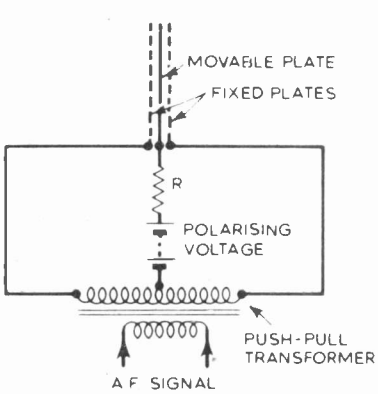
Loading Problems

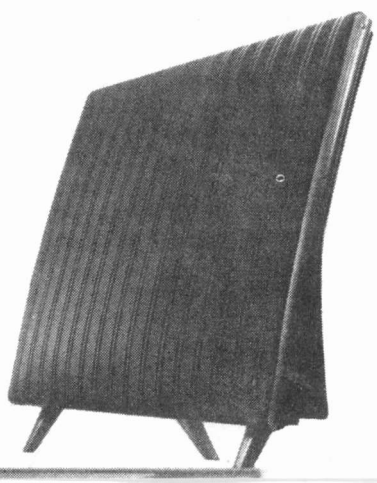
Another less serious drawback is that transformer into which the electrical signal is fed. This presents an awkward load to the amplifier, and can produce some nasty effects from transistor amps.

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

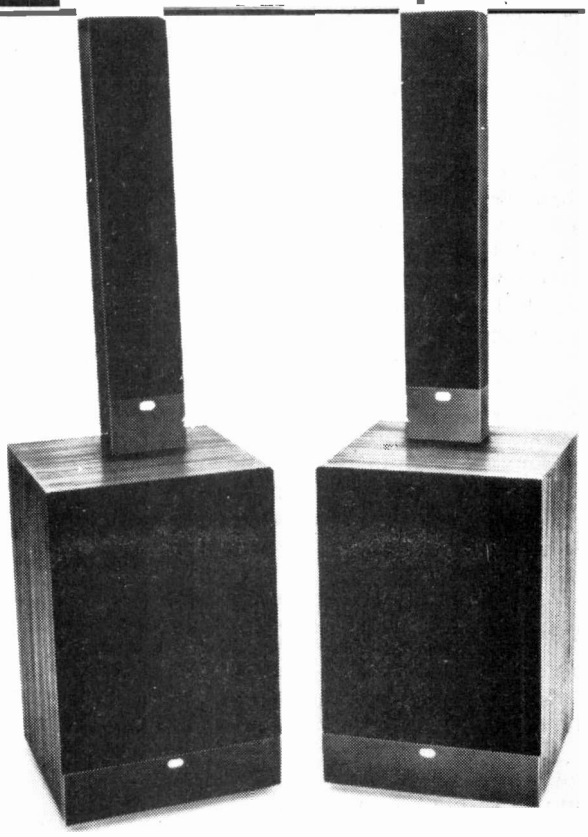
With the release of the Stathearn 21000 speakers, and the new Wharfedale series incorporating Isodynamic tweeters, this approach is gaining ground. It certainly has a lot of promise, which we shall undoubtedly see exploited as time goes on.

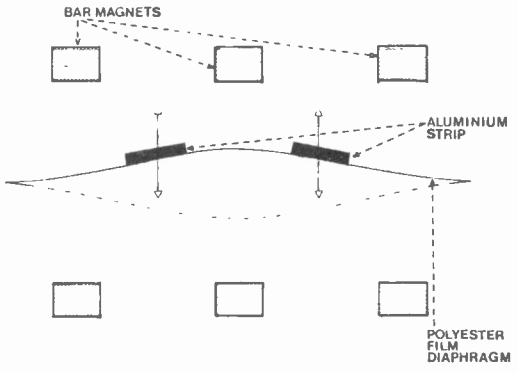
The principle was pioneered by Wharfedale with their Isodynamic headphones some six years ago or so. It is really an attempt to gain the advantages of the electrostatic system, without the need for high voltages and attendant drawbacks.

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.

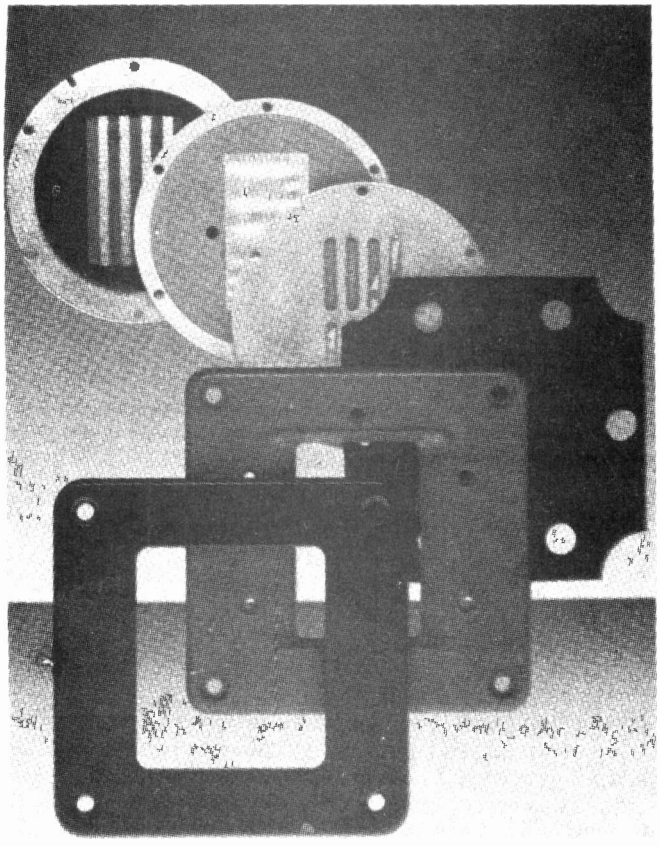
Once again colouration is low, and driver mass small—but also once again to obtain bass means large areas, and conductors capable of handling large currents. Strathearns units are above 500Hz operators only and are transformer coupled to the input. Wharfedale employ their invention in high frequency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

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

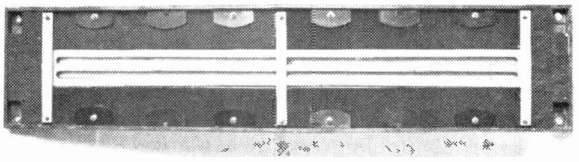


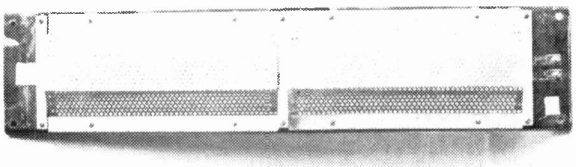


The 21000 from all angles. At the top we have the full system. Below that the diagram shows the operating principle of the SLC1. The polyester diaphram acts as the speaker cone. Below this caption two internal views of the unit. The radiating areas can be seen in the top diagram, and the lower rear view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



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.





▶

RIBBON

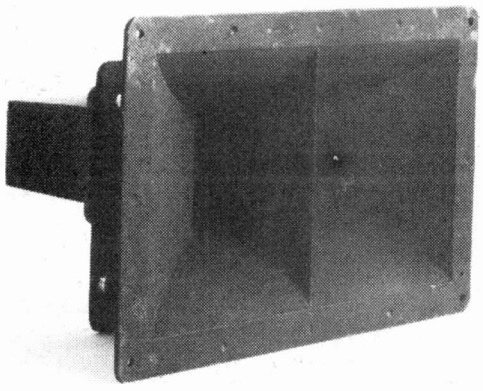
If we take the voice coil of moving coil speakers, and make this the active element, instead of the cone, we would do away with a lot of the causes of colouration in the process. Mass would be much smaller, break-up or rippling would be greatly reduced, if not eliminated and thus transient handling improved.

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.

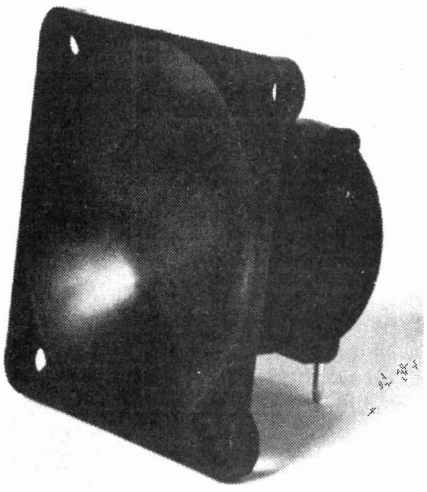
PIEZO-ELECTRIC

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

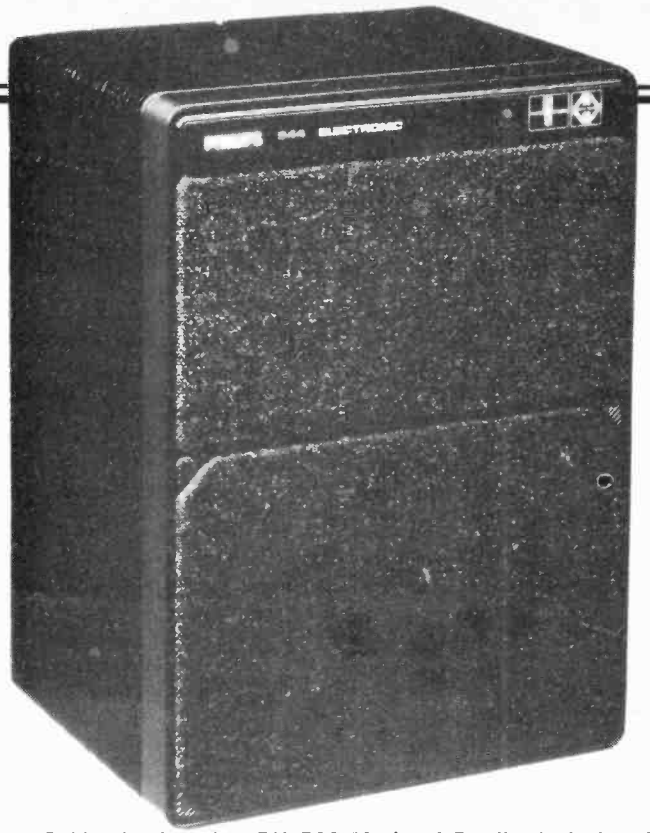
Due to the nature of its impedence, it is difficult to compare efficiency with normal units, suffice it to say that 4V RMS produces 105d BA at 18ins distance, and that this can be considered efficient!

. . . . . 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.



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.

MOTIONAL FEEDBACK

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

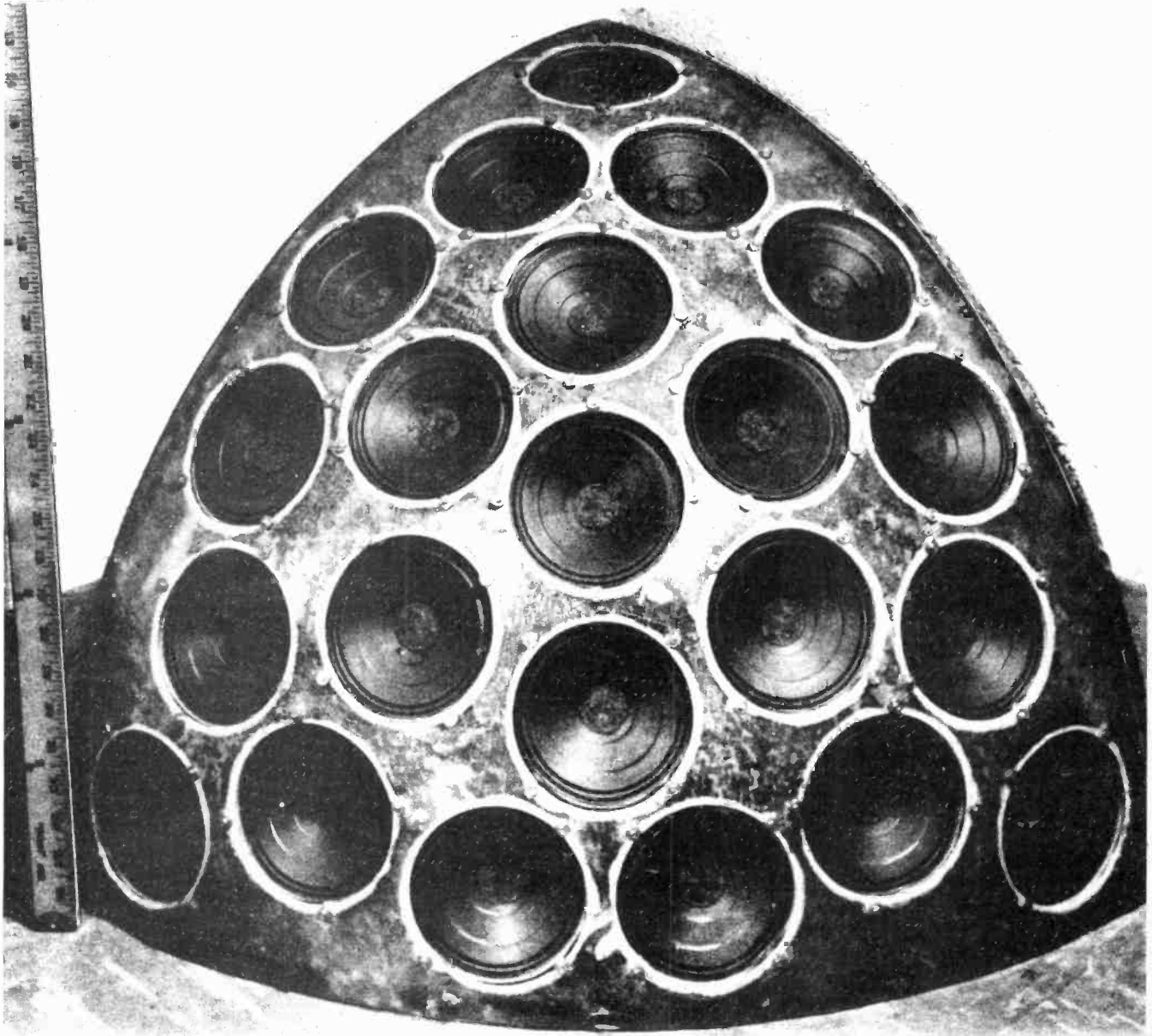
Motional feedback is a form of feedback control of the driver cone in moving coil systems. The power amplifier are mounted within the enclosure, a separate amp for each drive unit, and so signal feed is from a preamplifier. The system is marketed by Philips.

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

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	2N6124	0.45	BC108A	0.16	BC178B	0.35					BC337	0.20	BD240A	0.49
2N697	0.31	2N2218A	0.38	2N3394	0.17	2N4058	0.22	2N5193	0.75	2N6125	0.47	BC108B	0.16	BC179	0.25	BC213L	0.17	BC548	0.23	BD240C	0.59
2N698	0.49	2N2219	0.38	2N3395	0.19	2N4059	0.17	2N5194	0.80	40361	0.55	BC108C	0.17	BC179A	0.25	BC213LA	0.17	BC547	0.13	BD241A	0.49
2N699	0.58	2N2219A	0.39	2N3396	0.19	2N4060	0.22	2N5195	0.97	40362	0.55	BC109	0.16	BC179B	0.25	BC213LB	0.17	BC547A	0.13	BD241C	0.65
2N706	0.30	2N2220	0.39	2N3397	0.19	2N4061	0.19	2N5245	0.37	40363	1.45	BC109B	0.17	BC179C	0.26	BC213LC	0.17	BC547B	0.13	BD242A	0.55
2N706A	0.30	2N2221	0.25	2N3438	0.85	2N4062	0.20	2N5246	0.38	40408	0.82	BC109C	0.18	BC182	0.12	BC214	0.17	BC548	0.13	BD242C	0.62
2N708	0.30	2N2221A	0.25	2N3440	0.75	2N4064	1.35	2N5247	0.44	40409	0.82	BC140	0.30	BC182A	0.12	BC214B	0.17	BC549	0.14	BD243A	0.65
2N718	0.30	2N2222	0.25	2N3441	0.92	2N4074	2.65	2N5248	0.44	40410	0.82	BC141	0.32	BC182B	0.13	BC214C	0.17	BC549B	0.14	BD243C	0.87
2N718A	0.54	2N2222A	0.25	2N3442	1.45	2N4121	0.27	2N5294	0.44	40411	3.10	BC147	0.13	BC182L	0.15	BC214L	0.18	BC549C	0.15	BD244A	0.70
2N720A	0.85	2N2369	0.27	2N3638	0.17	2N4122	0.27	2N5295	0.44	40594	0.87	BC147B	0.13	BC182LA	0.15	BC214LB	0.18	BC557	0.14	BD244C	0.87
2N722	0.45	2N2369A	0.27	2N3638A	0.17	2N4123	0.19	2N5296	0.44	40595	0.98	BC148	0.13	BC182LB	0.15	BC214LC	0.18	BC558	0.13	BD245A	0.69
2N727	0.50	2N2646	0.80	2N3702	0.14	2N4124	0.19	2N5298	0.44	40673	0.80	BC148B	0.13	BC183	0.12	BC237B	0.15	BC559	0.15	BD245C	0.85
2N914	0.38	2N2647	1.55	2N3703	0.14	2N4125	0.19	2N5447	0.16	40674	1.30	BC148C	0.13	BC183A	0.12	BC238A	0.13	BC560	0.21	BD246A	0.72
2N916	0.33	2N2904	1.60	2N3704	0.14	2N4126	0.19	2N5448	0.16	AC126	0.48	BC149	0.15	BC183B	0.13	BC238B	0.13	BC561	0.26	BD246C	0.93
2N917	0.38	2N2904	0.31	2N3705	0.14	2N4284	0.38	2N5449	0.20	AC127	0.48	BC149C	0.15	BC183C	0.13	BC238C	0.13	BC572	0.18	BD433	0.44
2N918	0.45	2N2904A	0.31	2N3706	0.14	2N4286	0.22	2N5457	0.38	AC128	0.48	BC157A	0.15	BC183L	0.15	BC239B	0.16	BD115	0.88	BD434	0.46
2N929	0.37	2N2905	0.31	2N3707	0.14	2N4287	0.22	2N5458	0.35	AC151	0.43	BC158A	0.15	BC183LA	0.15	BC239C	0.17	BD131	0.55	BD435	0.46
2N929A	0.37	2N2905A	0.31	2N3708	0.12	2N4288	0.22	2N5459	0.32	AC152	0.54	BC158B	0.15	BC183LB	0.15	BC257A	0.18	BD132	0.75	BD436	0.46
2N930	0.37	2N2906	0.25	2N3709	0.12	2N4289	0.22	2N5460	0.65	AC153	0.59	BC159A	0.17	BC183LC	0.15	BC258B	0.19	BD135	0.40	BD437	0.55
2N930A	0.95	2N2906A	0.25	2N3771	2.16	2N4347	2.20	2N5484	0.37	AC153K	0.59	BC159B	0.17	BC184	0.12	BC259B	0.19	BD136	0.40	BD438	0.55
2N1711	0.30	2N2907	0.25	2N3772	2.20	2N4348	2.65	2N5485	0.40	AC176K	0.70	BC160	0.38	BC184B	0.13	BC300	0.43	BD137	0.41	BD529	0.49
2N1889	0.30	2N2907A	0.25	2N3773	3.15	2N4918	0.65	2N5486	0.40	AC176	0.54	BC161	0.38	BC184C	0.13	BC301	0.43	BD138	0.41	BD530	0.55
2N1890	0.30	2N2923	0.17	2N3819	0.36	2N4919	0.70	2N5490	0.64	AC187	0.59	BC167	0.13	BC184L	0.15	BC302	0.37	BD139	0.43	BD535	0.70
2N1893	0.30	2N2924	0.17	2N3820	0.39	2N4920	0.83	2N5492	0.64	AC187K	0.65	BC167B	0.13	BC184LB	0.15	BC303	0.54	BD140	0.43	BD536	0.70
2N2102	0.50	2N2925	0.19	2N3821	0.96	2N4921	0.54	2N5494	0.65	AC188	0.54	BC168A	0.13	BC184LC	0.15	BC307	0.16	BD181	1.90	BD537	0.74
2N2192	0.58	2N2926	0.17	2N3900	0.28	2N4922	0.60	2N5496	0.67	AC188K	0.65	BC168B	0.13	BC212	0.15	BC307A	0.16	BD182	2.20	BD538	0.77
2N2193	0.50	2N3053	0.25	2N3901	0.30	2N4923	0.75	2N6027	0.64	AD161	1.00	BC168C	0.13	BC212A	0.15	BC307B	0.16	BD183	2.35	BD539	0.60
2N2193A	0.52	2N3054	0.72	2N3903	0.20	2N4924	1.15	2N6107	0.45	AD162	1.00	BC169B	0.13	BC212B	0.15	BC308	0.16	BD187	0.95	BD540	0.60
2N2194	0.42	2N3055	0.75	2N3904	0.18	2N5086	0.30	2N6108	0.55	AF106	0.60	BC169C	0.13	BC212L	0.18	BC308B	0.16	BD235	0.46	BDX14	1.32
2N2194A	0.45	2N3390	0.50	2N3905	0.18	2N5087	0.30	2N6109	0.55	AF109	0.52	BC177	0.22	BC212LA	0.18	BC309A	0.16	BD236	0.44	BDX18	1.90
2N2195	0.40	2N3391	0.40	2N3906	0.18	2N5088	0.30	2N6111	0.49	BC107	0.16	BC177A	0.22	BC212LB	0.18	BC309B	0.16	BD237	0.44	BDY20	1.10
2N2195A	0.40	2N3391A	0.45	2N4031	0.55	2N5089	0.30	2N6121	0.41	BC107A	0.16	BC177B	0.25	BC213	0.15	BC309C	0.16	BD238	0.44	BDY55	1.90
2N2217	0.55	2N3392	0.17	2N4036	0.72	2N5191	0.75	2N6123	0.48	BC108	0.16	BC178A	0.25	BC213B	0.15	BC327	0.22	BD239A	0.44	BDY56	2.10
																BC328	0.20	BD239C	0.59	BF115	0.39

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	0.27	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														
BD537	0.74	BF245B	0.44	BU205	2.40	MPSA14	0.33	ZTX500	0.16														
BD538	0.77	BF257	0.35	BU206	2.70	MPSA55	0.27	ZTX530	0.25														
BD539	0.60	BF258	0.35	BU208	2.70	MPSA56	0.27																
BD540	0.60	BF259	0.35	ME4001	0.22	R20088	2.45																
BDX14	1.32	BF336	0.42	ME4002	0.22	R20108	2.15																
BDX18	1.90	BF337	0.49	ME4004	0.17	TIP29A	0.49																
BDY20	1.10	BF338	0.52	ME4012	0.22	TIP29C	0.65																
BDY55	1.90	BF839	0.30	ME4014	0.22	TIP30A	0.54																
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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
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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. ►

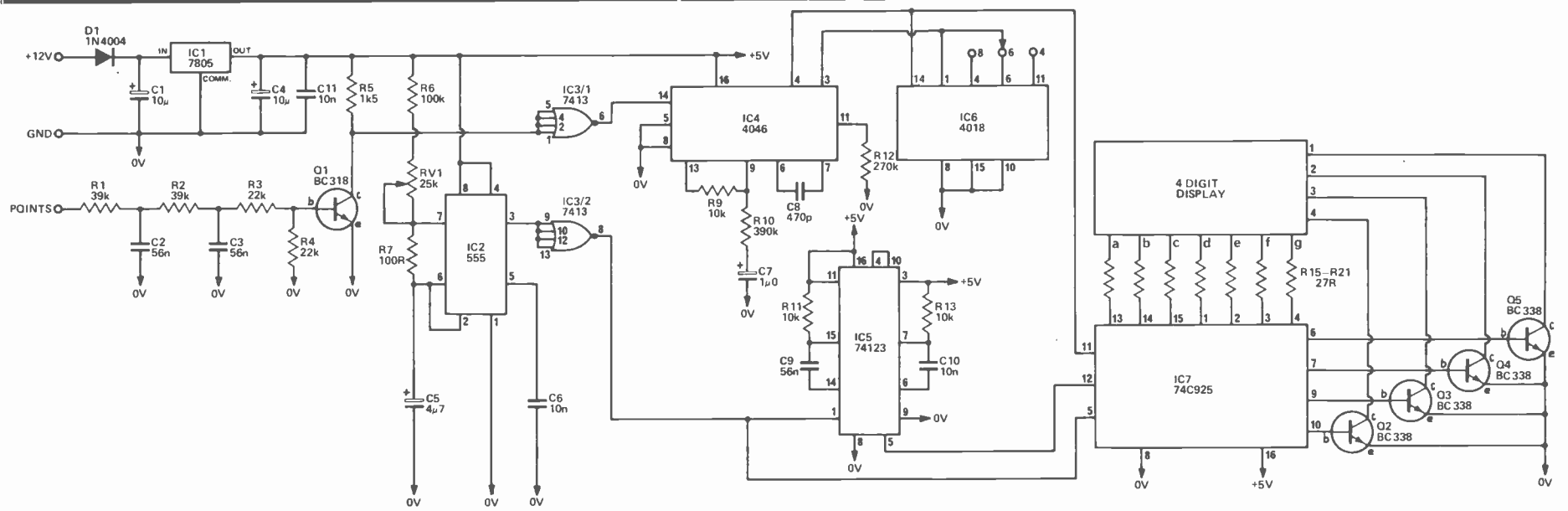


Fig. 2. Full circuit diagram for the digital car tacho unit.

HOW IT WORKS

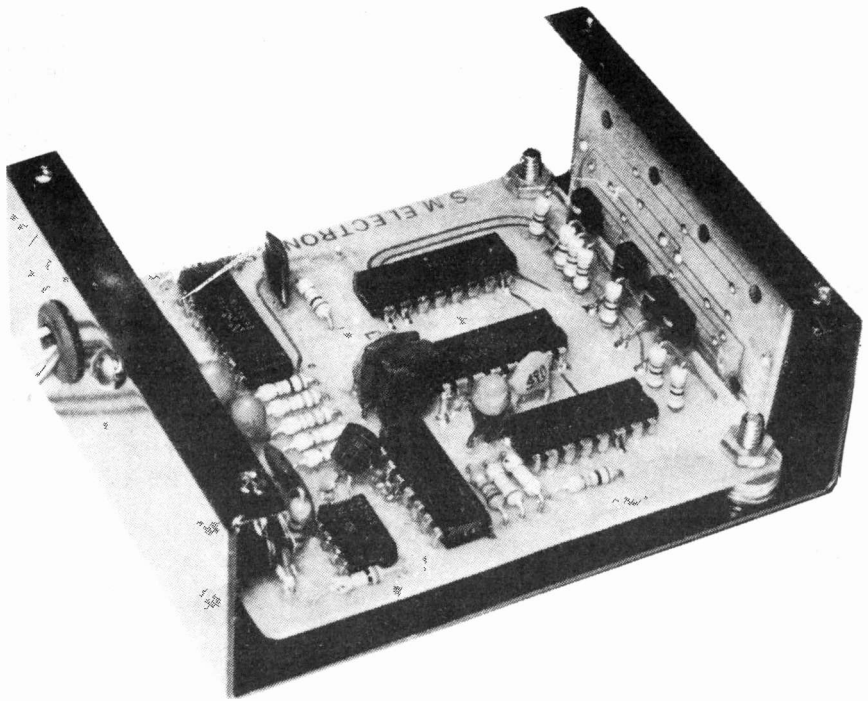
The output from the points of the distributor is basically a 0 to 12V square wave with a 200 volt pulse on the rising edge. A filter network, R1-R4, C2, 3 is used to remove the high voltage pulse (and points bounce) and Q1 buffers it giving a +5 to 0V output on its collector. As the filter network removes 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.



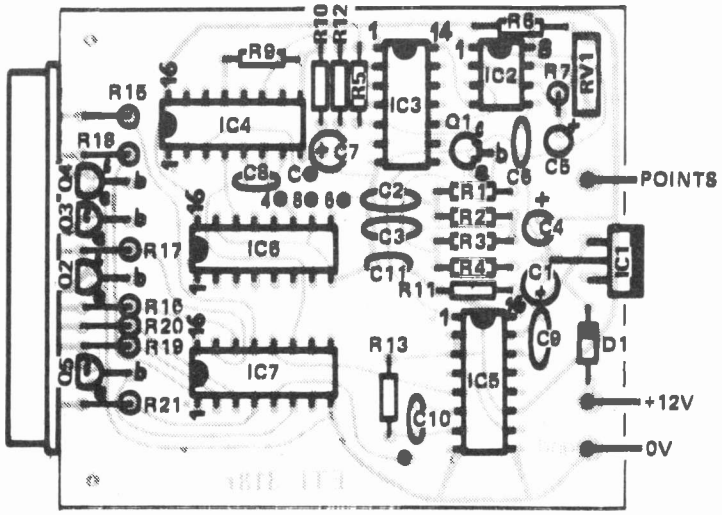


Fig. 1. The component overlay for the board. The board is double sided although only the lower surface is shown here. Note the link between the two surfaces of the board near C10.

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

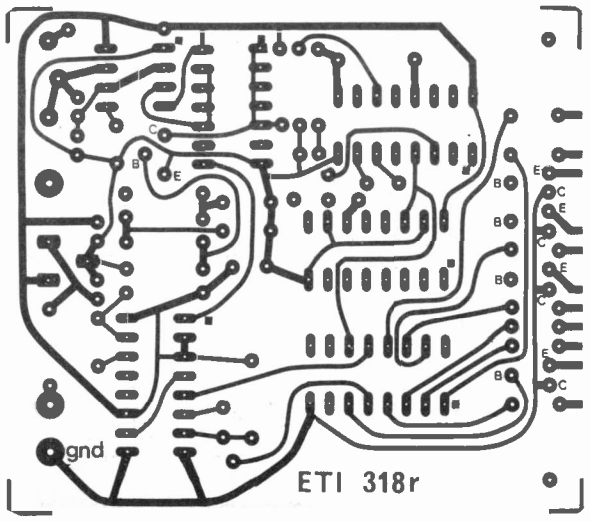
BUYLINES

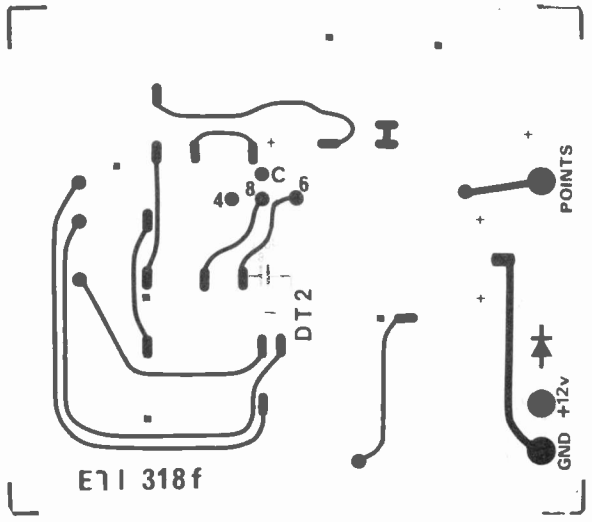
The components employed here are all readily available from any of the major mail order companies advertising in this issue. Note that the counter is a CMOS chip, and not a standard bi-polar TTC chip. The standard component will not operate on this mode.

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	

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





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.

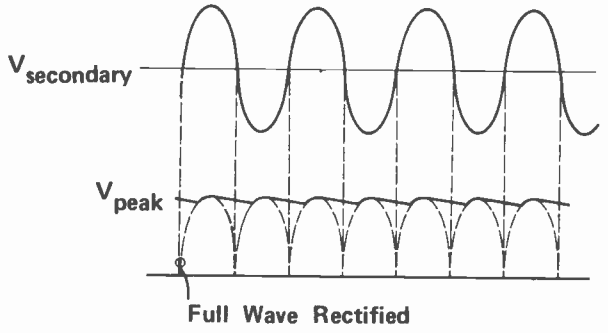


Figure 1. Below: an unregulated power supply. Above: The output (with a load resistor).

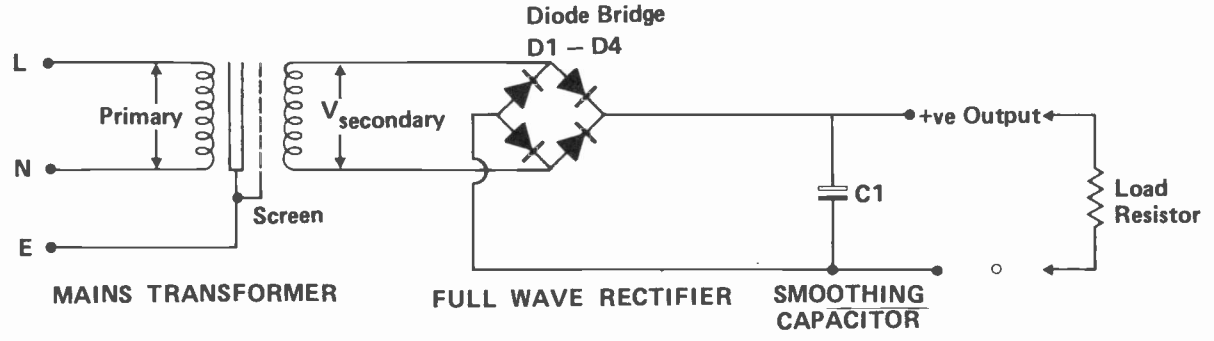
The function of a mains isolating transformer is to physically separate the user end of a piece of equipment from the 'potentially'(!) lethal mains voltage. The transformer also provides a suitable voltage which can be rectified and smoothed and connected to a voltage regulator. This is the secondary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

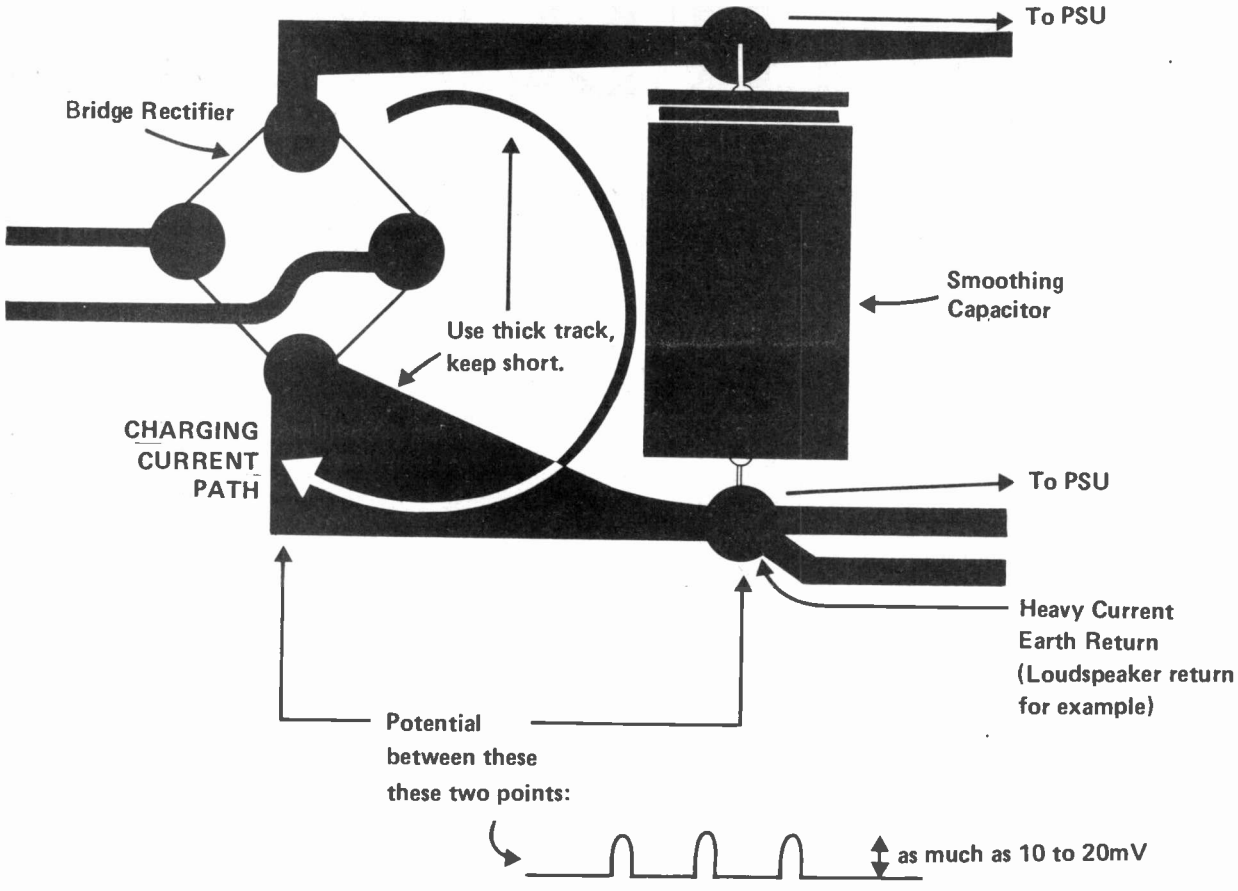
Thus care has to be taken when selecting a transformer such that the smoothing capacitor working voltage is not exceeded. Also, make certain that the polarity on this capacitor is correct, they can LITERALLY explode if wired up backwards! ▶



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.



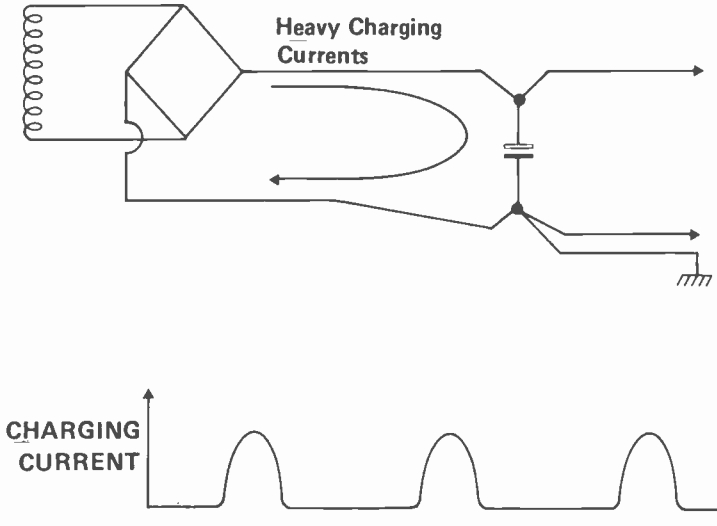
When a load is placed upon the power supply shown above, the output voltage appears as a DC voltage on top of which is a ripple voltage. This can be thought of as two separate periods, a charge period where the capacitor is charged up by the power supply and a discharge period where the load discharges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

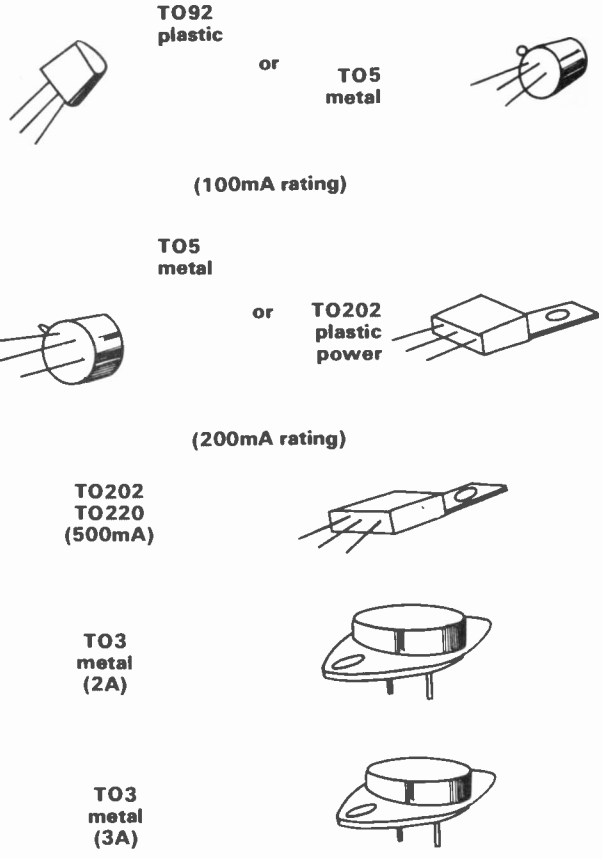
As a rule of thumb the regulator case should not exceed about 80° C (which is hot to touch). However, always run the device at as low a temperature as possible. It is thermal ageing that eventually kills electronic devices and for higher temperatures the ageing process is disproportionally faster.

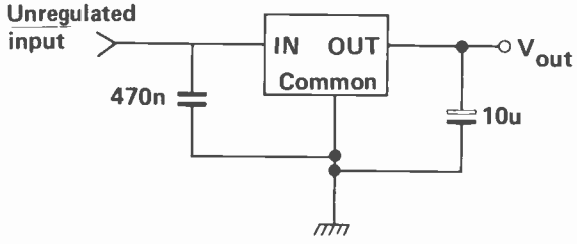
Some applications of voltage regulators are given below.

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.

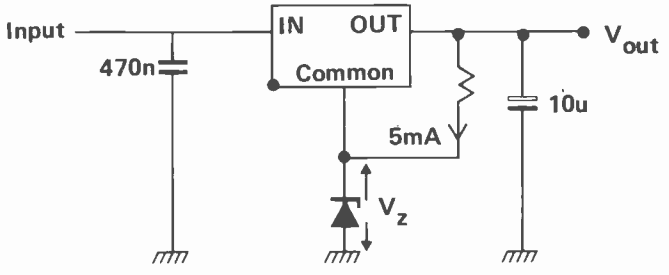
TABLE ONE

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



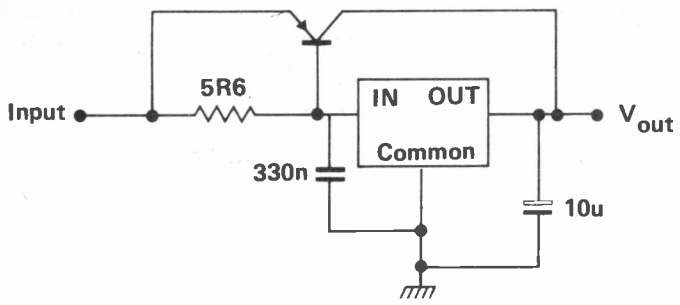


A)
This circuit shows a conventional arrangement of a three terminal device. It is advisable to use a decoupling capacitor connected close to the input terminals. This prevents high frequency instability. If this capacitor is left out then regulation can sometimes be greatly reduced. The decoupling capacitor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

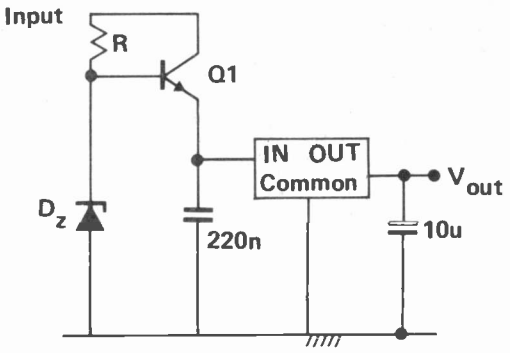


B)
The output voltage of a regulator can be increased by applying a voltage to the common terminal. This can be done by using a zener diode.

▶



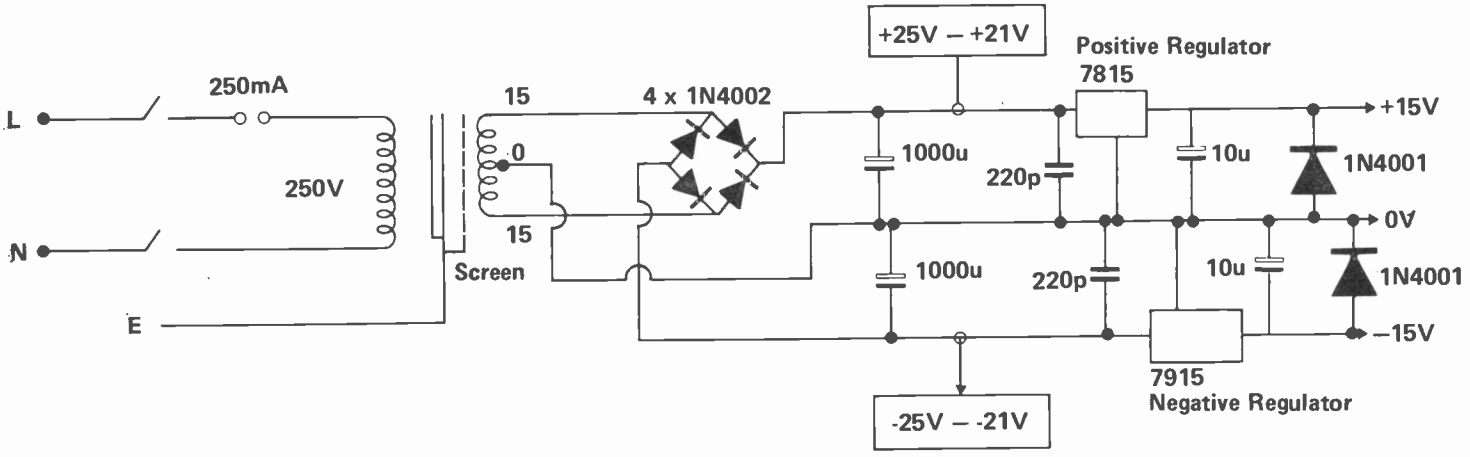
C)
The output current can be increased by using a bypass transistor. When the current flowing through the voltage regulator exceeds 100 mA (the voltage across the 5R6 being 560 mV), the bypass transistor begins to turn on. This transistor takes all currents in excess of 100 mA and yet the output still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



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

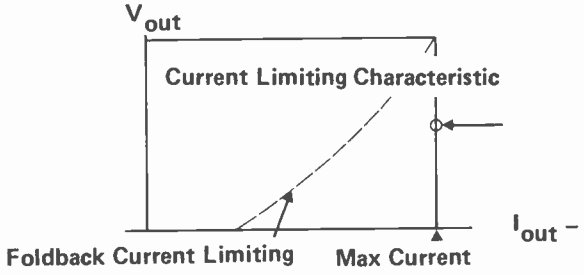
Dual Power Supply

The circuit shows a complete regulated dual power supply. The unregulated rails are obtained from a split secondary transformer, a bridge rectifier and two smoothing capacitors. A positive and a negative regulator have been used to generate the + and — rails. These regulators should be mounted on heat sinks and they should be insulated. The pin out of the negative regulator is different to that of the positive regulator. The two diodes at the output prevent latching up situations (on load) whereby one side starts up faster than the other and forcibly reverse biases it, preventing it from operating.



Tracking Regulator

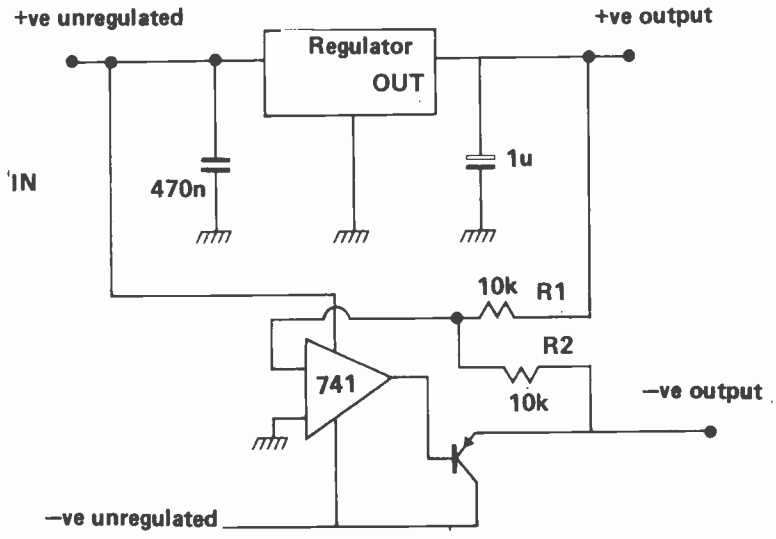
Instead of using a negative voltage regulator to obtain the negative rail, an op amp and a power transistor can be used. The resistor ratio, R1, R2 determines the negative rail voltage. The negative rail is not, however, current limited. The internal current limiting of the regulator is shown. When the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



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

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

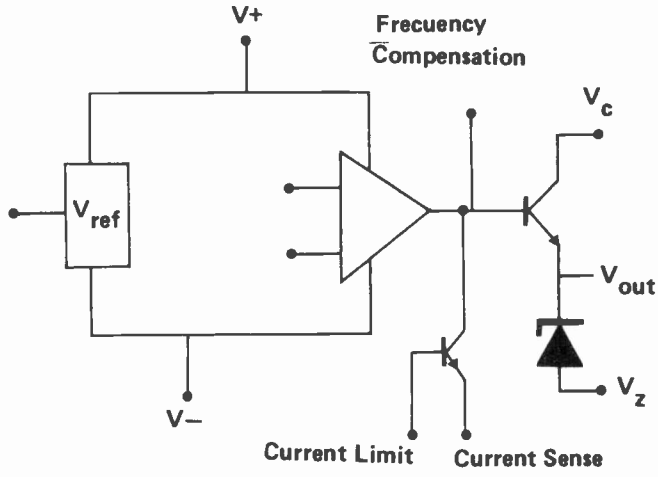
With foldback the short circuit power dissapated in the regulator is less than that with current limiting.



723 Voltage Regulator

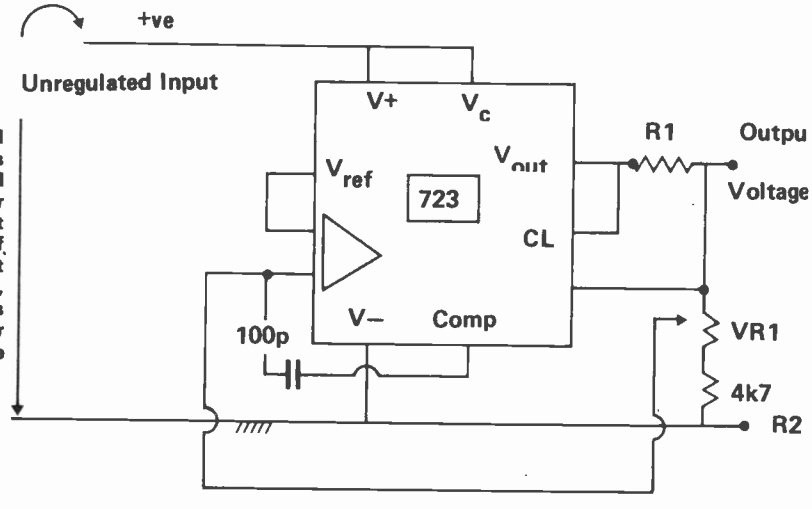
The 723 is an industry 'standard' device. Many manufacturers produce it and the device itself is versatile. It comes in a 10 pin TO5 can or a 14 DIL pack. The device contains a precision voltage reference, with a temperature coefficient of 50ppm/°C, an error amplifier, an internal transistor capable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



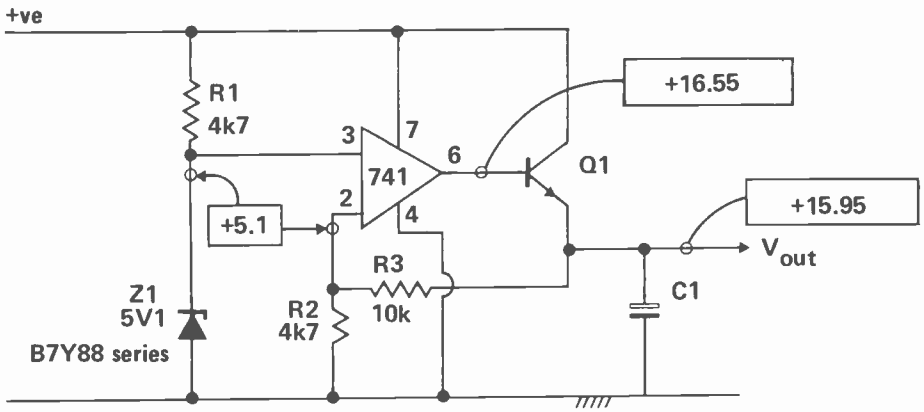
Adjustable Positive Voltage Regulator

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.



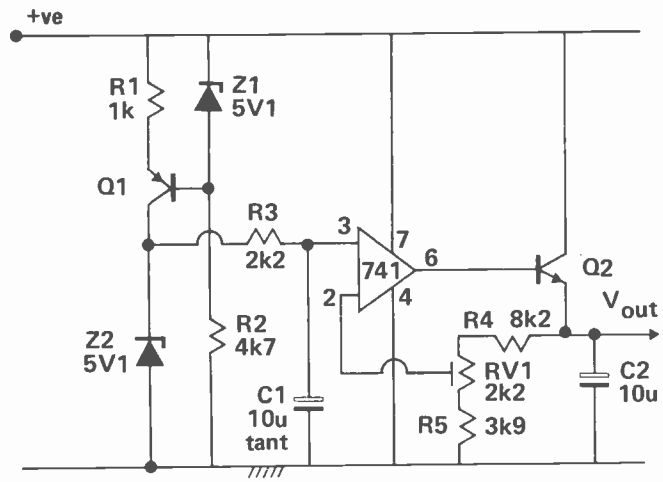
Left: Circuit diagram of discrete component PSU. Voltage measurements are taken with high impedance voltmeter.

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.

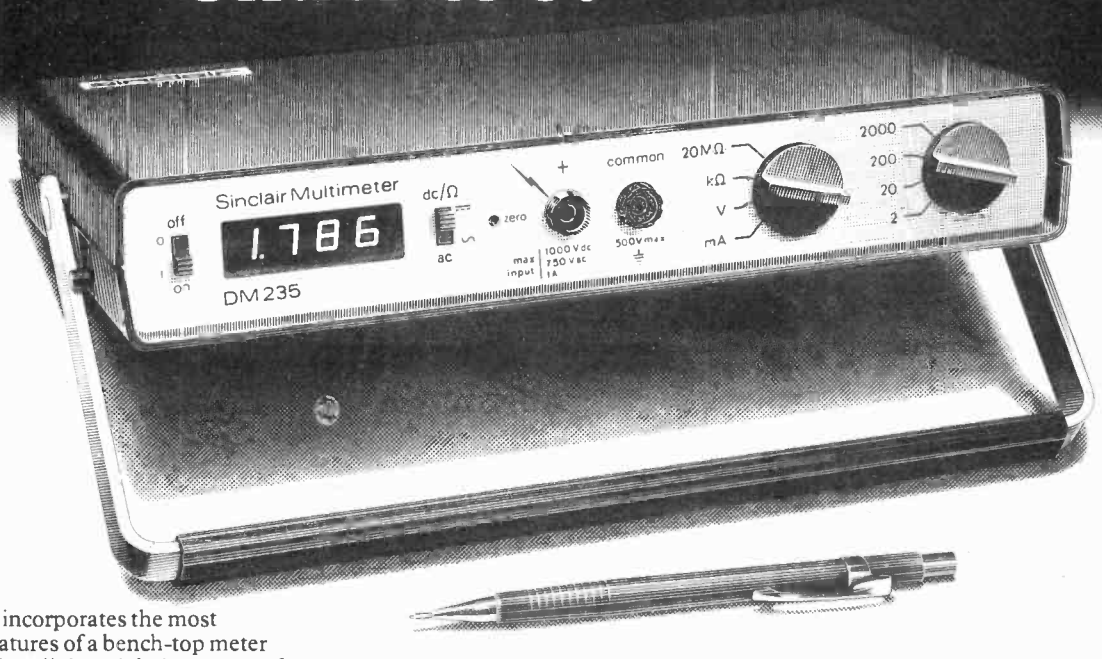


If a precision power supply is required then a precision voltage reference should be used. These can be obtained with temperature coefficients as low as 10ppm/°C. When using this level of stability, high stability resistors (TC = 10ppm/°C), and a low drift op amp should be used. Also, to reduce mains 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

New Sinclair DM235 digital multimeter.

3½ digits...6 functions... fully portable...

Under £50!



The DM235 incorporates the most important features of a bench-top meter into a rugged yet lightweight instrument for true portability. High accuracy, resolution and input impedance mean superior performance to analogue meters – but at a price significantly lower than many. The DM235's design and specification makes it ideal for all but the most demanding applications.

Big, bright, unambiguous display

Full 3½ digit display, reading to ±1999.
8 mm LEDs, ultra wide angle of view.

Six functions, 26 ranges

DC Volts..... 1 mV to 1000V
AC Volts..... 1 mV to 750 V
DC Current..... 1μ A to 1A
AC Current..... 1μ A to 1A
Resistance..... 1Ω to 20 MΩ
Diode test..... 0.1μ A to 1 mA
10 MΩ input impedance.

High accuracy

Basic accuracy of 0.5% (2 V DC range).
Other DC ranges and Resistance 1.0%.
AC ranges 1.5% 30 HZ – 10 kHz.

Easy to use, by anyone, anywhere

Automatic polarity operation, automatic decimal point placement, automatic out-of-range indication.

Lightweight but strong

High-impact moulded ABS case, size 10 in x 5.8 in x 1.6 in. Weight less than 1½ lb.
Basic operation from disposable cells, for independence from AC supply.
Line operation available via optional AC charger/adaptor.

A full range of optional accessories

DM235 meter complete with test leads and prods..... £49.80
AC adaptor/charger 240 V 50 HZ..... £3.50
Eveready carrying case with lead stowage compartment..... £8. 50
Rechargeable battery units..... £8.00
30 KV high voltage probe..... £15.00
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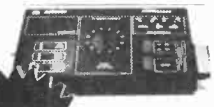

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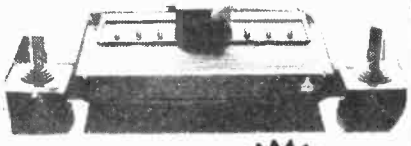

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0-15-20, 0-15-20	700(DC)	221	3.10	.70
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1.0	103	4.20	.85
2.0	104	6.10	1.00
3.0	105	7.85	1.00
4.0	106	9.80	1.10
6.0	107	14.95	1.30
8.0	118	15.75	1.50
10.0	119	20.50	2.00

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

Amps	Ref. No.	Price £	P&P
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3.0	125	9.15	1.10
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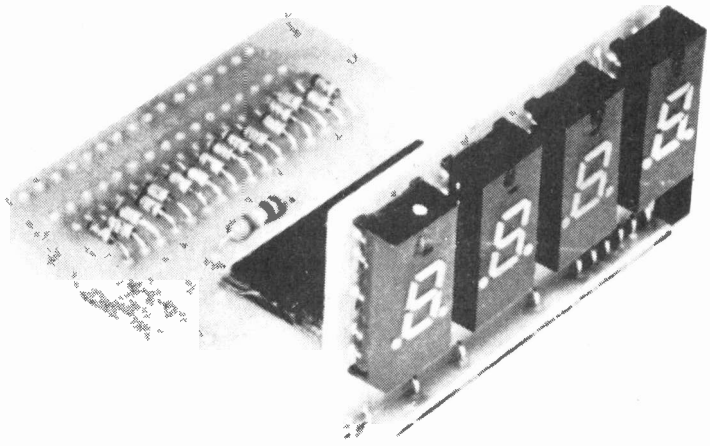
DIGITAL MODULE

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



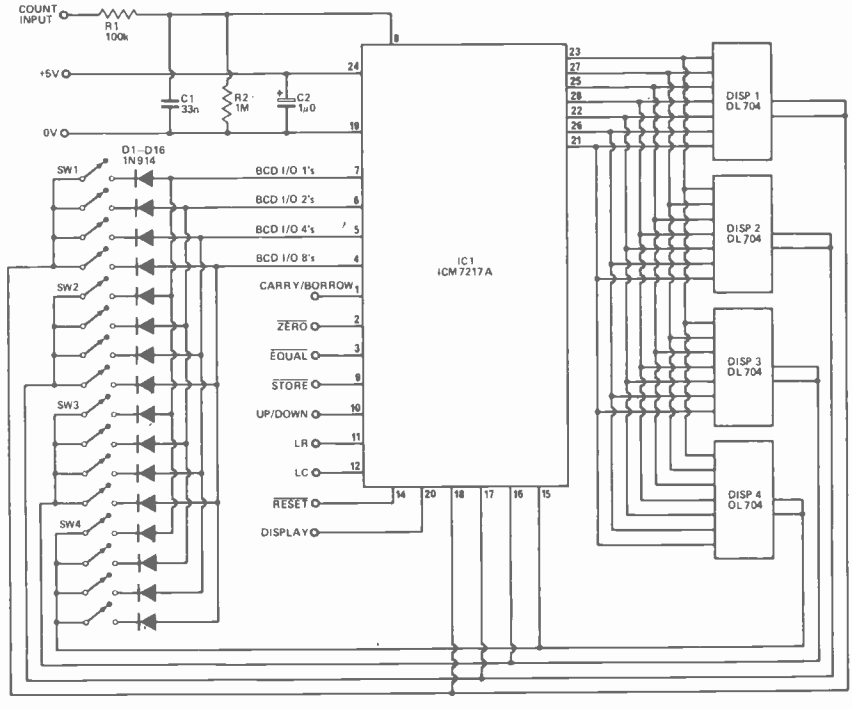
SPECIFICATION

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!

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?



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

►

(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

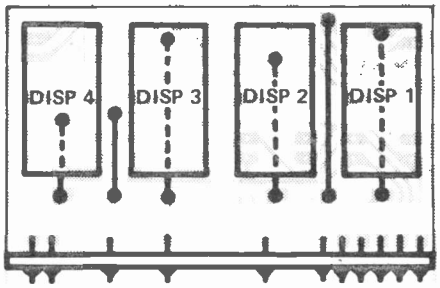


Fig. 2. The positioning of the displays and the links which must be installed before the displays.

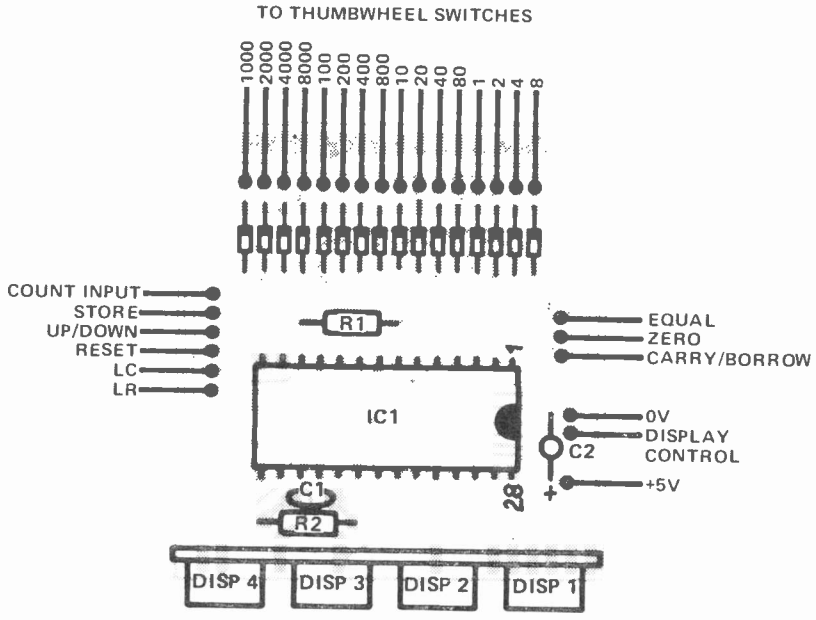
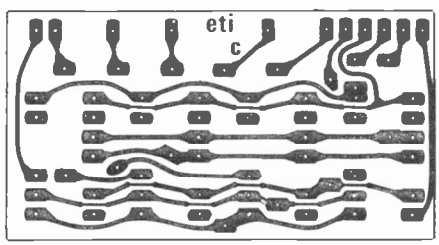
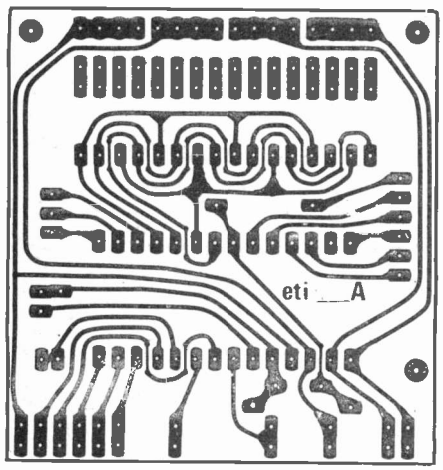
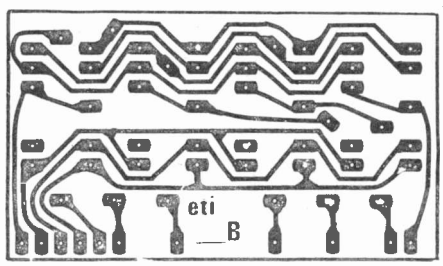


Fig. 3. The component overlay for the main board. The common connection from each of the thumbwheel switches goes to the track next to the other connections.





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.

PROJECT: Digital Module

Display Control — Pin 20

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

Scan — Pin 13

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

BCD I/O — Pin 4-7

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

Digit Drives — Pins 15-18

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

Zero — Pin 2

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

Equal — Pin 3

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

Carry/Borrow — Pin 1

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

PARTS LIST

RESISTORS (all 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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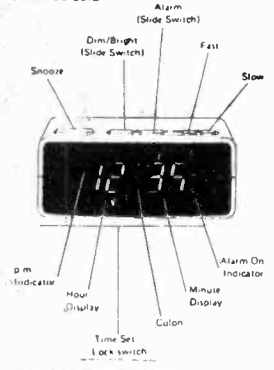

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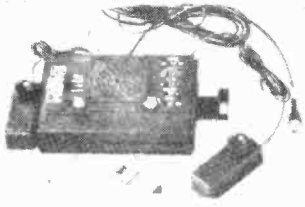

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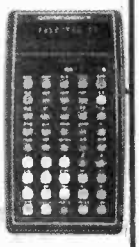

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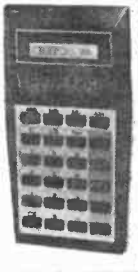

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A HISTORY OF ELECTRONICS IN MEDICINE

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).

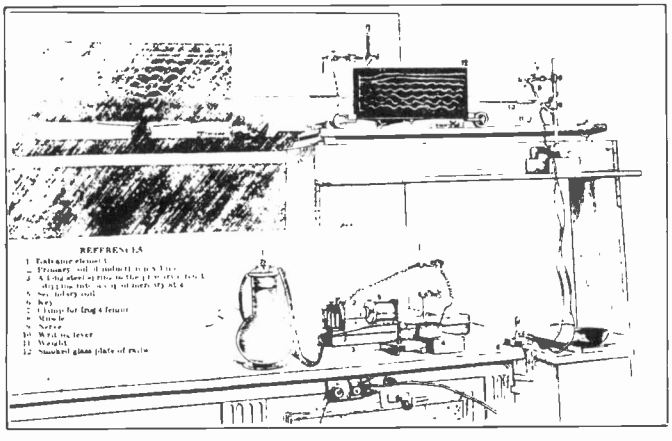


Fig. 2. Apparatus used by McKendrick to give lectures on life in motion to Royal Institution, London, audiences around 1890.

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 electro-magnetic galvanometer which became available in its crudest form around 1830. A typical laboratory electro-medical instrumentation set-up of the 1890s is shown in Fig 2. A smoked glass plate moved steadily across the end of a mechanical pen secured to the end of a frog's leg muscle. The muscle was energised by high-voltage generated from a vibration induction coil which was energised by a chromate primary single cell of the Grenet kind. Smoked screen recorders are still in use today in some medical research measurements, blood flow parameters being one example.

The 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.

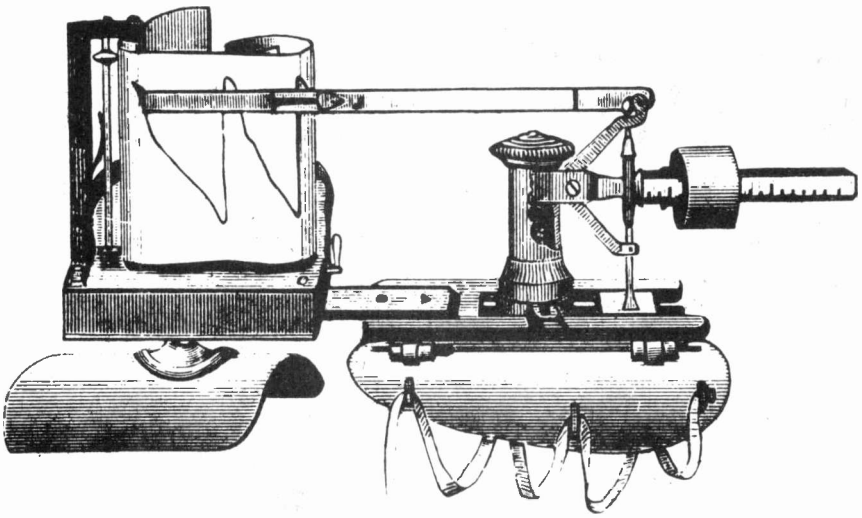


Fig. 3. Verdin's apparatus of the 1890s for recording action of the pulse.

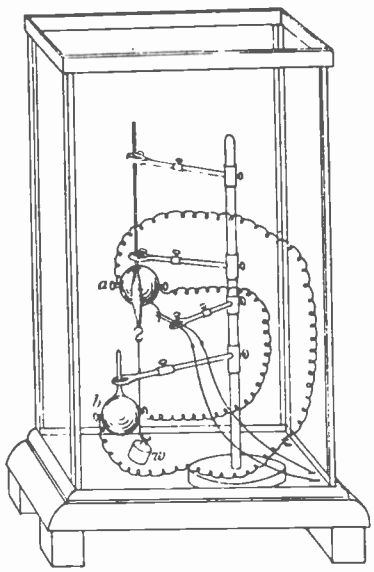


Fig. 4. Schematic of McKendrick's 1891 method for measuring heat generation in muscle.

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.

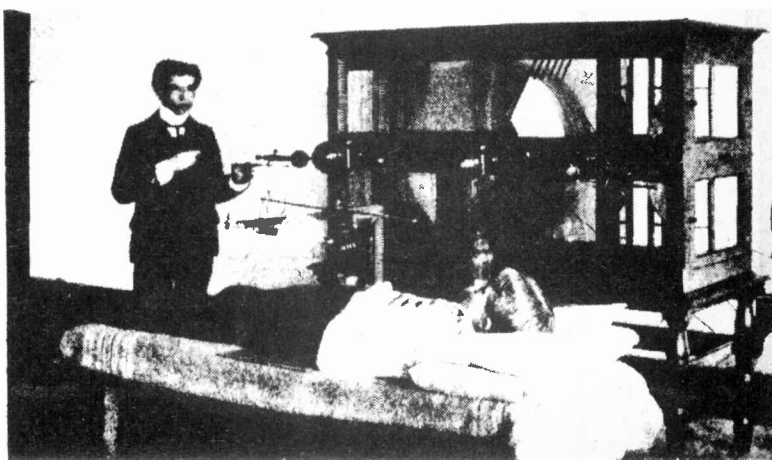
As with all disciplines, electronic method opened the door to new accomplishments. In medical electronics it happened from the 1920s onward. Equipment for researching physiology at Oxford University, in 1949 is shown in Fig 7 The unit, advanced for its time, incorporated amplifiers, a temperature control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



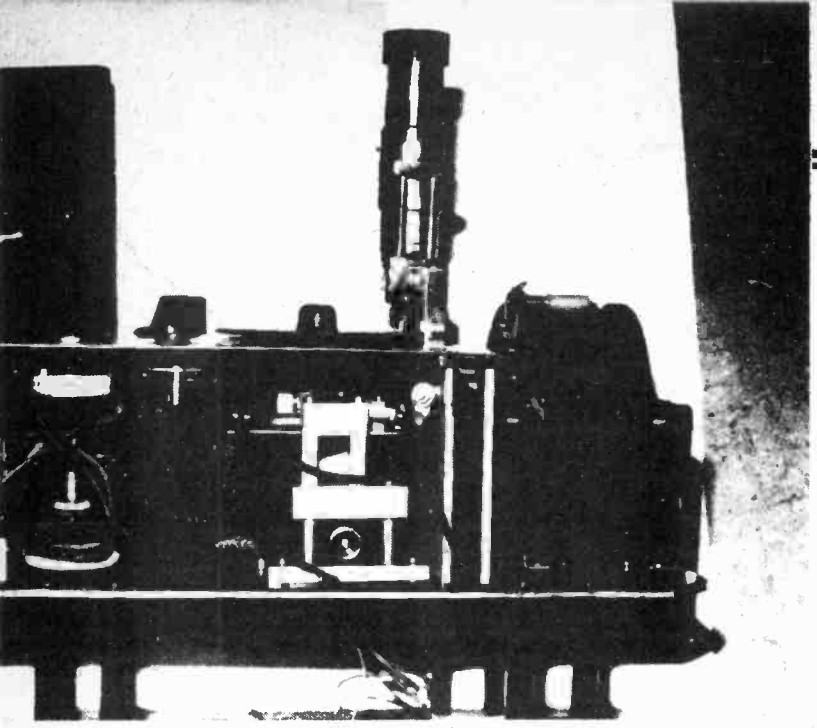


Fig. 6. Interior view of a Both portable electro-cardiograph machine made in Adelaide around 1930.

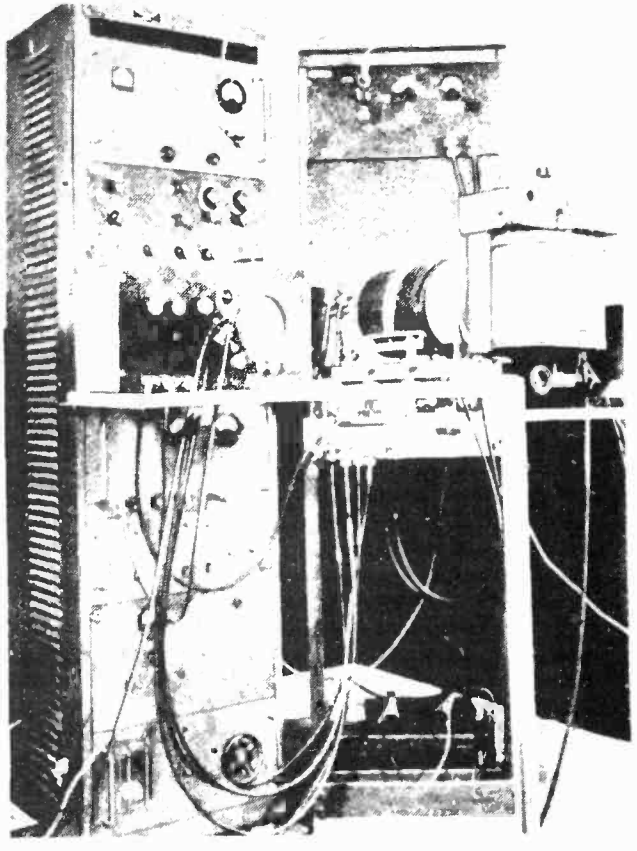


Fig. 7. E Electro-physiological research equipment used by Dickinson at Oxford University in 1949.

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.

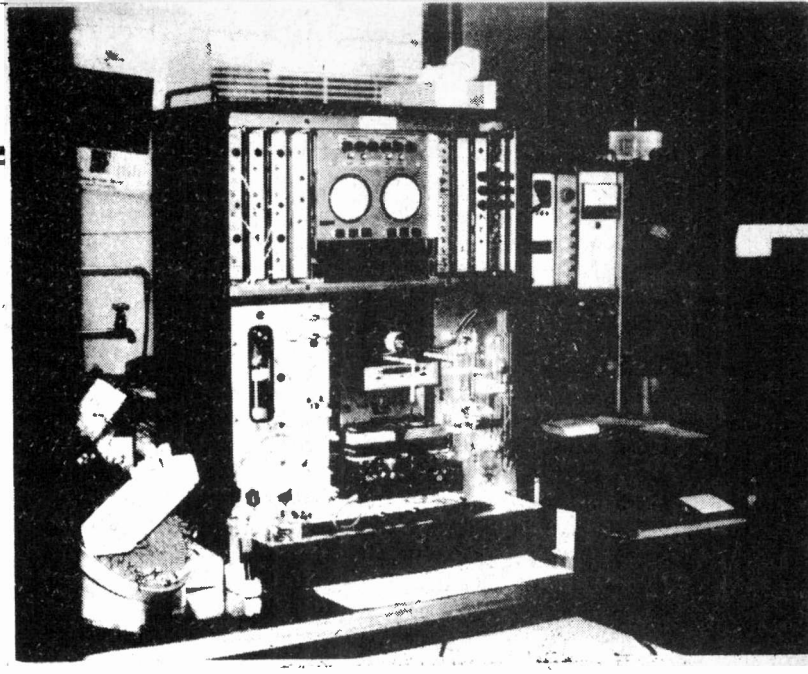


Fig. 8. Coulter counter unit of today that analyses blood sample particles providing a printout (IMUS, Adelaide).

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.

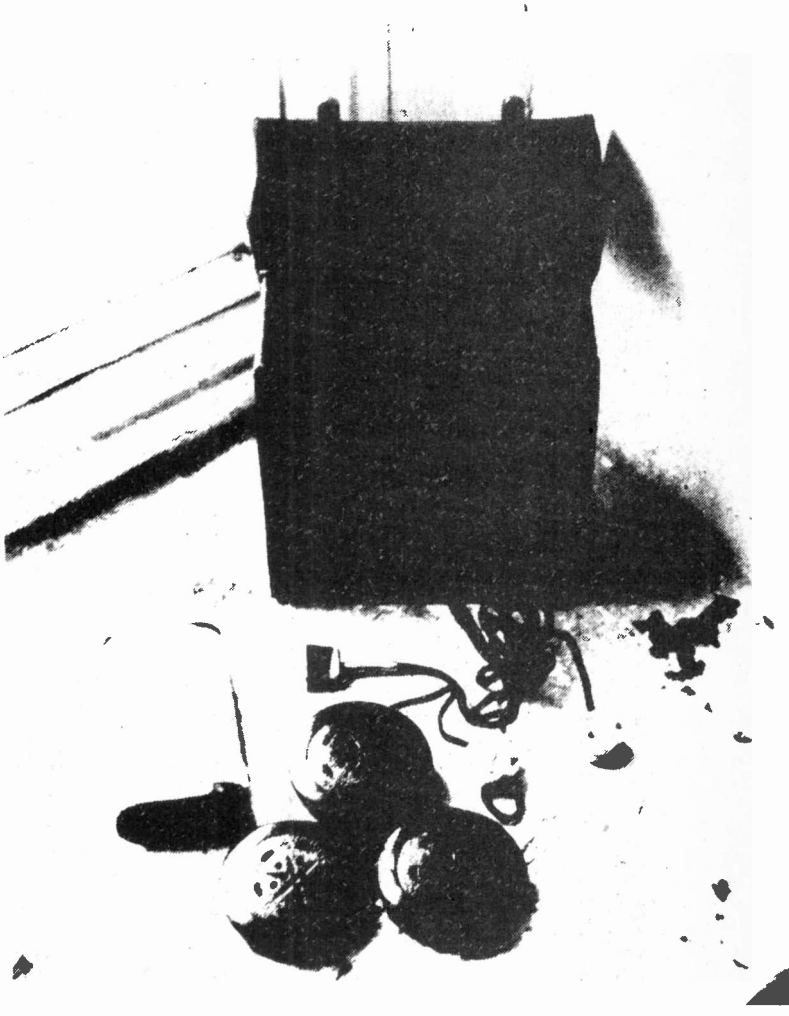


Fig. 9. 1900's hearing aid. The three receivers, which fit into the case, provide signal to the two earpieces. No active amplifier was involved. (Birdwood Mill Museum, S.A) ▶

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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(2.5mm)

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0.022µF 40V #	3p
0.022µF 63V	5p
0.033µF 63V	5p
0.047µF 63V	5p
0.068µF 63V	6p

CERAMIC FLAT TUBULAR B37449 ●
(5mm)

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0.068µF 63V	5p
0.1µF 63V	6p
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270 — 1000pF	3p
E6 values	
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6800pF	3p

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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% (0r 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	●	8o
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

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6800, 10,000pF	6p

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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
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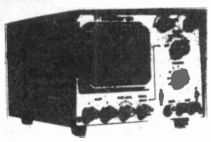

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HORIZONTAL AXIS (X)	
Deflection Sensitivity	— 0-400mV/division
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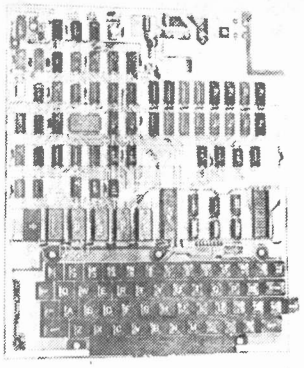

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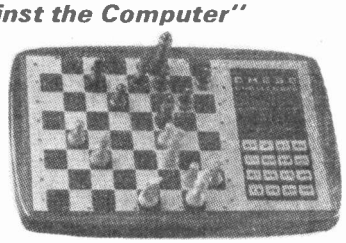

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DIGITAL DIAL

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 ►

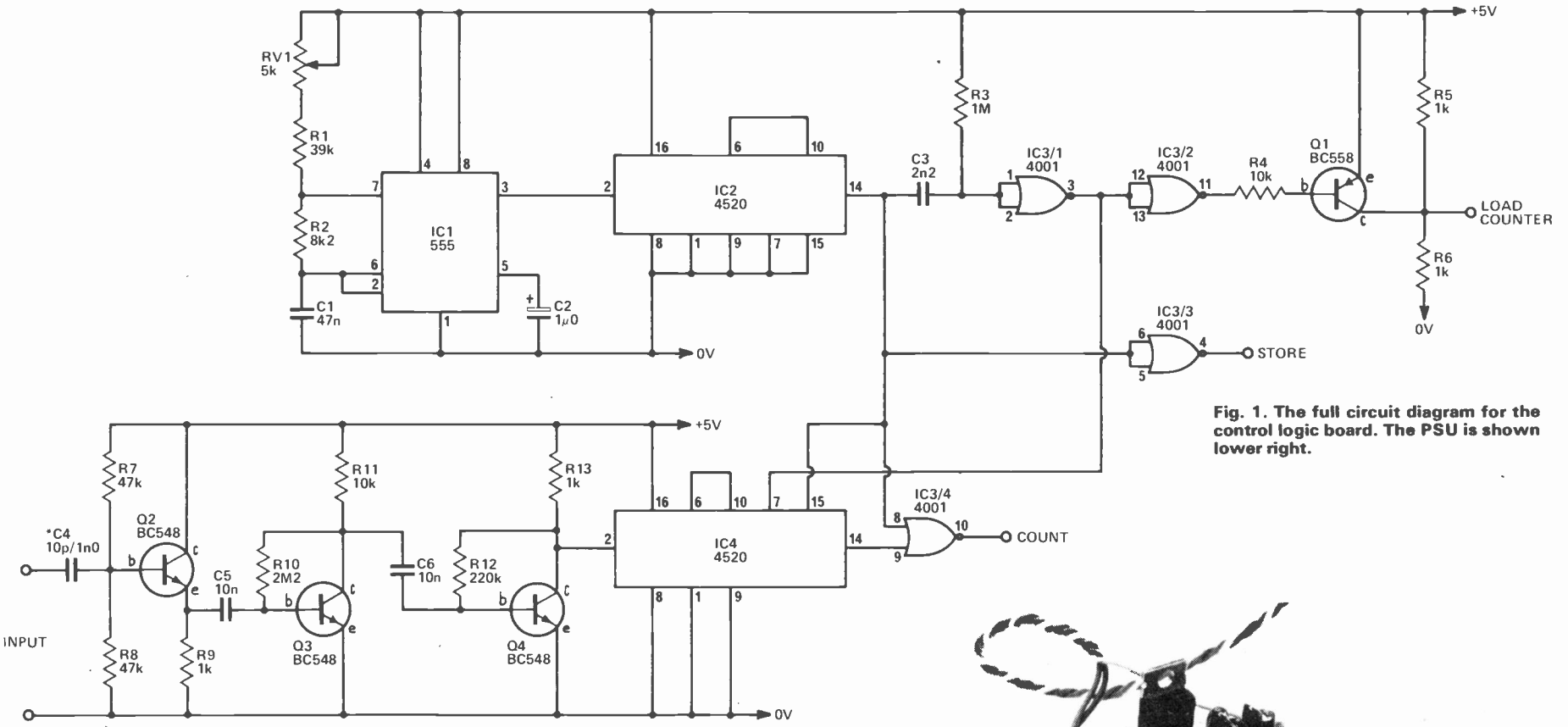
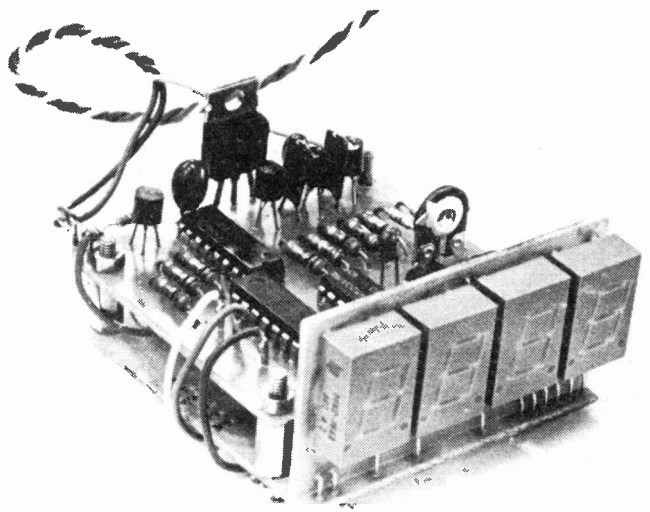


Fig. 1. The full circuit diagram for the control logic board. The PSU is shown lower right.



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).

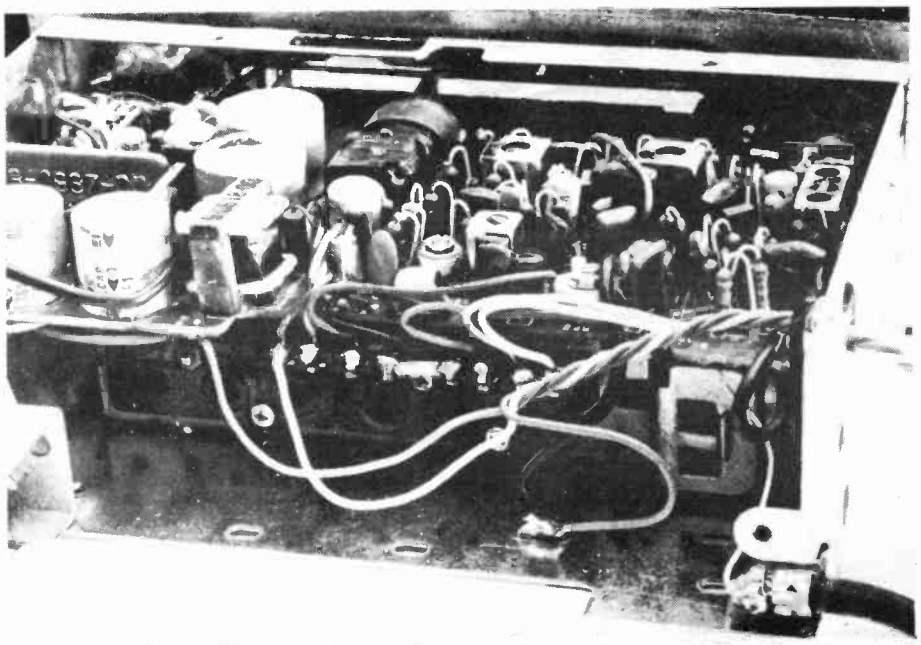
When connecting into a car radio, tune the set to a local station and try the pickup wire on the terminals of the tuning coils in turn until one is found which will give a reading without moving it off station. Permanently connect to this point. With a portable radio try moving the pickup coil around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

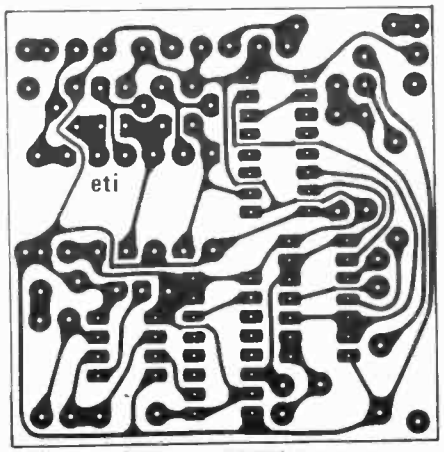
Calibration

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.

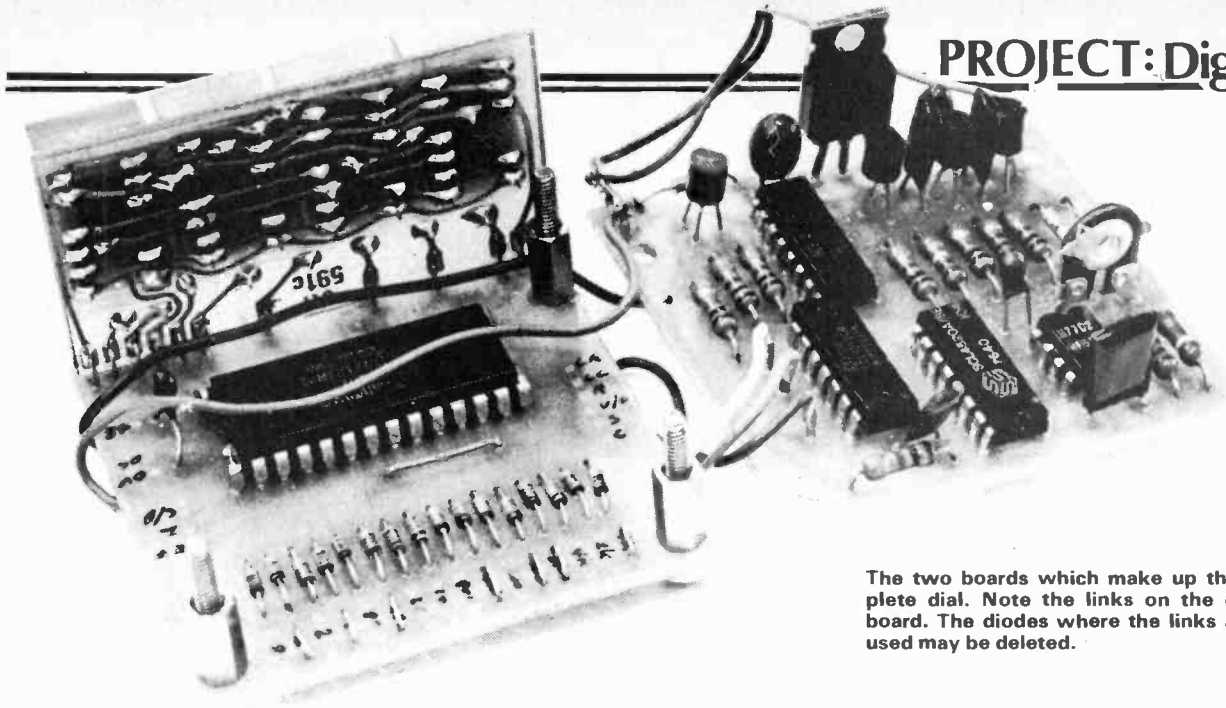
Alternatively feed a known signal of between 1 and 2 MHz from an oscillator into the input and adjust RV1 until it reads 455 less than that frequency. ►

Photo showing where we tapped into the car radio.

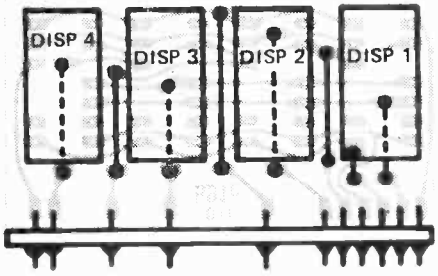




Right: full site foil patterns for the Digidial control board. Refer to the module article for details of those PCBs. Not shown here i.e. the two display boards and the third for high brightness seven segment types.



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.



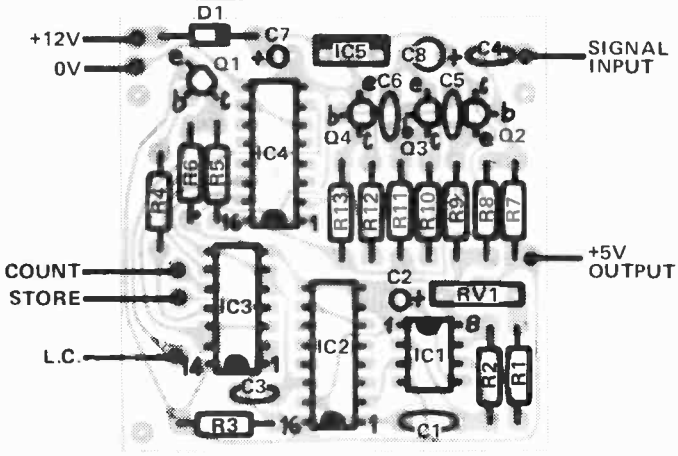


Fig 3(a) The overlay for the display board employing the high brightness displays. (b) Below that (left) the control board overlay.

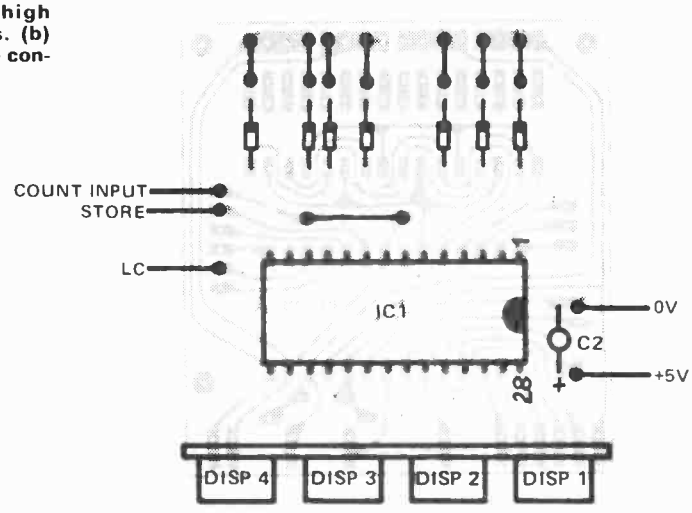


Fig. 4. The component overlay of the display module showing the diodes and links required.

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

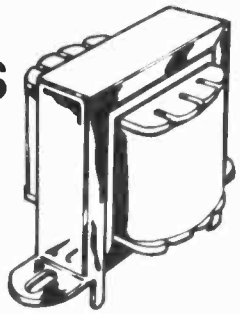
Veropins — single sided per 100
0.1in 35p
0.15in 40p

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

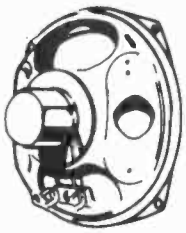
Secondary rated at 100mA.
Available with secondaries of: 6 - 0 - 6, 9 - 0 - 9 and 12 - 0 - 12. 92p each

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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AC127	17p	BCY71	14p	ZTX109	14p
AC128	16p	BCY72	14p	ZTX300	16p
AC176	18p	BD131	35p	2N697	12p
AD161	38p	BD132	35p	3N1302	38p
AD162	38p	BD135	38p	2N2905	22p
BC107	8p	BD139	35p	2N2907	22p
BC108	8p	BD140	35p	2N3053	18p
BC109	8p	BF244B	36p	2N3055	50p
BC147	7p	BFY50	15p	2N3442	135p
BC148	7p	BFY51	15p	2N3702	8p
BC149	8p	BFY52	15p	2N3704	8p
BC158	9p	MJ2955	98p	2N3705	9p
BC177	14p	MPSA06	20p	2N3706	9p
BC178	14p	MPSA56	20p	2N3707	9p
BC179	14p	TIP29C	60p	2N3708	8p
BC182	10p	TIP30C	70p	2N3819	22p
BC182L	10p	TIP31C	65p	2N3904	8p
BC184	10p	TIP32C	80p	2N3905	8p
BC184L	10p	ZTX107	14p	2N3906	8p
BC212	10p	ZTX108	14p	2N4058	12p
BC212L	10p			2N5457	32p
BC214	10p			2N5458	30p
BC214	10p			2N5459	32p
BC477	19p			2N5777	50p
BC478	19p				
BC479	19p				
BC548	10p				
BCY70	14p				

DIODES

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

BZY88 series 2V7 to 33V 8p each.

LINEAR

A SELECTION ONLY! DETAILS IN CATALOGUE.

709	25p	LM324	50p	NE556	60p
741	22p	LM339	50p	NE565	120p
747	50p	LM380	75p	NE567	170p
748	30p	LM382	120p	SN76003	200p
CA3046	55p	LM1830	150p	SN76013	140p
CA3080	70p	LM3900	50p	SN76023	140p
CA3130	90p	LM3909	60p	SN76033	200p
CA3140	70p	MC1496	60p	TBA800	70p
LM301AN	28p	MC1458	35p	TDA1022	650p
LM318N	125p	NE555	25p	ZN414	75p

OPTO

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

DISPLAYS

DL704	0.3 in CC	130p
DL707	0.3 in CA	130p
FND500	0.5 in CC	100p

RESISTORS

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

E12 series. 4.7ohms to 10M. Any mix:

	each	100+	1000+
0.25W	1p	0.9p	0.8p
0.5W	1.5p	1.2p	1p

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

CAPACITORS

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TANTALUM BEAD

	each
0.1, 0.15, 0.22, 0.33, 0.47, 0.68,1 & 2.2uF @ 35V	9p
4.7, 6.8, 10uF @ 25V	13p
22 @ 16V, 47 @ 6V, 100 @ 3V	16p

MYLAR FILM

0.001, 0.01, 0.022, 0.033, 0.047	3p
0.068, 0.1	4p

RADIAL LEAD ELECTROLYTIC

63V	0.47	1.0	2.2	4.7	10		5p
			22	33	47		7p
	100						13p
			220				20p
25V	10	22	33	47			5p
	100						8p
		220					10p
				470			15p
	1000						23p
10V		220					5p
				470			9p
	1000						13p
		2200					23p

74LS

		LS95	65p
		LS123	56p
		LS125	40p
		LS126	40p
LS00	16p	LS132	60p
LS01	16p	LS136	36p
LS02	16p	LS138	54p
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

TTL

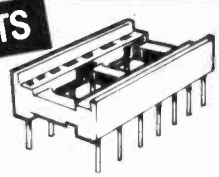
		7493	34p
		7494	52p
		7495	52p
		7496	50p
7400	12p	74121	25p
7401	12p	74122	33p
7402	12p	74123	40p
7404	12p	74125	35p
7408	14p	74126	35p
7410	12p	74132	50p
7413	25p	74141	56p
7414	48p	74148	90p
7420	12p	74150	70p
7427	24p	74151	50p
7430	12p	74156	52p
7442	43p	74157	52p
7447	55p	74164	70p
7448	58p	74165	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

CMOS

FULL DETAILS IN CATALOGUE

		4029	60p
		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
4023	15p	4093	48p
4024	45p	4510	70p
4026	95p	4511	70p
4027	35p	4518	70p
4028	52p	4520	65p

SKTS



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8 pin	10p	24 pin	24p
14 pin	12p	28 pin	28p
16 pin	13p	40 pin	40p

Soldercon pins: 100: 50p
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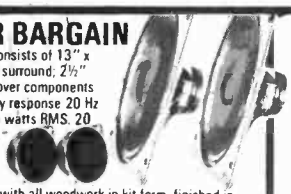

Stereo pair 350 kit. System consists of 13" x 8" approx. woofer with rolled surround; 2½" approx. Audax tweeter, crossover components and circuit diagram. Frequency response 20 Hz to 20 KHz. Power handling 15 watts RMS. 20 watts max. 8 ohm impedance.

£14.95 Per stereo pair + £3.40 p&p.

★ As above but complete with all woodwork in kit form, finished in simulated teak veneer, with instructions. Size approx 20" x 11" x 9½" **£28.00** Per stereo pair + £5.00 p&p.

EASY BUILD RECORD PLAYER KIT

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

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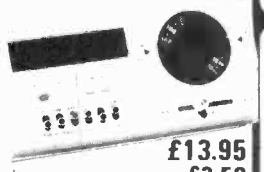

125 Watt Power Amp Module **£13.95**

Mains power supply for above unit. **£3.50**

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MULLARD Built power supply **£1.50**

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DECCA 20w Stereo speaker kit comprising 2 8" approx. bass units + 2 3½" approx. tweeter inc. crossovers **£20.00**

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Ready built. Designed in a slim form for compact, modern installation.
Rotary Controls Vol On/Off, Bass, Treble, Balance.
Push Buttons for Gram, Tape, VHF, MW, LW and 5 button rotary selection switch.
Power Output 5 watts per channel Sine at 2% THD into 15 Ohm 7 watts speech and music.
Tape Sensitivity Playback 400mV/30K OHM for max output Record 200mV/50K output available from 25KHz. (150mV/100K) deviation FM signal **Frequency Range (Audio)** 50Hz to 17KHz within ± 1dB
Radio FM sensitivity for 3dB below limiting better than 10 uV AM sensitivity for 20dB S/N MW 350 uV/Metre LW 1mV/Metre
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240 Volts AC Complete with Circuit diagram. **£19.95** p&p £2.25

Mullard

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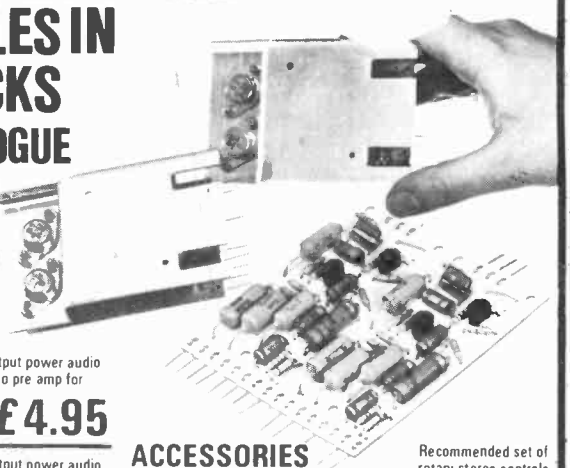

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Suitable power supply parts including mains transformer, rectifier, smoothing and output capacitors. £1.00 p+p **£1.95**

Recommended set of rotary stereo controls comprising BASS, TREBLE, VOLUME and BALANCE. p+p 50p **95p**

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added to our bargain packs
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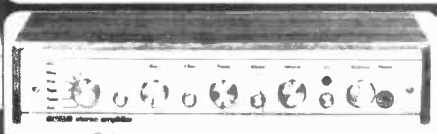
p & p £2.50 **£12.85**



20 x 20 WATT STEREO AMPLIFIER

Viscount IV unit in teak finished cabinet. Silver fascia with aluminium rotary controls/pushbuttons, red mains indicator and stereo jack socket. Functions switch for mic, magnetic and crystal pickups, tape tuner and auxiliary. Rear panel features two mains outlets DIN speaker and input sockets plus fuse 20x20 watts RMS 40x40 watts peak. For use with 8 to 15 ohm speakers. **£29.90** + £2.50 p&p

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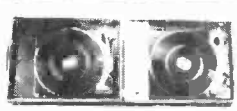
BARGAIN

PORTABLE DISCO CONSOLE



with built-in pre-amp

Here's the big-value portable disco console from RT-VC! It features a pair of BSR MP 60 type auto-return, single play professional series record decks. Plus all the controls and features you need to give fabulous disco performances. Simple connects into your existing slave or external amplifier.

£64.00 p & p £6.50

50 WATT MONO DISCO AMP **£29.95** P&P £2.50

Size approx. 13¾" x 5¼" x 6¾"
50 watts rms. 100 watts peak output. Big features include two disc inputs, both for ceramic cartridges, tape input and microphone input. Level mixing controls fitted with integral push-pull switches. Independent bass and treble controls and master volume.
SPECIAL OFFER. The above 50 watt amp plus 4 Goodmans Type 8P. 8" speakers. Package price £45.00 + £4.00 P&P.

70 & 100 WATT MONO DISCO AM

Size approx. 14" x 4" x 10½"
Brushed aluminium fascia and rotary controls.
Five vertical slide controls master volume, tape level, mic level, deck level, PLUS INTER-DECK FADER for perfect graduated change from record deck No. 1 to No. 2, or vice versa. Pre-fade level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level.
Output 100 watts RMS 200 watts peak.
70 watt 140 watt peak p & p £4.00
100 watt **£65**

STEREO CASSETTE TAPE DECK ASSEMBLY

Consisting of ready built tape transport system/mechanism, mated to the electronics. Unit is ready built for installing into cabinet of own choice. Features include pause control, solenoid assisted auto-stop, 3 digit tape counter, belt driven balanced fly wheel by DC motor with electronic speed control, twin VU meters. Specification Power Output, more than 0.5v, mic. -65dB 10KΩ, DIN -47dB 100KΩ. Track-2 channel stereo record play-back, Tape speed 4.8cm/sec Freq. response 50.12000 Hz signal to noise ratio 42dB Recording system AC bias Erasing system AC erase Bias freq. 57KHz Compatible for both normal and chrome dioxide tapes. Size of mechanism only 4½" x 6¾" x 11¼" approx.. included a moulded top-plate as illustrated 13¾" x 9¾" approx. with circuit diagram. **£25.00** P&P £2.50
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RTVC

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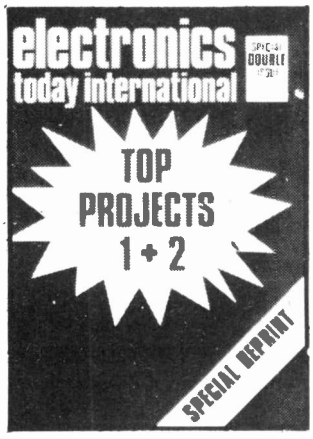

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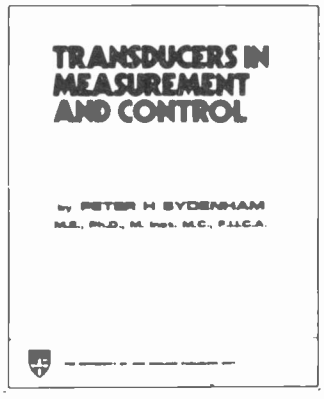

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This book is rather an unusual reprint from the pages of ETI. The series appeared a couple of years ago in the magazine, and was so highly thought of by the University of New England that they have re-published the series splendidly for use as a standard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

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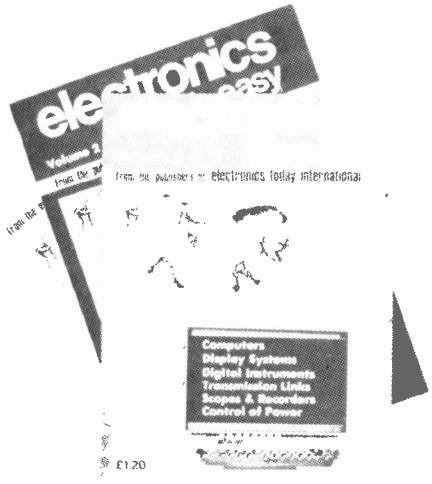

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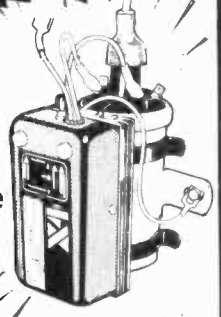

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DATA SHEETS EXPLAINED

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

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

A representative of a semiconductor distributor was showing data on a new power device to a lecturer. The lecturer said that the device data was wrong, since the maximum collector current was quoted as 12A and the maximum collector-emitter voltage (V_{CEO}) as 80V; this is a power level of 12 × 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}
I_{CM}, I_{BM} or I_{EM} collector cut-off current in a specified circuit
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}m 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.

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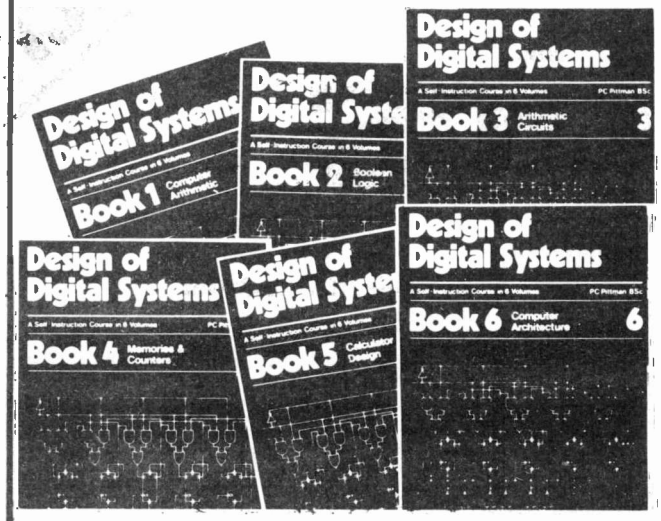

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Book 1 Octal, hexadecimal and binary number systems; conversion between number systems; representation of negative numbers; complementary systems; binary multiplication and division.

Book 2 OR and AND functions; logic gates. NOT, exlusive OR. NAND, NOR and exclusive-NOR functions; multiple input gates; truth tables; De Morgans Laws; canonical forms; logic conventions; Karnaugh mapping; three-state and wired logic.

Book 3 Half adders and full adders; subtractors; serial and parallel adders; processors and arithmetic logic units (ALUs); multiplication and division systems.

Book 4 Flip flops; shift registers; asynchronous and synchronous counters; ring, Johnson and exclusive-OR feedback counters; random access memories (RAMs) and read only memories (ROMs).

Book 5 Structure of calculators; keyboard encoding; decoding display data; register systems; control unit; program ROM; address decoding; instruction sets; instruction decoding; control program structure.

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Contents include: Binary, octal and decimal number systems; conversion between number systems; AND, OR, NOR and NAND gates and inverters; Boolean algebra and truth tables; De Morgans Laws; design of logic circuits using NOR gates; R-S and J-K flip flops; binary counters, shift registers and half adders.

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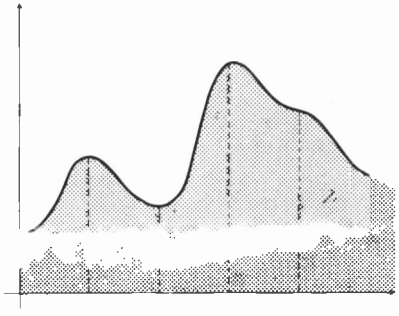
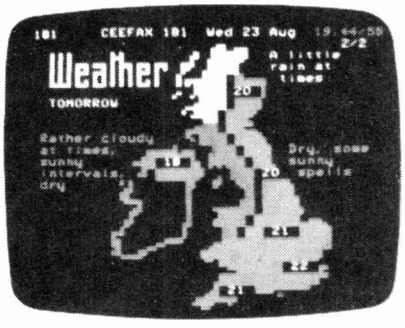


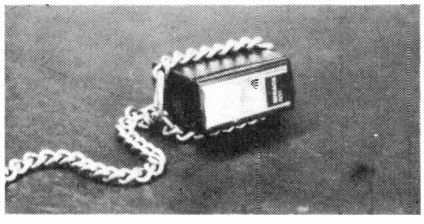
A fully-fledged graphic equaliser with four bands, allowing you to adjust the response of your Hi-Fi to suit the room it's in! Alternatively, this unit can be used as a really sophisticated tone control. This project was designed by a professional audio consultant especially for HE. We think it'll be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

Viewdata



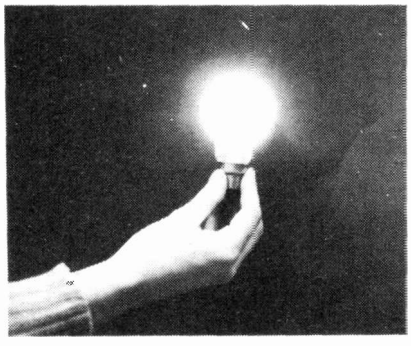
One of the most exciting developments in modern TV technology is the advent of data transmission and display. Viewdata is Britain's answer to advances which could mean shopping from the home, a computer terminal in every room or even the abolition of commuting!

Slave Flash



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

Touch Switch

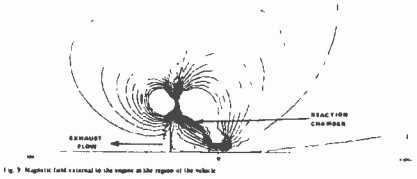


A switch with no moving parts! Just touch it and turn on the lights, motors or whatever turns you on. By the way, the above photo is not an illustration of the switch in action, but one of our staff having a bright idea.

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.

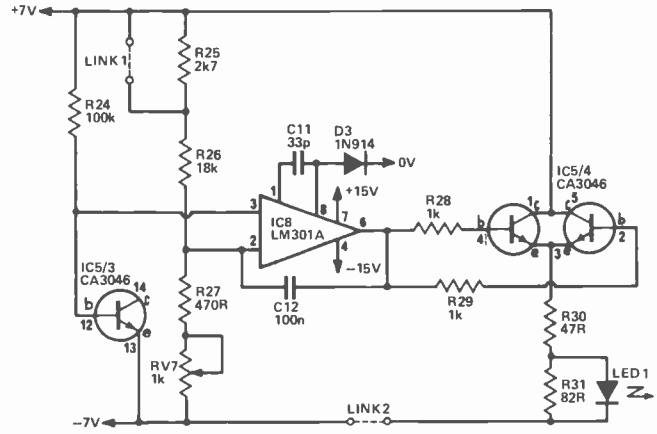
January issue will be on sale on December 8th

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.



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

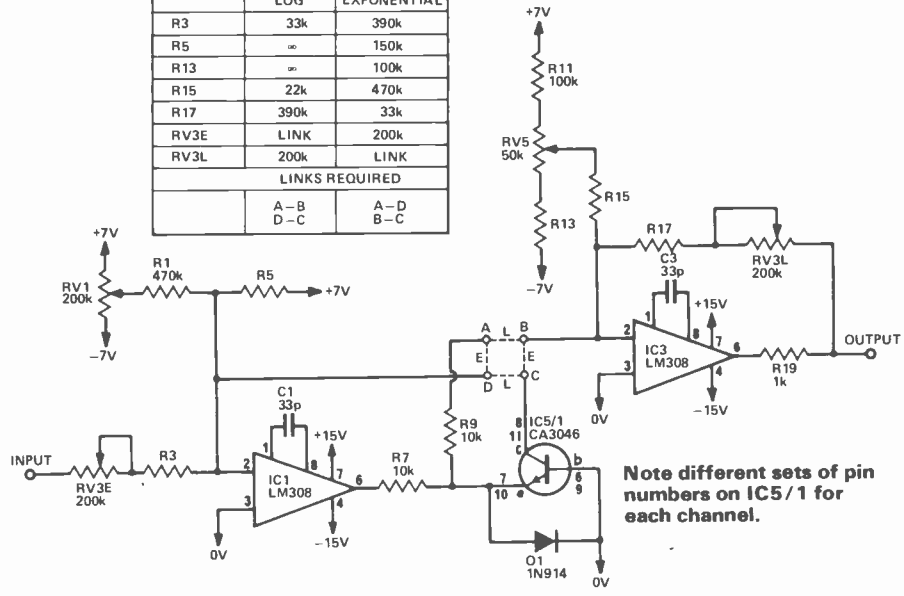
Trouble

This is where the trouble usually starts. An exponential converter is normally used which relies for its operation on the relationship between current and voltage in a silicon diode or transistor. However, unless temperature stabilisation is used the oscillator will not stay in tune for very long. With this unit the transistor used is heated to around 55° C and stabilised at this temperature, eliminating the problem of thermal drift.

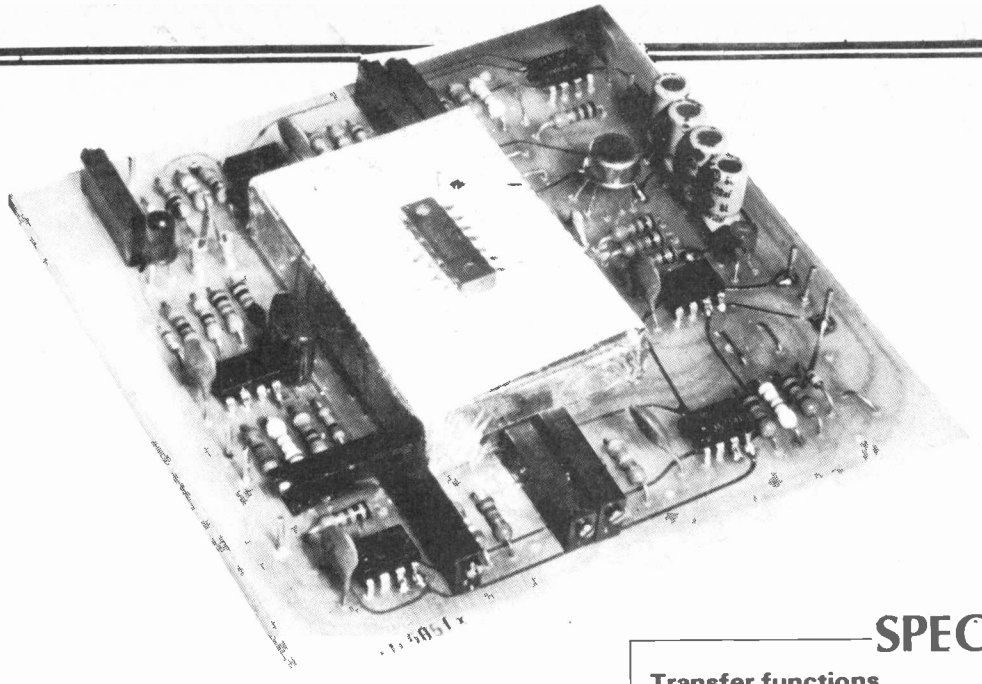
In the instrumentation field a lot of functions are displayed in dBs which are a logarithmic measurement. As this unit can be connected in either exp or log modes it is useful for this purpose also.

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

VALUES OF UNMARKED COMPONENTS		
	LOG	EXPONENTIAL
R3	33k	390k
R5	∞	150k
R13	∞	100k
R15	22k	470k
R17	390k	33k
RV3E	LINK	200k
RV3L	200k	LINK
LINKS REQUIRED		
	A–B 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.

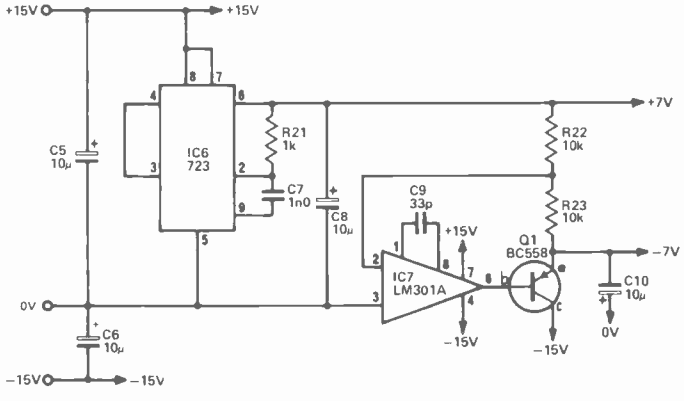


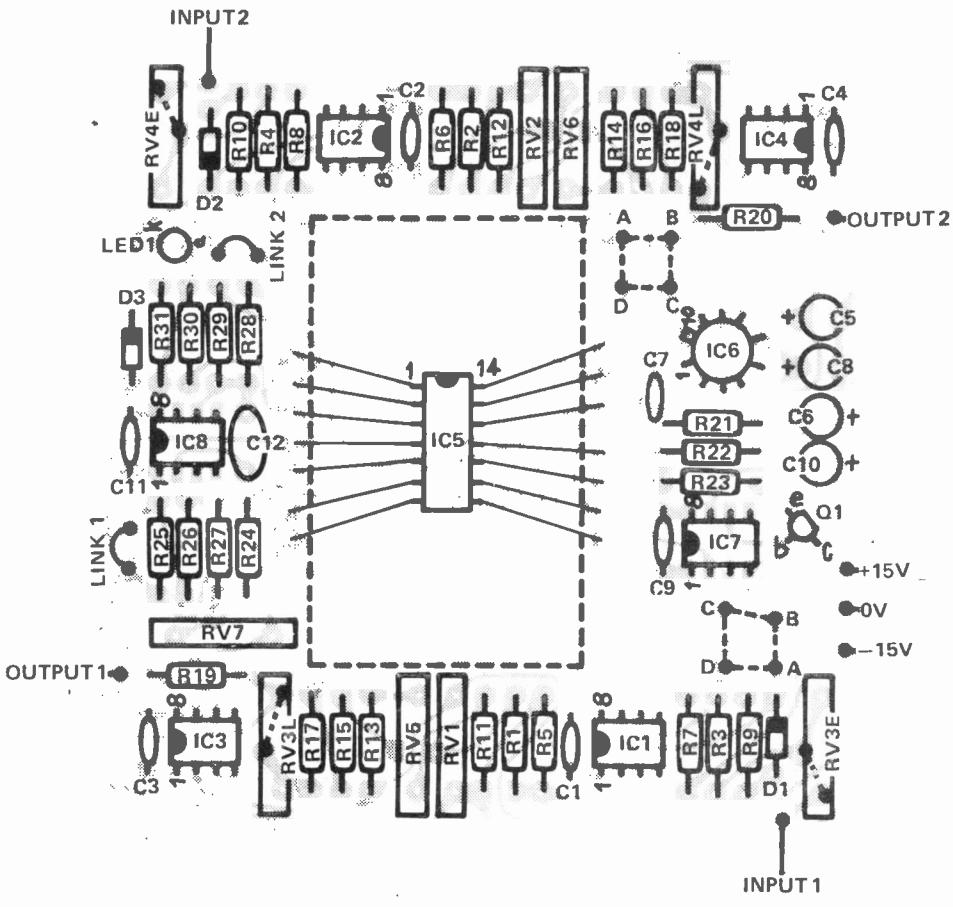
Fig. 1b. The power supply section which supplies the stable ± 7 V needed for the bias and adjustment controls.

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

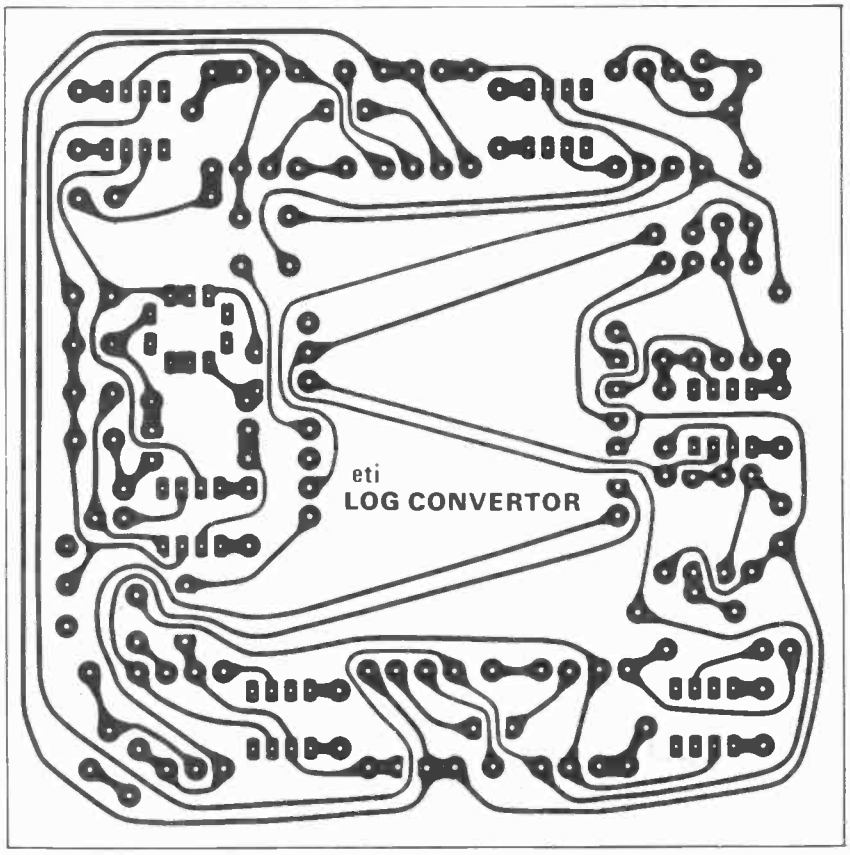
1. Set 0 V on the input.
2. Monitor the voltage on the junction. of R7 and R9.
3. Adjust RV1 to give a negative voltage on this point. Now adjust RV1 slowly until the voltage just switches positive.
4. Set 0.15625 V in the input.
5. Adjust RV5 to give 0 V output.
6. Set 5.00 V on the input.
7. Adjust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

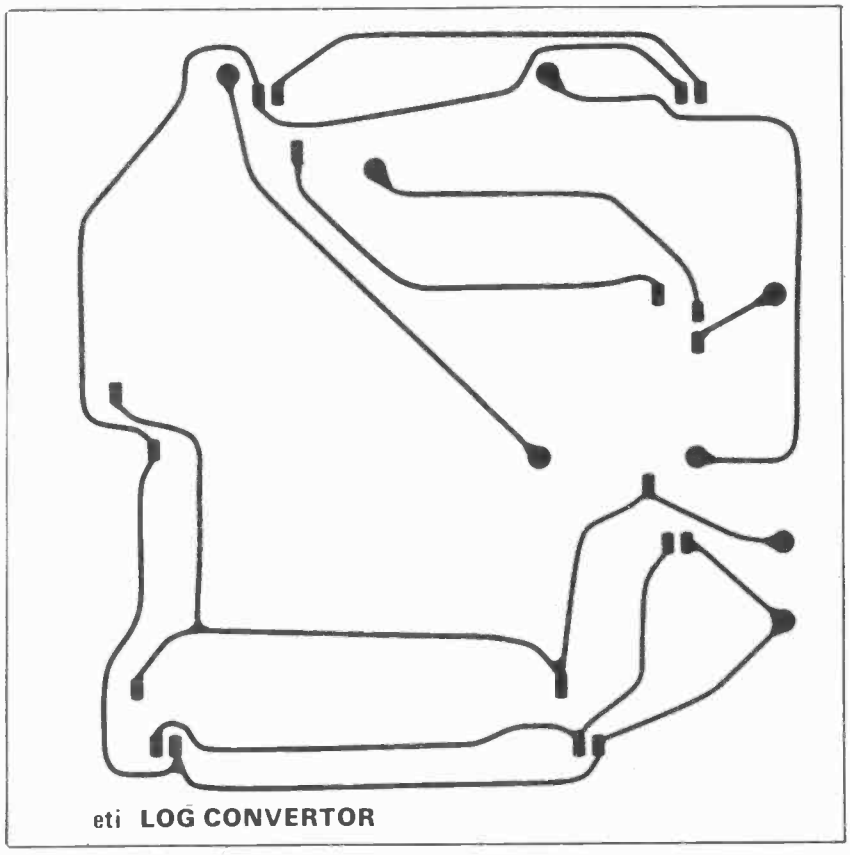
Continue until all three points are correct.

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.

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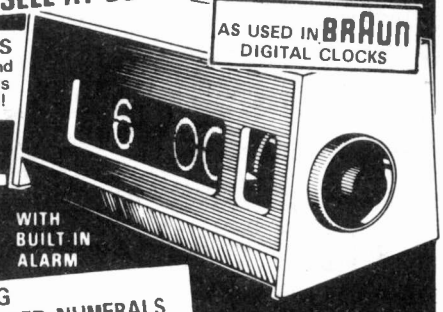

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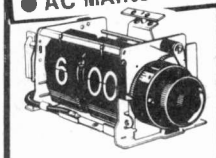

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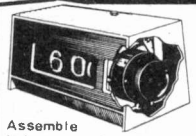

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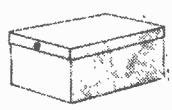

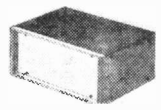

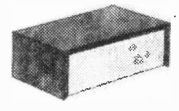

Aluminium box with lid and screws.

L W H	
3 x 2 x 1	44p
4 x 3 x 1½	52p
4 x 3 x 2	60p
6 x 4 x 2	67p
6 x 4 x 3	78p
8 x 6 x 2	105p
8 x 6 x 3	118p

Professional black P.V.C. coated case with satin anodised front panel and trim.

W D H	
9 x 6 x 3	443p
9 x 6 x 4½	479p
9 x 6 x 6	512p
12 x 8 x 3	544p
12 x 8 x 4½	618p
12 x 8 x 6	660p

Black P.V.C. top with U-shaped aluminium chassis.

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6 x 4 x 3½	145p
8 x 5½ x 2½	165p
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OC36	60p	BD1B3	80p	BF394	30p
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BC148	8p	BF137	24p	LM741C	17p
BC149C	9p	BF194	10p	TBA120A	75p
BC154	9p	BF195	10p	SN76013N	120p
BC171B	9p	BF198	21p	SN76033N	120p
BC172B	9p	BF200	21p	SN76110N	75p
BC183A	10p	BF255	23p	SN76131N	150p
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22/25v	7p	470/16v	15p	220/16v	11p
33/35v	8p	470/40v	15p	220/40v	12p
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100/63v	10p	10/25v	6p	330//50v	15p
		10/50v	7p	470/25v	15p
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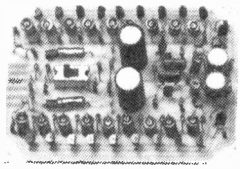

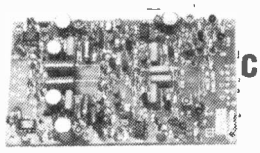

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The best pre-amplifier in the U K The superiority of the CPR 1 is probably in the disc stage The overload margin is a superb 40dB, this together with the high slewing rate ensures clean top, even with high output cartridges tracking heavily modulated records Common-mode distortion is eliminated by an unusual design R I A A is accurate to 1dB; signal to noise ratio is 70dB relative to 3 5mV; distortion < 005% at 30dB overload 20kHz. Following this stage is the flat gain/balance stage to bring tape, tuner, etc , up to power amp signal levels. Signal to noise ratio 86dB; slew-rate 3V/uS, T.H.D 20Hz — 20kHz< 008% at any level F.E T. muting. No controls are fitted There is no provision for tone controls. CPR 1 size is 138 x 80 x 20mm Supply to be ± 15 volts.

MC 1 PRE-PRE-AMPLIFIER

Suitable for nearly all moving-coil cartridges. Sensitivity 70/170uV switchable on the p.c b. This module brings signals from the now popular low output moving-coil cartridges up to 3 5mV (typical signal required by most pre-amp disc inputs) Can be powered from a 9V battery or from our REG 1 regulator board.

REG 1 — POWER SUPPLY

The regulator module, REG 1 provides 15-0-15v to power the CPR 1 and MC 1 It can be used with any of our power amp supplies or our small transformer TR 6. The power amp kit will accommodate it

POWER AMPLIFIERS

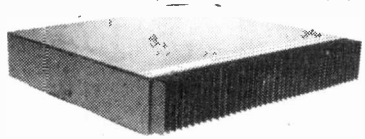
It would be pointless to list in so small a space the number of recording studios, educational and government establishments, etc , who have been using CRIMSON amps satisfactorily for quite some time We have a reputation for the highest quality at the lowest prices The power amp is available in five types, they all have the same specification T H D typically .01% any power 1kHz 8 ohms, T.I.D insignificant; slew rate limit 25V/uS; signal to noise ratio 110dB, frequency response 10Hz-35kHz, —3dB; stability unconditional; protection drives any load safely, sensitivity 775mV (250mV or 100mV on request), size 120 x 80 x 25mm.

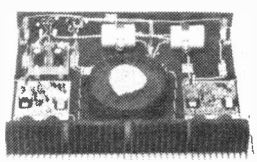
POWER SUPPLIES

We produce suitable power supplies which use our superb TOROIDAL transformers only 50mm high with a 120-240 primary and single bolt fixing (includes capacitors/bridge rectifier)

POWER AMPLIFIER KIT

The kit includes all metalwork, heatsinks and hardware to house any two of our power amp modules plus a power supply. It is contemporarily styled and its quality is consistent with that of our other products Comprehensive instructions and full back-up service enables a novice to build it with confidence in a few hours





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MC1	£18.50	MC1S	£29.49

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microfile

This month dynamic Gary (mines a pint) Evans goes random, ROMs the seas as a pirate and plays strange games with a T.V., but still finds time to visit North London.

BEING CAUGHT PIRATING software could lead to all sorts of unpleasantness—boys in blue or more likely the boys in black (the legal eagles) looking for a large fee in some test case. At any rate copying, or rather being caught copying, software that someone, somewhere is willing to protect is something to avoid. It's for this reason that the guys at Transam — they who supply kits for the Triton — suffered a few nervous twitches when they heard that someone called Dobbs on the phone and he wanted to have a few words with them.

Now the BASIC that was used in the Triton has been around for some time. When development of the computer started we realised we could not undertake to write an 8080 interpreter from scratch and we looked around for something that was "in the public domain". The listing of an interpreter that appeared in Dr. Dobbs journal seemed to us to be just the thing we wanted — had we made a dreadful mistake.

Well gentle reader (I'm an Asimov fan) as it turned out we need not have worried at all. On picking up the phone, instead of some irate, distant American voice a softspoken northerner (north of England that is) 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 Mol has to charge its customers more than is reasonable! Mol is taking action to contest the high prices. (When the choice of books is wider there will be no need to buy from such suppliers)."

A 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 Mol again — "It means extra hassle and expense to bring books to Britain" — but not as much expense and hassle as some would have us believe.

I wish Mol luck in their campaign and if you would like their lists send an SAE to

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By the way members of the North London Computer Club get 10% off the prices in the list — yet another reason to pay a visit to the club. ▶

NEWS: Microfile

The trend in America at the moment, or at least one of the trends, is for the home computer and the TV games to meet in a sort of common ground. One example of such a product is the Bally Arcade ''box''. The machine features a calculator style keyboard with slot for a Bally cartridge as well as sockets into which a number of accessories can be plugged, these include the two hand controllers supplied with the basic machine.

The machine features a number of built in games including the excellent gunfight which many of you may have seen in the arcades over here. This game produces good high resolution graphics in colour as well as a repertoire of musical sounds.

By plugging a ROM cartridge into the 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. ETI

KEY:

1: The bit of chocolate you thought you'd leave for later.

2: Coffee stains (instant).

3: A useful-sized bit of stiff paper to stop the window from rattling.

4: Rough calculations for your new combined egg timer/laser cannon project.

5: ETI makes a fair soldering iron stand.

6: The dog insisted on carrying your copy to you along with your slippers.

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AC153	58p	BCY59	24p	TIP30	40p	7403	12p	74105	40p	4000	15p	4585	105p
AC176	18p	BCY70	14p	TIP31	50p	7404	12p	74107	25p	4001	15p		
AC187	23p	BCY71	14p	TIP32	55p	7405	13p	74109	30p	4002	15p		
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AD162	38p	BD124	97p	TIP36A	389p	7409	14p	74120	125p	4009	35p	7812	60p
AF114	30p	BD131	35p	TIP41A	69p	7410	12p	74121	25p	4010	35p	7815	60p
AF118	30p	BD132	35p	TIP42A	69p	7411	19p	74122	33p	4011	15p	7818	60p
AF125	27p	BD135	38p	TIP2955	126p	7412	17p	74123	40p	4012	15p	7824	60p
AF126	27p	BD136	37p	TIP3055	64p	7413	25p	74125	35p	4013	35p	7905	79p
AF127	27p	BD137	38p	ZTX108	14p	7414	48p	74126	35p	4014	60p	7912	79p
AF139	36p	BD138	38p	ZTX109	14p	7416	24p	74132	50p	4015	60p	7915	79p
AF186	54p	BD139	35p	ZTX300	16p	7417	24p	74136	79p	4016	35p	7918	79p
AF239	40p	BD140	35p	ZTX500	16p	7420	12p	74141	56p	4017	55p	7924	79p
ASY53	81p	BF115	25p	2N706	13p	7421	22p	74142	200p	4018	64p		
ASY54	81p	BF167	29p	2N1131	23p	7422	18p	74145	58p	4019	40p		
ASY55	69p	BF173	27p	2N1132	23p	7427	24p	74147	110p	4020	60p	THYRISTORS	
BC107	8p	BF178	34p	2N1302	38p	7428	28p	74148	90p	4021	60p	1A/50V	28p
BC108	8p	BF179	37p	2N1304	54p	7430	12p	74150	70p	4022	55p	1A/100V	30p
BC109	8p	BF180	37p	2N1305	25p	7432	23p	74151	50p	4023	15p	1A/200V	38p
BC113	17p	BF181	37p	2N1306	39p	7433	24p	74153	50p	4024	45p	1A/400V	40p
BC117	20p	BF182	37p	2N1308	40p	7437	22p	74154	85p	4025	15p	3A/100V	36p
BC119	29p	BF183	37p	2N1613	22p	7438	22p	74155	52p	4027	35p	3A/200V	38p
BC140	34p	BF184	28p	2N1711	21p	7440	13p	74156	51p	4028	52p	3A/400V	51p
BC142	27p	BF185	30p	2N1893	44p	7441	51p	74157	51p	4029	60p		
BC143	27p	BF194	13p	2N2217	27p	7442	42p	74160	60p	4030	35p		
BC147	8p	BF196	13p	2N2219	21p	7443	74p	74161	65p	4035	60p	LINEARS	
BC149	8p	BF197	16p	2N2369	16p	7444	74p	74162	65p	4041	57p		
BC157	9p	BF198	16p	2N2483	26p	7445	64p	74163	65p	4042	54p	710CN	40p
BC158	9p	BF200	36p	2N2484	22p	7446	55p	74164	70p	4043	54p	741-8	22p
BC159	9p	BF224	16p	2N2905	22p	7447	55p	74165	70p	4044	50p	747C-14	50p
BC168	8p	BF257	37p	2N2906	22p	7448	57p	74166	80p	4047	95p	748C-8	30p
BC170	9p	BF258	40p	2N2907	22p	7450	14p	74167	180p	4048	63p	CA3011	80p
BC171	9p	BF259	44p	2N2926	10p	7451	14p	74173	94p	4049	28p	CA3018	80p
BC172	9p	BFR39	30p	2N3053	18p	7452	13p	74174	70p	4050	28p	CA3028BA	85p
BC173	9p	BFR40	30p	2N3054	50p	7453	14p	74175	65p	4066	40p	CA3035	140p
BC182	10p	BFR79	30p	2N3055	50p	7454	14p	74176	60p	4068	20p	CA3036	120p
BC183	10p	BFR80	30p	2N3702	8p	7460	14p	74177	60p	4069	16p	CA3046	75p
BC184	10p	BFX29	25p	2N3703	8p	7470	24p	74178	80p	4070	16p	CA3054	110p
BC186	23p	BFX30	38p	2N3704	8p	7472	24p	74180	80p	4071	16p	CA3080	70p
BC187	26p	BFX85	29p	2N3706	9p	7473	25p	74181	145p	4072	16p	CA3140E	70p
BC207	10p	BFX86	31p	2N3707	9p	7474	25p	74182	60p	4073	16p	LM301AN	28p
BC212	10p	BFX87	20p	2N3710	8p	7475	32p	74184	110p	4077	25p	LM308N	64p
BC213	10p	BFY50	15p	2N3711	8p	7476	28p	74190	72p	4078	16p	LM380N	76p
BC214	10p	BFY51	15p	2N3772	177p	7480	46p	74191	72p	4081	16p	LM381N	120p
BC237	14p	BFY53	28p	2N3773	290p	7485	69p	74192	65p	4082	16p	NE555	25p
BC238	14p	BSX19	25p	2N3866	54p	7486	24p	74193	64p	4086	59p	NE556	60p
BC301	30p	BSX20	21p	2N3904	8p	7490	32p	74194	60p	4501	19p	TBA641	240p
BC303	30p	BU205	140p	2N4061	12p	7491	45p	74195	55p	4507	40p	TBA800	70p
												TBA810	100p

DIODES	
BY127	16p
OA47	10p
OA91	15p
OA200	6p
OA202	9p
IN4148	4p
IN916	5p
IN4001	4p
IN4002	4p
IN4003	5p
IN4004	6p
IN4005	7p
IN4006	8p
IN4007	9p
IN5400	13p
IN5401	14p
IN5402	15p
IN5403	20p

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2A/100V	36p
2A/200V	38p
2A/400V	40p

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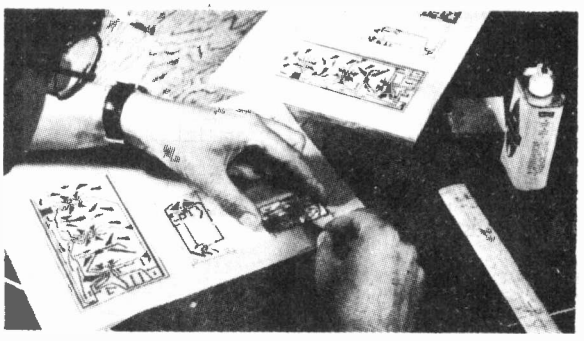

Lay down the ETIPRINT and rub over with a soft pencil until the pattern is transferred to the board. Peel off the backing sheet carefully making sure that the resist has transferred. If you've been a bit careless there's even a 'repair kit' on the sheet to correct any breaks!

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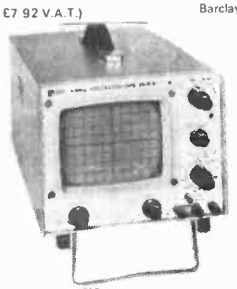

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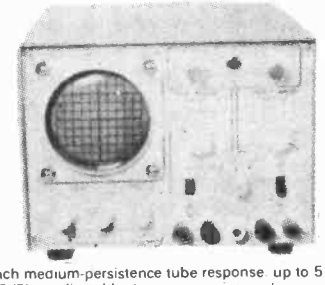

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CLICK ELIMINATOR

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

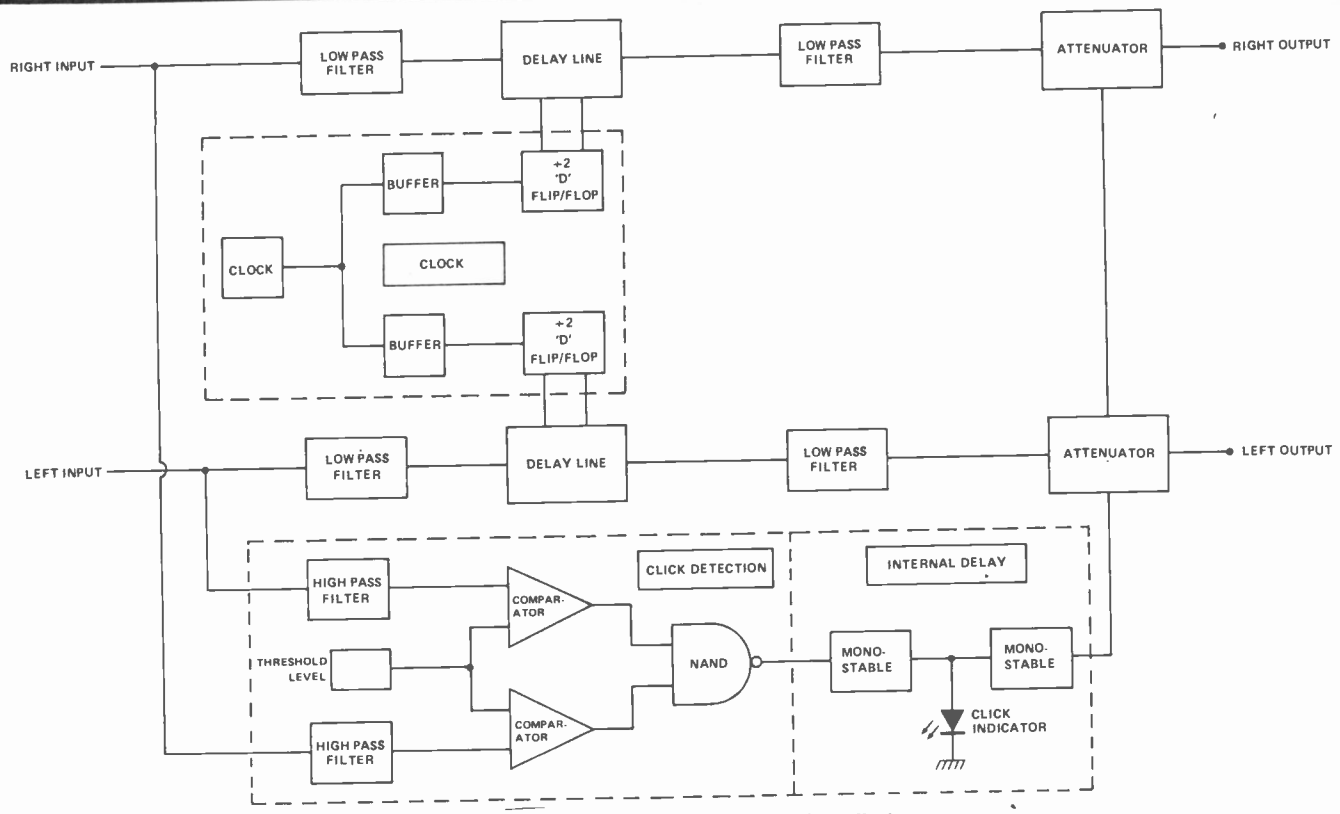


Fig. 1. Block diagram of the ETI click eliminator.

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.

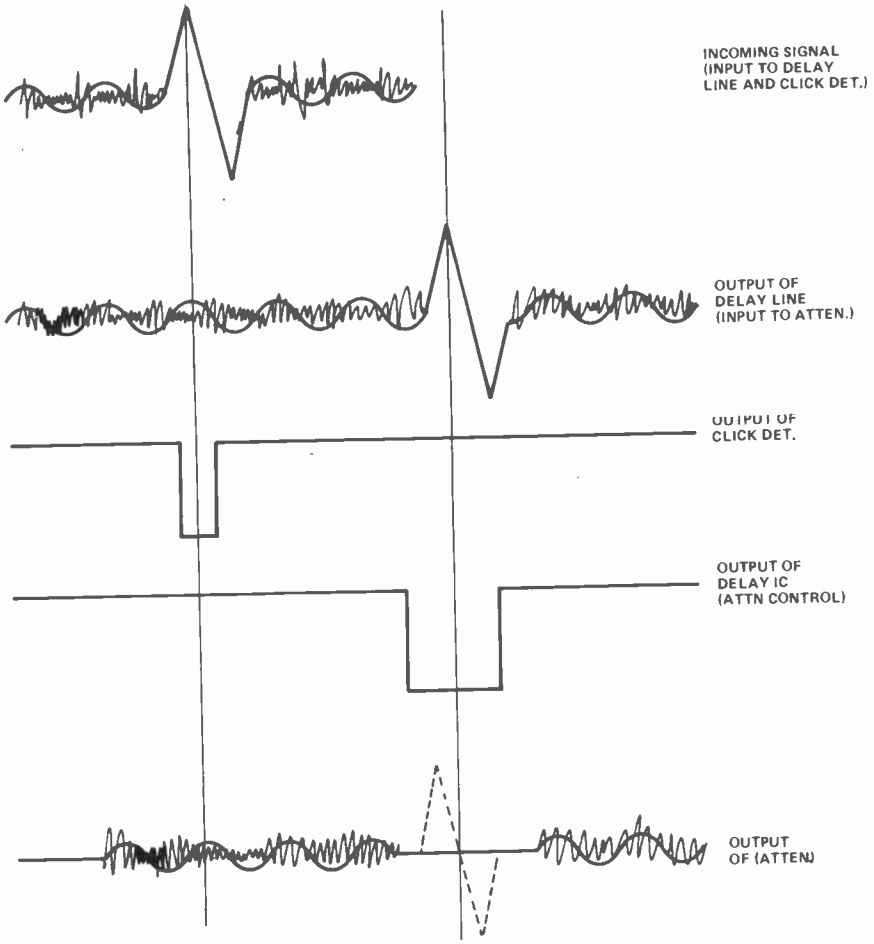
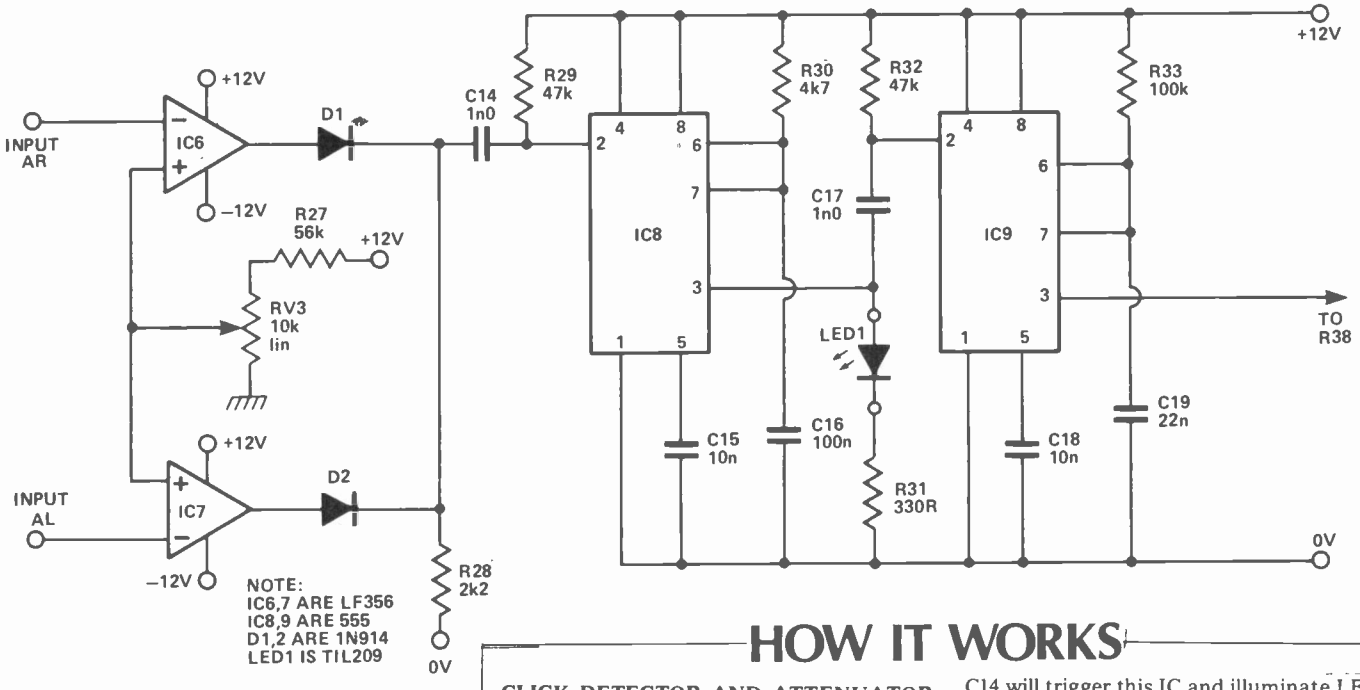
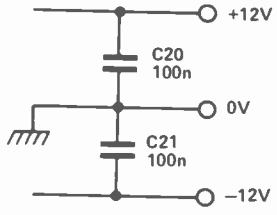


Fig. 2. Above are shown the waveforms that illustrate the action of the circuit when a click has been identified and is to be suppressed.





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.

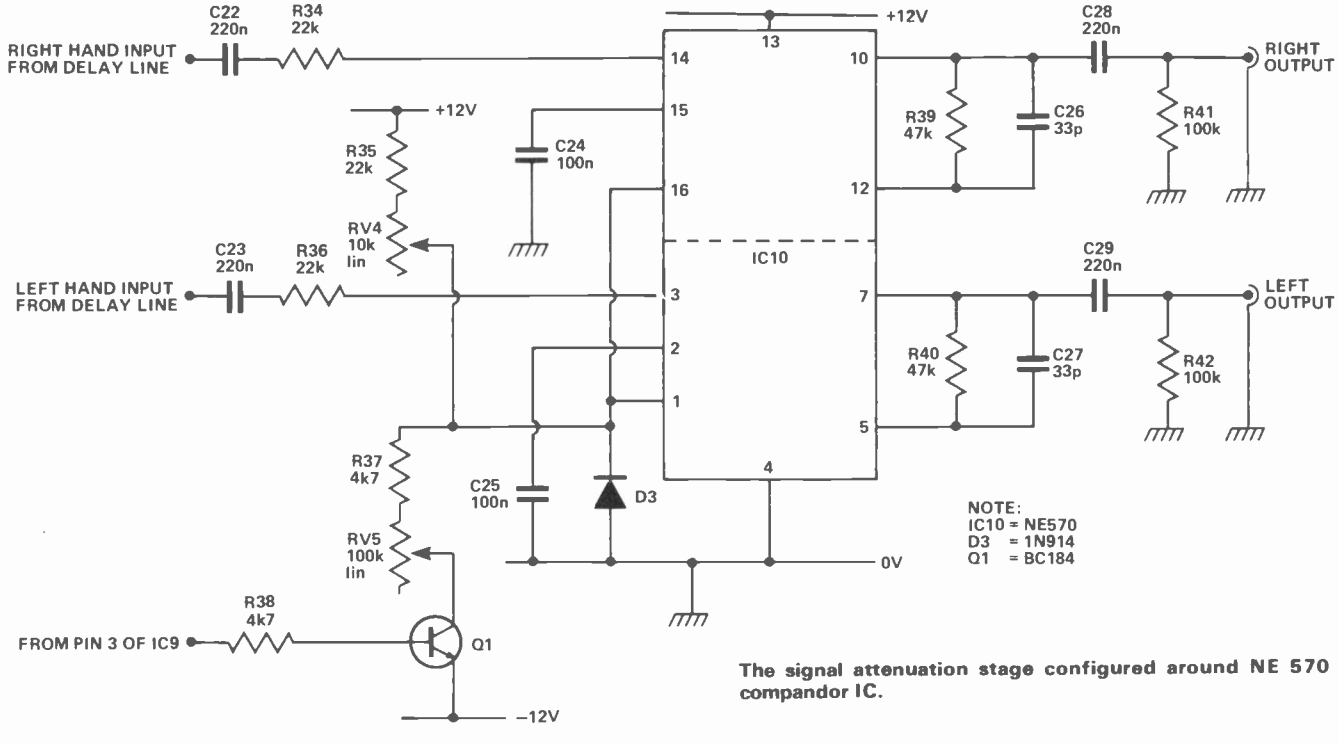
Another unique characteristic of a click is that it will appear on both channels simultaneously. We therefore pass the outputs of the comparator IC's to the NAND gate formed by D1, D2, and R28. The junction of these components and C14 will be high unless both the comparator outputs are low.

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

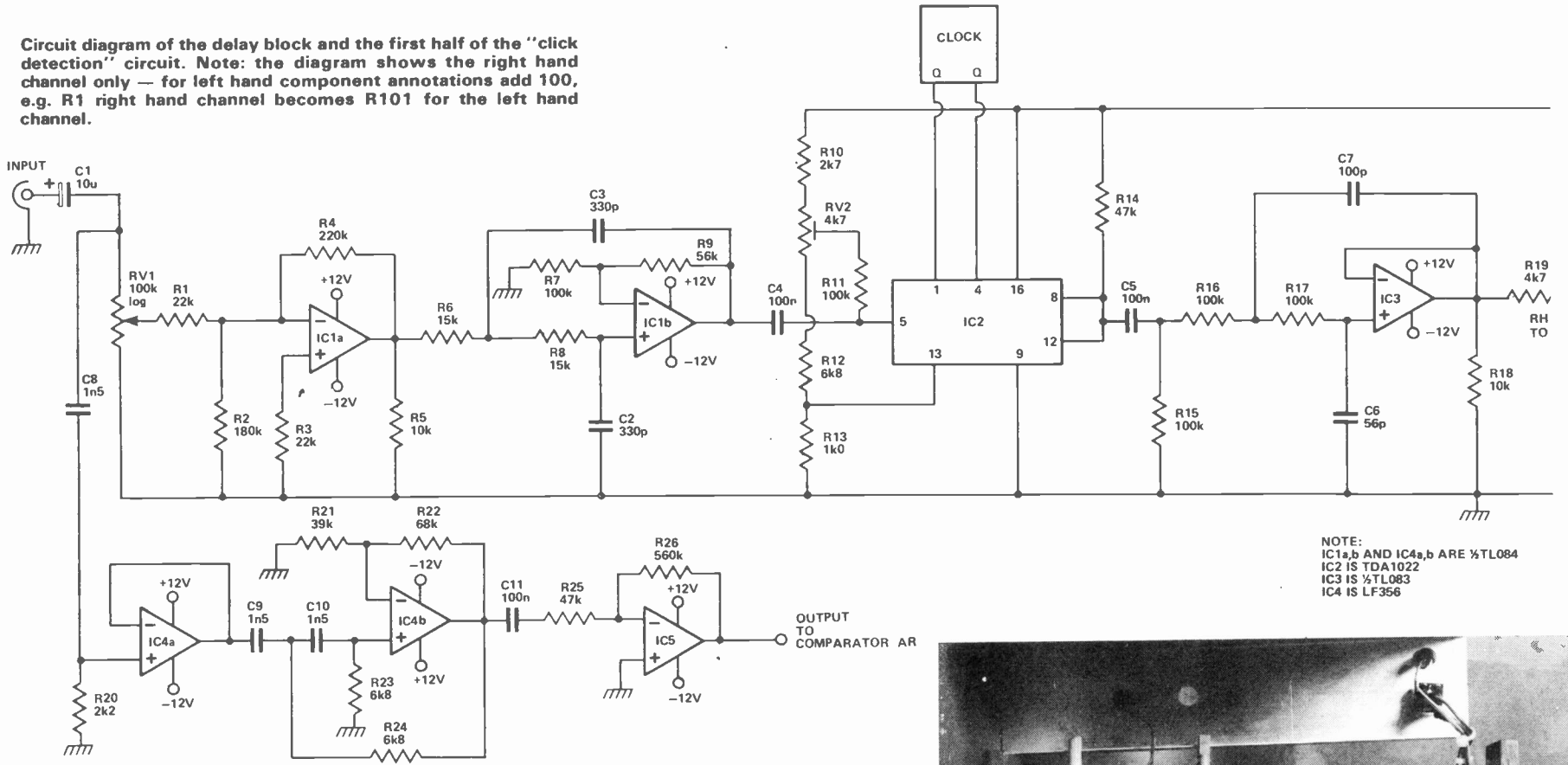
The attenuator is built around an NE570 dual compandor IC (see data sheet Oct 77 p.59). The inputs to the IC are at pins 14 and pin 3, the outputs — with suitable filters — are taken from pins 10 and 7. Gain control is achieved by robbing current from the NE570.

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.

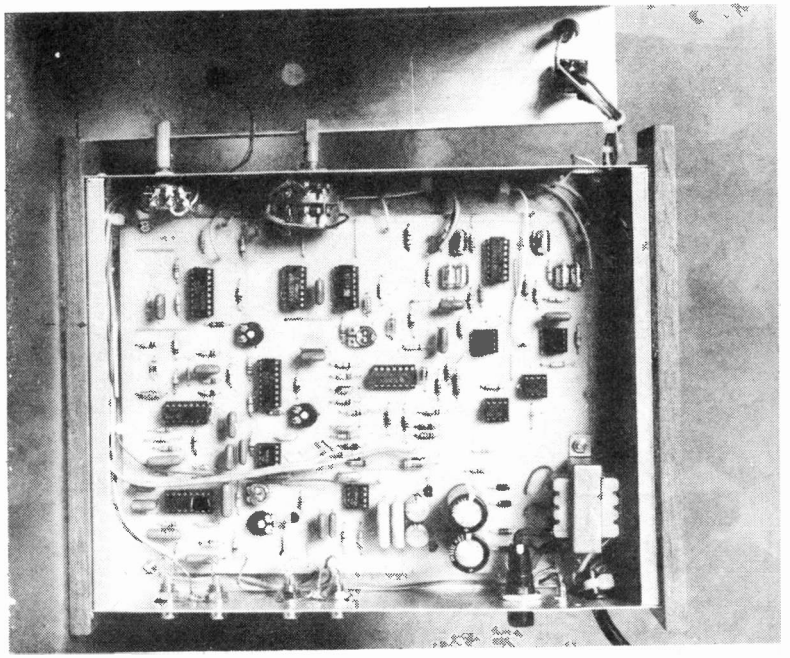


The signal attenuation stage configured around NE 570 dual compandor IC.

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.



NOTE:
IC1a,b AND IC4a,b ARE ½TL084
IC2 IS TDA1022
IC3 IS ½TL083
IC4 IS LF356



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.

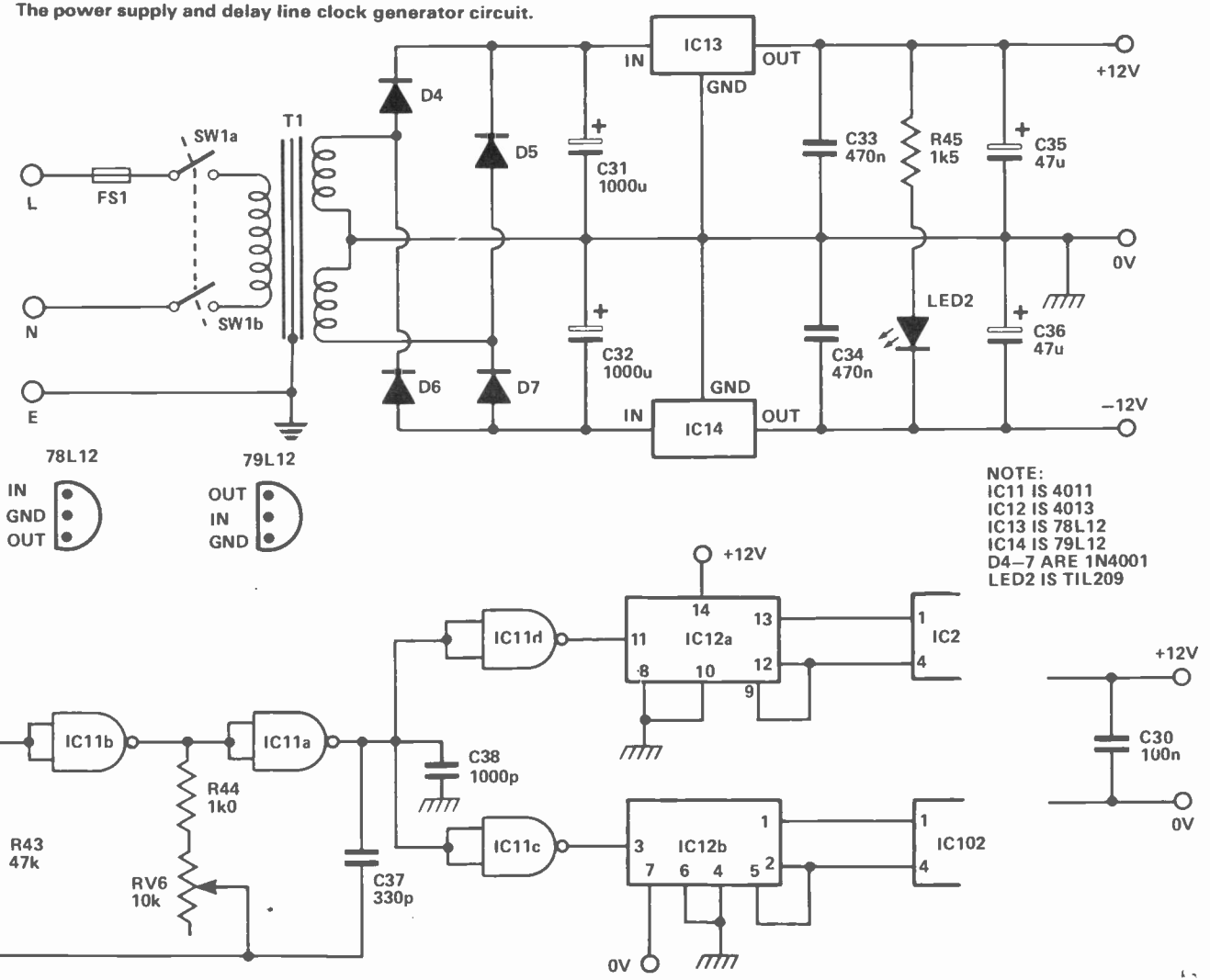
The output from the delay line is taken, via C5, to another Butterworth filter, this stage being used to remove any high frequency click detector described below.

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

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What to look for in the February issue: On sale Jan 5th

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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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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.

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7427	.24	.28
7428	.28	.32
7430	.12	.20
74530	.30	
7432	.23	.24
7433	.32	
7437	.22	.25
7438	.22	.25
7440	.13	.25
7441	.52	
7442	.43	
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7445	.55	
7446	.62	
7447	.50	.80
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7460	.13	
7470	.28	
7472	.24	
7473	.25	.34
7474	.25	.35
74S74	.50	
7475	.32	.40
7476	.28	.34
7478		.34
7480	.45	
7481	.90	
7482	.75	
7483	.60	.75
7484	.90	
7485	.70	.80
7486	.24	.38
74S86	1.50	
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7490	.34	.60
7491	.65	
7492	.36	
7493	.32	.80
7494	.80	
7495	.52	.80
7496	.50	
7497	1.90	
74100	1.90	
74104	.42	
74105	.40	
74107	.25	.38
74109	.30	.38
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74113	.30	.38
74114		.38
74116	1.25	
74124	1.75	
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74126	.35	.46
74128	.65	
74130	.50	
74132	.50	.78
74134	.36	
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74136	.55	.38
74137	.80	
74138		.60
74139		.60
74141	.56	
74142	2.00	
74143	2.50	
74144	2.50	
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74147	1.10	
74148	.90	
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74163	.65	.75
74164	.70	1.10
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74186	7.50	
74188	2.70	
74189		3.60
74190	.72	.92
74191	.72	.92
74192	.70	.90
74193	.65	.90
74194	.62	
74195	.60	1.30
74196	.65	1.00
74197	.62	1.05
74198	1.10	
74199	1.10	
74221	1.50	1.00
74247		.95
74248		.97
74249		.97
74251		.80
74253	1.00	
74257	1.05	
74258	1.15	
74266	.42	
74273	2.15	2.40
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74352		1.00
74353		1.05
74365		.52
74366		.52
74367		.46
74368		.52
74386		.58
74390	1.92	
74393	2.12	
74670		1.75

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SN76003N	1.95
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TAA5508	.35
TAA661B	1.20
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TBA641A	1.88
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TBA810S	.90
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40-pin DIL	.44

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4000	.14
4001	.14
4002	.14
4006	.90
4007	.13
4008	.64
4009	.34
4010	.40
4011	.14

4012	.14	4160	.95	BC107	.09
4013	.34	4161	.95	BC1078	.10
4014	.80	4162	.95	BC108	.09
4015	.66	4163	.95	BC1088	.10
4016	.36	4164	.95	BC109	.10
4017	.86	4174	1.10	BC1098	.11
4018	.70	4175	1.10	BC109C	.12
4019	.42	4194	1.10	BC142	.25
4020	.75	4404	.88	BC143	.25
4021	.75	4412	.25	BC147	.09
4022	.68	4428	.68	BC148	.09
4023	.15	4445	1.30	BC149	.09
4024	.50	4449	.28	BC157	.10
4025	.15	4501	.17	BC158	.11
4026	.99	4502	.80	BC159	.11
4027	.36	4503	.62	BC171	.10
4028	.58	4506	.48	BC172B	.11
4029	.66	4507	.48	BC177	.15
4030	.36	4508	2.10	BC178	.15
4031	2.00	4510	.68	BC182/L	.11
4032	.95	4511	.80	BC183/L	.11
4033	1.20	4512	.70	BC184/L	.11
4034	1.80	4513	1.60	BC208	.12
4035	1.10	4514	2.50	BC212/L	.12
4036	2.60	4515	2.50	BC213/L	.11
4037	.90	4517	3.80	BC214/L	.13
4038	.90	4518	.70	BC237B	.16
4039	2.50	4519	.42	BC261B	.15
4040	.70	4520	.70	BC327	.13
4041	.75	4521	1.60	BC328	.12
4042	.58	4522	.85	BC337	.13
4043	.60	4526	.85	BC477	.16
4044	.70	4527	1.25	BC549	.12
4045	1.20	4528	.95	BCY42	.25
4046	.99	4529	1.10	BCY70	.17
4047	.90	4530	.90	BCY71	.18
4048	.45	4531	.80	BCY72	.15
4049	.36	4532	1.05	BD115	.50
4050	.35	4534	4.50	BD121	1.25
4051	.58	4536	3.00	BD123	1.35
4052	.58	4538	1.15	BD124	1.50
4053	.65	4539	.78	BD131	.40
4054	1.00	4541	1.00	BD132	.41
4055	1.00	4543	1.28	BD133	.50
4060	.98	4549	3.25	BD135	.40
4066	.40	4553	3.60	BD139	.38
4067	2.80	4554	1.05	BD140	.40
4068	.20	4555	.82	BD189	.60
4069	.16	4556	.82	BF241	.20
4070	.16	4557	3.65	BF258	.24
4071	.16	4558	1.05	BFR39	.24
4072	.16	4559	3.25	BFR40	.24
4073	.16	4560	1.62	BFR41	.26
4075	.16	4561	.70	BFR79	.24
4076	.90	4562	4.45	BFR80	.26
4077	.43	4566	1.15	BFR81	.24
4078	.17	4568	1.98	BFX34	.75
4081	.16	4569	1.55	BFX85	.23
4082	.17	4580	5.00	BFX86	.24
4085	.65	4581	2.25	BFX87	.22
4086	.65	4582	.90	BFX88	.22
4093	1.35	4583	.80	BFY50	.20
4094	.48	4584	.38	BFY51	.20
4095	1.50	4585	1.03	BFY52	.18
4096	.90	AC128	.16	BFY64	.20
4097	3.25	AD161	pr .72	BR100	.22
4098	1.00	AD162		BRY39	.28
4099	1.30	BAX13	.04	BSX19	.18
		BAX16	.05	BSY21	.20

BSY25	.25
BY127	.15
BY206	.32
BYX10	.18
BYX36-150	.08
BZX61c3v3–c100V	.16
BZY88c2v7–c33V	.09
BZY91c15v	.50
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1N4004	.065
1N4005	.07
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1N5402	.16
1N5404	.17
1S44	.05
1SQ20	.11
1SQ20	.06
1S921	.07
1S922	.08
1S923	.09
2N438	.50
2N696	.15
2N697	.15
2N706	.20
2N708	.18
2N929	.20
2N930	.18
2N1303	.28
2N1305	.35
2N1307	.35
2N1613	.21
2N1711	.24
2N1893	.26
2N2219	.20
2N2219A	.24
2N2221	.17
2N2221A	.20
2N2222	.18
2N2222A	.20
2N2368A	.20
2N2368	.20
2N2369	.22
2N2646	.42
2N2647	.50
2N2904	.20
2N2904A	.22
2N2905	.18
2N2906	.18
2N2906A	.19
2N2907	.20
2N3053	.17
2N3054	.50
2N3055	.60
2N3440	.50
2N3644	.16
2N3702	.08
2N3703	.07
2N3704	.07
2N3705	.07
2N3706	.08
2N3707	.08

2N3709	.08
2N3710	.07
2N3771	2.20
2N3773	2.70
2N3819	.20
2N3903	.13
2N3904	.12
2N3905	.12
2N3906	.12
2N4058	.12
2N4062	.12
2N4123	.16
2N4124	.16
2N4126	.16
2N4443	.72
2N4444	.68
2N5060	.29
2N5061	.32
2N5062	.38
2N5063	.41
2N5064	.45
2N5133	.12
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0.8A 150v	.41
0.8A 200v	.45
1A 200v	.38
4A 200v	.50
4A 400v	.60
7A 100v	.50
7A 400v	.65
8A 400v	.72
8A 600v	.88
10A 100v	.75

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Green	.15	.15
Yellow	.15	.15
LED clip	.03	.04

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1A 200V	.30
1A 600V	.35
6A 50V	.70
6A 100V	.72
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6A 600V	.86
25A 50V	1.30
25A 100V	1.50
25A 200V	1.80

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0.262	4.30
0.300	4.30
1.000	4.30
1.008	4.30
1.8432	4.25
2.000	4.25
2.097	4.25
2.457	4.20
3.276	3.40
3.579	3.40
3.932	3.40
4.000	3.40
4.433	1.50
4.915	3.40
5.000	3.75
5.068	3.75
5.185	3.75
5.875	3.75
6.000	3.75
6.144	3.75
6.553	3.75
8.000	3.75
8.8867	3.79
10.000	3.75
12.000	3.75
13.516	3.75
18.000	4.15
18.432	4.15
19.660	4.30
20.000	4.30
32.000	4.05
48.000	4.05

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2.2	.045	.05	.055	.06
3.3	.045	.05	.055	.06
4.7	.045	.05	.055	.06
6.8	.05	.055	.06	.07
10	.05	.06	.07	.09
22	.06	.07	.09	.13
33	.07	.085	.10	.15
47	.08	.10	.12	.19
68	.09	.12	.16	.23
100	.10	.13	.18	.26
150	.11	.15	.20	.28
220	.12	.16	.22	.32
330	.14	.18	.26	.36
470	.16	.20	.29	.40
680	.18	.24	.35	.48
1000	.20	.29	.41	.56

.29	.41	.56		
2200	.38	.48	.65	.95
4700	.47	.60	.90	
4700uF			6.3v	.20
6800uF			6.3v	.25

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BORIS IN CHECK

There are quite a few chess machines lying around the shops these days, and this one has a reputation for being one of the best. Armed with his "Best of Spassky Volume 2" Ron Harris went to check it out.

BORIS is a multi-level chess machine with the disconcerting ability to comment on its opponent's (your) moves. The level of its analysis is set by the user who determines how long BORIS may consider its reply. Thus a tyro may set the machine to minimum time to begin with, and steadily advance the machine as he improves.

Present Arms

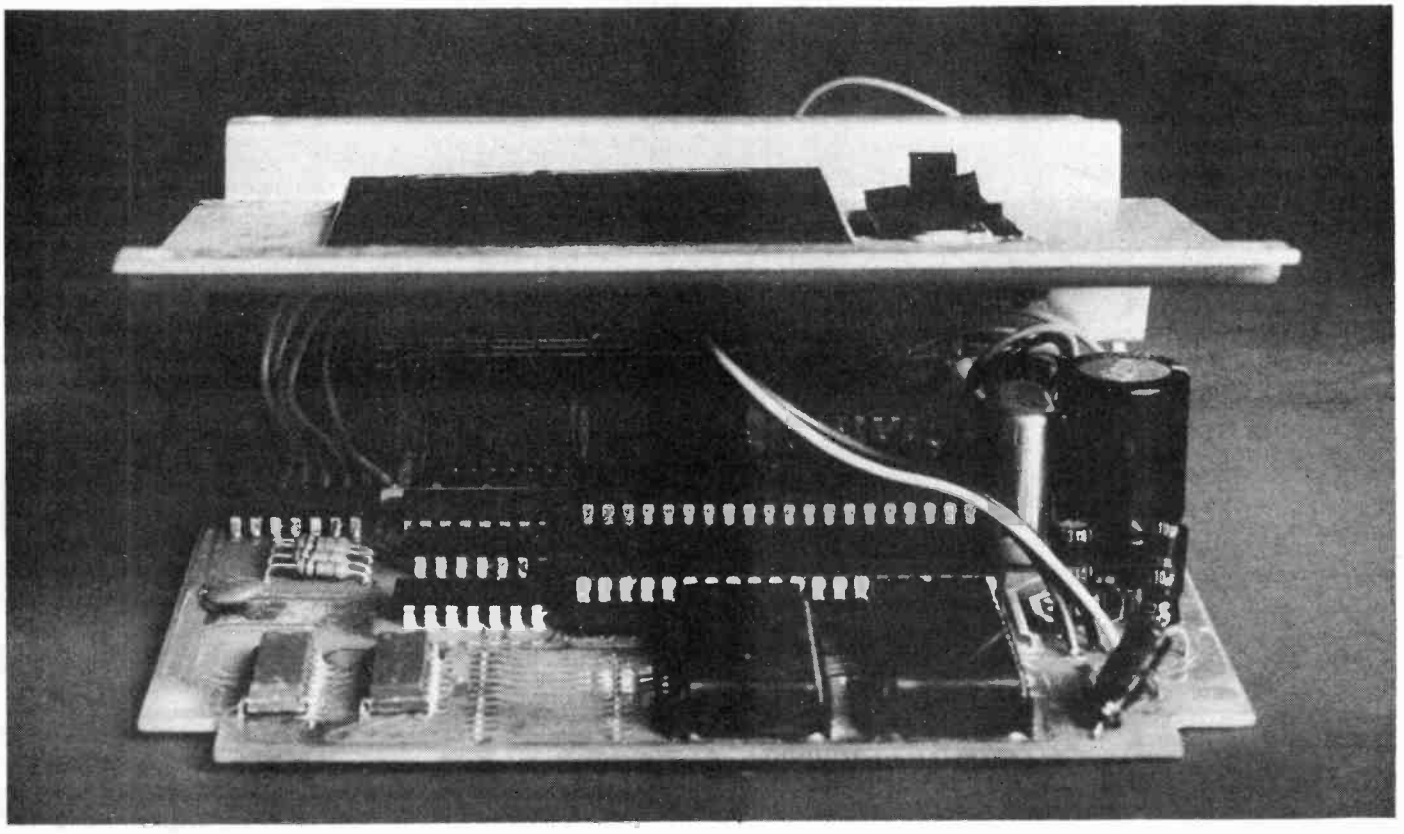
The presentation of the machine is excellent. The electronics consist of an F8 based system accessed by a 16 (multi-function) key array and interfaced to the outside world by a display consisting of eight alpha numeric devices. These are packed into a very smart wooden case which also holds the mains adaptor and chess pieces. A board is also provided, but is of a standard which suggests it is included out of duty rather than devotion. Alas, the chess pieces fall into this lamentable category also, but improvements are now being made by the importers, and the quality of replacements is much higher.

On the two units we were able to examine the mains adaptor terminates in a two pin American 'hi-fi' type of plug — which now fails BS of course. This is moulded into the adaptor body and makes life very awkward for the buyer. At first glance there is no way of getting mains into BORIS aside from wrapping wires around them. DANGEROUS. The importers *must* look into this very quickly. We are assured they are doing so — let us hope.

In the meanwhile I would advise purchasers to take a trip down to good ole Woolies and make off with one of their shaving adaptor plugs, into which BORIS's adaptor will neatly plug. 240V AC is a poor opening gambit in any game.

Getting Rooked . . . and Pawned And . . .

Using this machine is both simple and interesting. The keyboard sets up your move on the display — which is also showing elapsed time — and the ENTRY key presents it to BORIS for reply. ►



BORIS exposed to the world!

Once he's thinking about, the display flashes at 1 Hz, the timer counts down the time allotted to BORIS and the various moves he's cogitating appear on the display, settling finally at time 00 seconds. The display then counts down *your* time — but there's no penalty for not playing inside the time limits you've imposed on BORIS.

If for some reason (like cheating) you wish to alter the board at any time during a game, pressing RANK displays the contents of each row of the board using a very ingenious symbols set. The keyboard now creates or destroys pieces as required. Korchnoi could have done with *that* in his armoury. This makes correcting errors very easy.

Use of the RANK key while BORIS is having a think lets you watch the pieces moving around in his head(!?). Hypnotic.

Alpha-numeric Big Mouth

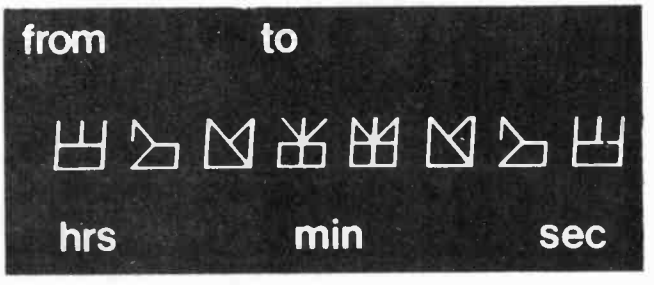
Undoubtedly the first thing to impress about BORIS has nothing to do with his chess abilities. It's his big mouth. Exactly how many comments his PROMs contains is anyone's guess — the importers Optimisation aren't saying — but we counted 47 in two evenings of chess, and I don't think we got them all!

The comments appear in the eight displays and are clocked along right to left at about 2Hz. At any position on the board the program limits BORIS to a shortlist of appropriate comments, and a 'random' choice is made amongst them — or indeed not to comment at all. Saying nothing is the most likely choice of all, which means that the sayings do not always appear and so do not become boring with repetition.

Play It Again BORIS

Once in play BORIS is a fair match for most people. On its basic level the machine plays a good beginner's game, and will find most things you leave lying around the board. Responses differ sufficiently even at this level to make 'psyching out' difficult. The biggest drawback of BORIS's chess is his passion for exchanging pieces.

Being cowards we started at this level to see what he could do. The first comment we got was 'AWFUL' to our opening move. Frightening! From here we kept increasing the time BORIS had to think about his answers. At five minutes he was winning consistently, and at two it's a long, long struggle to get him to lie down and die!



The symbols BORIS uses to identify the chess pieces. Shown here is the back rank of the white men. The black appear upside down so you can tell which men are which. Pawns appear as triangles.

Below: BORIS in play at the computer chess championship recently. He finished second to a private program.

We're only average chess players ourselves and so passed the infernal pawn-pusher onto a club standard player to get his comments.

On the longer response times, five minutes upwards, he considered BORIS a good opponent — and of course wouldn't admit how often he'd lost! Certainly everyone who had a game against him considered BORIS entertaining — the comments really do seem appropriate at times.

For example, in the middle of a game with BORIS hard pressed and the telephone ringing — I NEED LESS NOISE appears! Coincidence but fun all the same. One move away from being checkmated and he asks READY TO RESIGN? The classic must be after losing a queen to a knight fork — WHOOPS!

Conclusions

All in all then BORIS can be confidently recommended to anyone interested in the game of chess. It can play a good game, and entertain while doing so. It is very difficult indeed *not* to think of the machine containing an (evil) little elf — a grand master type elf — plotting against your every manoeuvre, and unleashing sarcastic comments where possible. A definite winner. ETI

Our thanks to Kramer and Co for their assistance in the preparation of this article — they lent us a BORIS! (They also supply to the public!)

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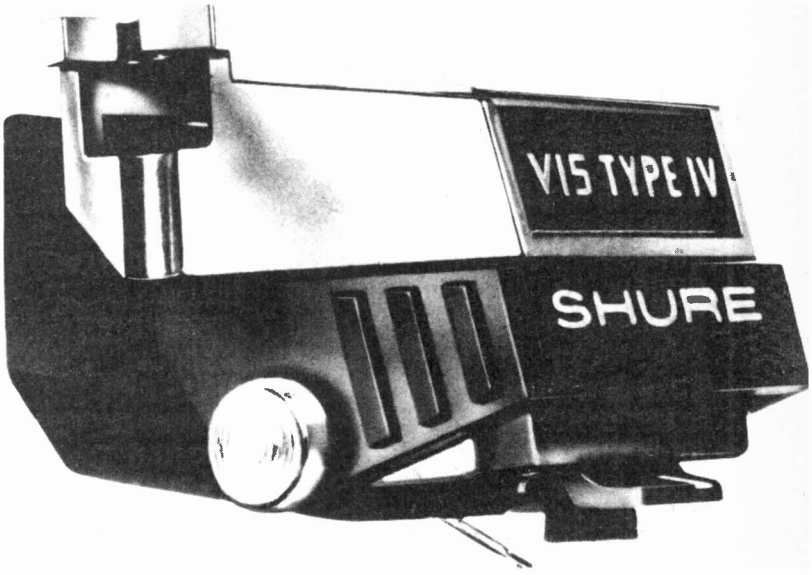
audiophile.....

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.

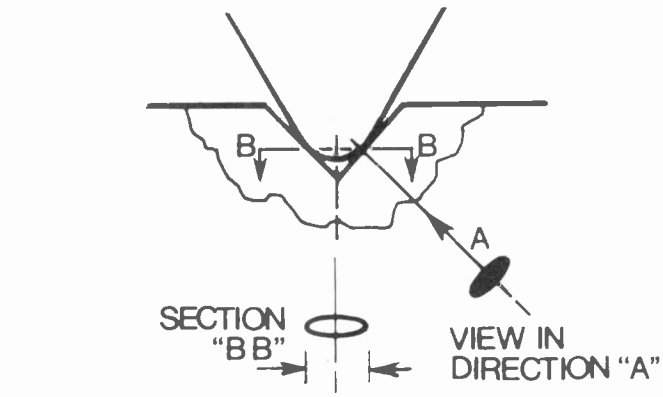
The new features to come out of of all this are a dynamic stabiliser — and it's *not* just a brush, a new cantilever assembly, a new stylus shape, and a static reduction system. In addition the effective mass of the dynamic system has been lowered significantly.

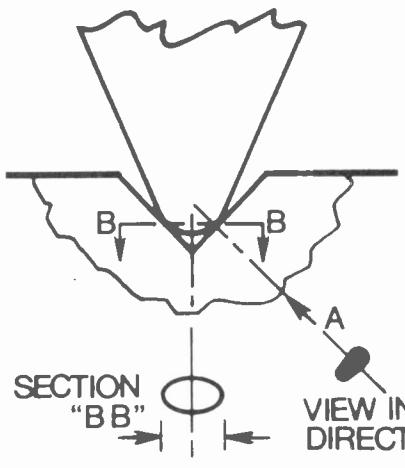
Tipped For Shape

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.

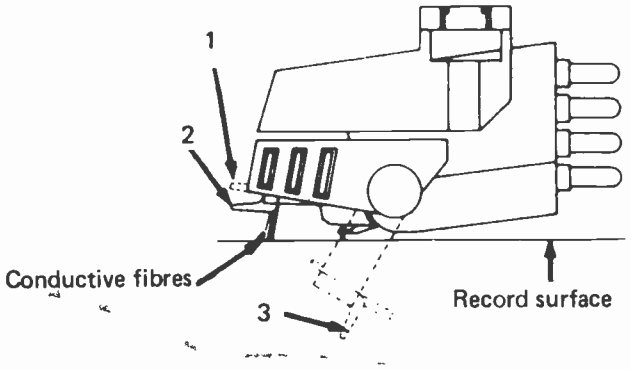
Another nasty well-known to LPs of all age groups is the warp. Warps come free with most records these days and provide such delights as variation in tracking angle, mis-tracking due to effective reduction of applied tracing force and overall disruption of the ideal conditions in which cartridges like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

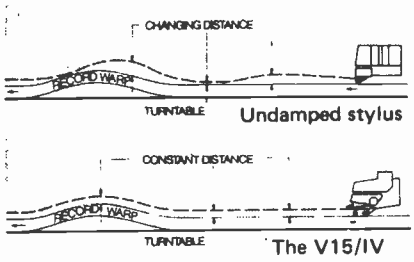
Bristling With Pride

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!

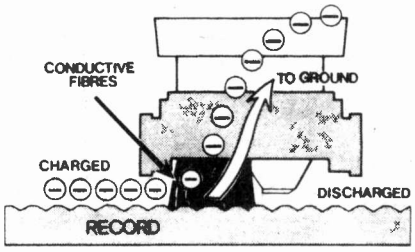
Sounds logical once someone tells you doesn't it? The brush does a good job shifting dust and muck out of the way too!



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.



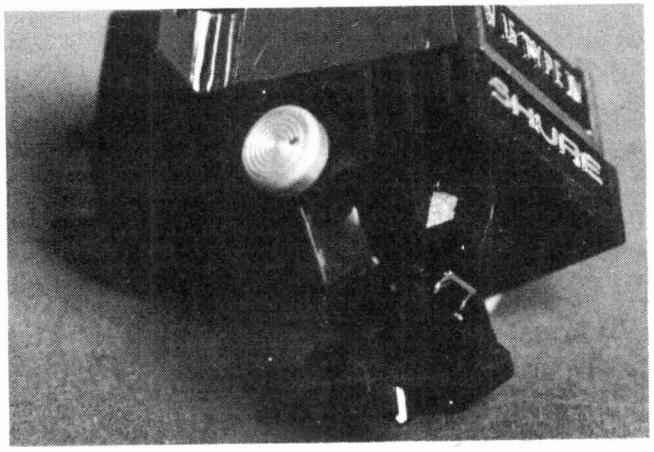
The V15 Type IV's brush with damped pivot is said to aid the tracking of warped discs by matching stylus movement more closely to the motion of the arm



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.

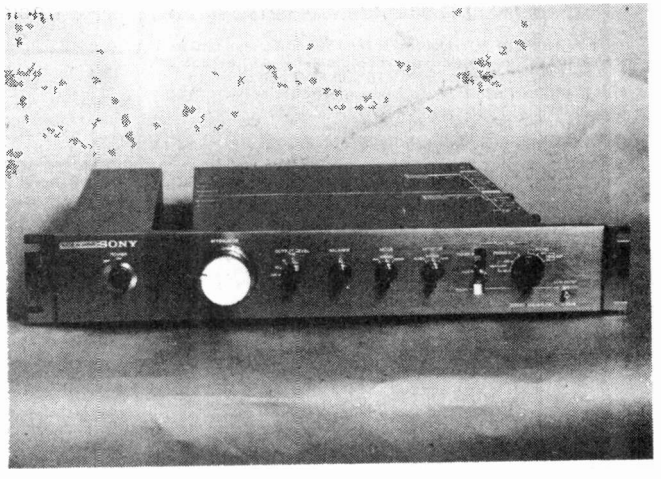
The cheapest such unit available is probably the RS mains suppressor. Your local component stockist should be able to order this for you, and fitting it is pretty simple. Its input comes from the mains, and its output feeds the hi-fi in question.

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. ET

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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.

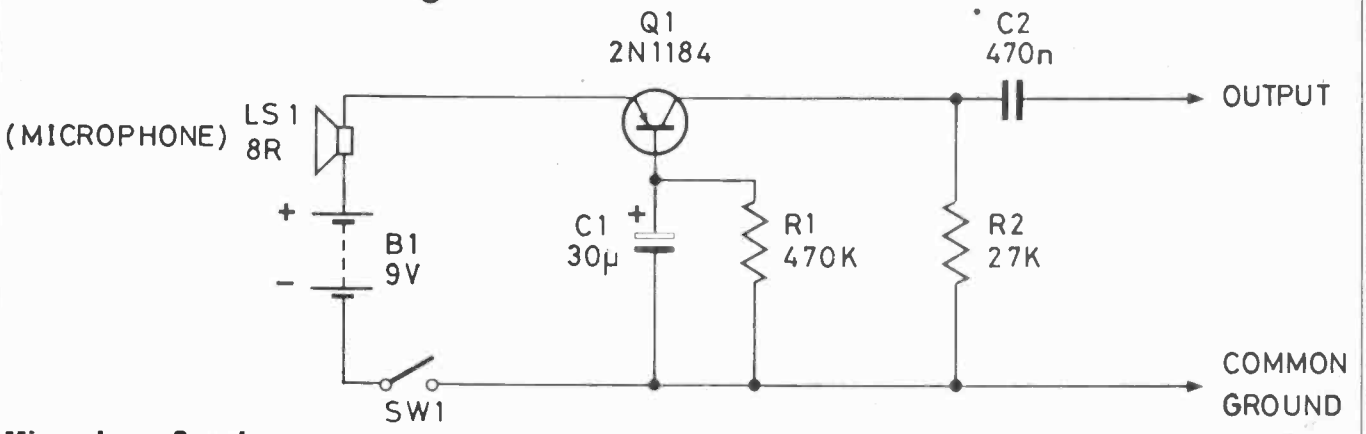
Conclusions

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

tech tips

Readers' Circuits



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

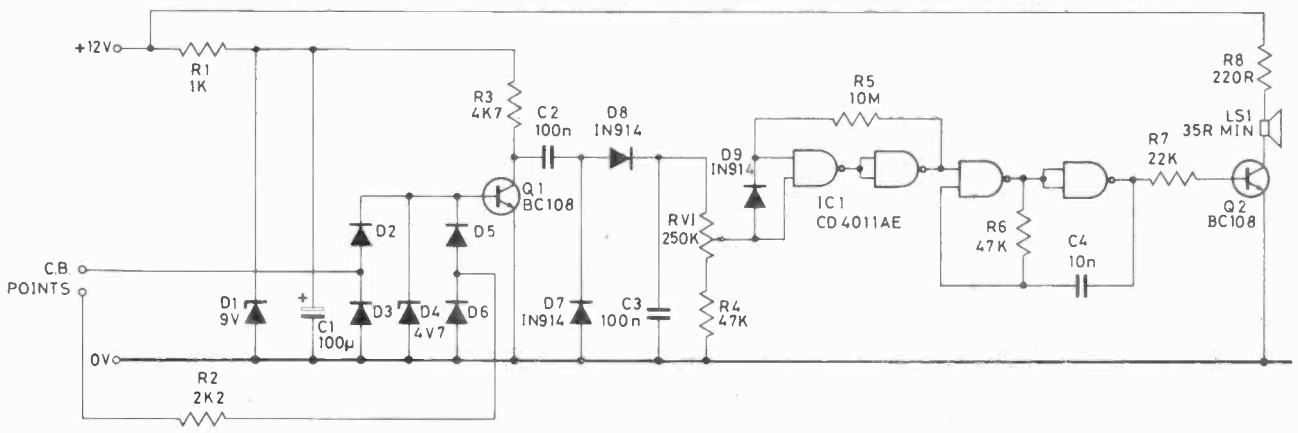
It is all too easy, during a long journey on a motorway, to allow one's speed to gradually creep beyond that point which the boys in blue take an unwelcome interest; this alarm gives an audible nudge whenever you drift over a pre-set speed.

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.



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

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 25-27 Oxford St., London W1R 1RF.

7400	10p	7460	12p	74137	90p	74195	50p	4055	130p	CA 3140	60p	LM 3909 N	65p	TBA 480 Q	200p
7401	10p	7470	25p	74138	100p	74196	50p	4056	120p	LF 356	80p	MC 1310 P	140p	TBA 520 Q	200p
7402	10p	7472	20p	74141	50p	74197	50p	4060	100p	LF 357	80p	MC 1312 P	150p	TBA 530 Q	200p
7403	10p	7473	25p	74142	180p	74198	100p	4066	35p	LM 211 H	250p	MC 1314 P	190p	TBA 540	200p
7404	12p	7474	25p	74143	270p	74199	100p	4069	12p	LM 300 TR5	170p	MC 1315 P	230p	TBA 550 Q	250p
7405	12p	7475	25p	74144	270p	74293	90p	4070	12p	LM 301 AN	30p	MK 50398	650p	TBA 560 C	250p
7406	25p	7476	25p	74145	55p	74L500	18p	4071	12p	LM 304	200p	MM 5314	380p	TBA 641 A12	250p
7407	25p	7480	40p	74147	100p	745112	80p	4072	12p	LM 307N	65p	MM 5316	480p	TBA 700	180p
7408	12p	7481	85p	74148	90p	**CMOS**		4081	12p	LM 308 TO5	100p	NE 529 K	150p	TBA 720 Q	225p
7409	12p	7482	75p	74150	65p	4000	12p	4082	12p	LM 308 DIL	100p	NE 555	25p	TBA 750 Q	200p
7410	12p	7483	75p	74151	45p	4001	12p	4093	70p	LM 309 K	100p	NE 556	90p	TBA 800	80p
7411	15p	7484	70p	74153	45p	4002	12p	4510	60p	LM 310 TO5	150p	NE 562 B	400p	TBA 810	100p
7412	15p	7485	60p	74154	70p	4006	80p	4511	70p	LM 311 TO5	150p	SAD 1024	1500p	TBA 820	100p
7413	25p	7486	25p	74155	45p	4007	14p	4516	65p	LM 317 K	325p	SL 917 B	650p	TBA 920 Q	280p
7414	45p	7489	130p	74156	45p	4009	30p	4518	65p	LM 324	70p	SN 76003 N	150p	TCA 270 Q	220p
7416	25p	7490	25p	74157	45p	4011	12p	4520	65p	LM 339	60p	SN 76013 N	110p	TCA 270 S	220p
7417	25p	7491	40p	74160	55p	4012	12p	4528	80p	LM 348 N	90p	SN 76013 ND	125p	TCA 760	300p
7420	12p	7492	35p	74161	55p	4013	30p	4583	70p	LM 380	60p	SN 76023 N	110p	TCA 4500 A	450p
7421	20p	7493	30p	74162	55p	4015	50p	**LINEAR**		LM 381 N	90p	SN 76023 ND	125p	TDA 1008	350p
7422	15p	7494	70p	74163	55p	4016	30p	AY3 8500	450p	LM 382	90p	SN 76033 N	150p	TDA 1034	450p
7423	20p	7495	45p	74164	60p	4017	50p	CA 3039	70p	LM 391	180p	SN 7627 N	160p	TDA 2002	300p
7425	20p	7496	45p	74165	60p	4018	55p	CA 3046	60p	LM 555	25p	SN 76228 N	180p	TDA 2020	300p
7426	22p	7497	120p	74166	75p	4019	40p	CA 3060	225p	LM 709 C	40p	SN 76660 N	75p	TL 084	120p
7427	22p	74100	80p	74167	160p	4020	50p	CA 3065	200p	LM 710 TO5	60p	TAA 300	100p	XR 320	250p
7428	25p	74104	40p	74170	100p	4022	50p	CA 3076	250p	LM 710 DIL	65p	TAA 350	190p	XR 2206	450p
7430	12p	74105	40p	74173	80p	4023	12p	CA 3080	75p	LM 723 TO5	40p	TAA 550	35p	XR 2207	450p
7432	20p	74107	25p	74174	60p	4024	40p	CA 3084	250p	LM 723 DIL	40p	TAA 570	220p	XR 2208	600p
7433	28p	74108	100p	74175	60p	4025	12p	CA 3085	85p	LM 733	120p	TAA 661B	140p	XR 2216	650p
7437	20p	74166	75p	74176	50p	4026	80p	CA 3086	60p	LM 741	20p	TAA 700	350p	XR 2567	250p
7438	20p	74109	25p	74177	50p	4027	30p	CA 3088	190p	LM 748	40p	TAA 790	350p	XR 4136	150p
7440	12p	74118	75p	74178	75p	4028	45p	CA 3089	160p	LM 1303 N	100p	TAD 100	150p	XR 4202	150p
7441	45p	74120	80p	74179	120p	4029	50p	CA 3090AQ	360p	LM 1458	100p	TAD 110	130p	XR 4212	150p
7442	40p	74121	25p	74180	90p	4030	30p	CA 3123 E	130p	LM 3080	75p	TBA 120 S	60p	XR 4739	150p
7443	60p	74122	35p	74181	130p	4032	80p	CA 3130	100p	LM 3900	55p	TBA 120 T	85p	ZN 414	100p
7444	60p	74123	40p	74182	50p	4033	100p								
7445	65p	74125	35p	74184	120p	4040	60p								
7446	50p	74126	35p	74185	100p	4043	60p								
7447	50p	74128	60p	74188	320p	4046	90p								
7448	50p	74130	120p	74190	70p	4047	80p								
7450	12p	74131	90p	74191	70p	4048	50p								
7451	12p	74132	45p	74192	60p	4049	25p								
7453	12p	74135	90p	74193	60p	4050	25p								
7454	12p	74136	80p	74194	55p	4054	100p								

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7410	11p	74154	60p	4017	48p
7413	22p	74157	36p	4024	40p
7414	36p	74160	45p	4046	85p
7420	11p	74164	45p	4049	27p
7430	11p	74190	45p	4510	59p
7441	45p	74192	45p	4518	58p
7442	32p	74193	45p	4528	52p
7447	40p	74196	48p		
7474	22p				
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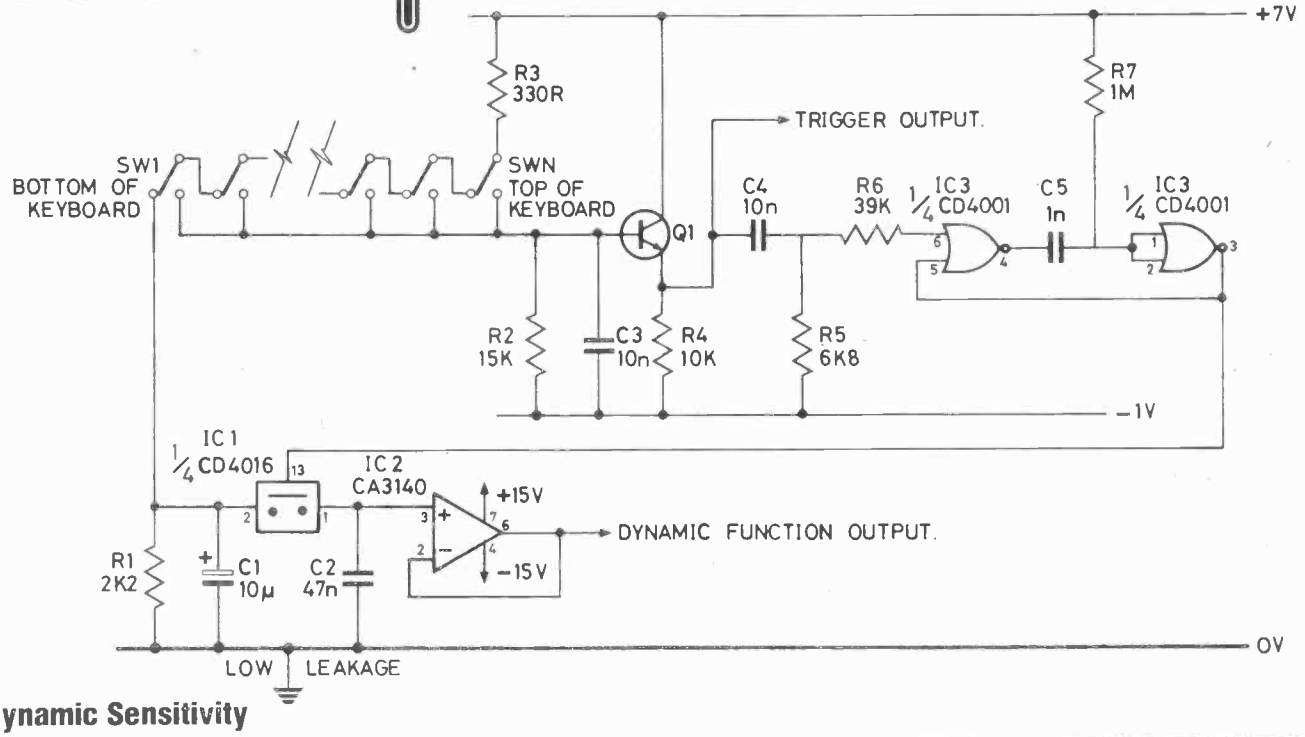


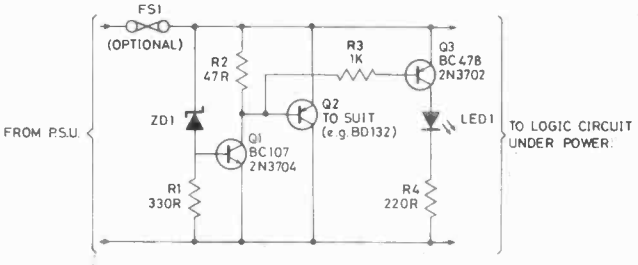
Dynamic Sensitivity

W. Stride

A dynamic function (touch sensitivity) greatly increases the flexibility of expression available to the player of a music synthesizer. This circuit achieves the dynamic function by measuring the change over time of the keyboard switches, and hence the velocity of the key depressed.

The circuit is basically composed of three parts; firstly an RC time-constant network (R_1 C_1) controlled by the keyboard switches, a buffer amplifier and monostable (Q_1 IC_3) and a sample/hold circuit (IC_1, C_2 IC_2).

Normally C_1 is kept charged up to +7 volts through the 'chain' of closed keyboard switches. When a key is depressed, the 'chain' is broken and C_1 discharges through R_1. As the key is further depressed, contact is made with the trigger busbar, TR_1 is turned on, and the monostable triggered. The monostable gives out a 1 millisecond pulse, which causes the analog switch (IC_1) to close allowing C_2 to charge up to the voltage on C_1 at that time. After this, the voltage is stored on C_2, the output being buffered by IC_2. Since the input impedance of IC is $\sim 1.5 \times 10^{12}$ ohms the delay time of C_2 is very long. An output is available from the emitter of 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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FX003 MEMORY BANK

"STAR" of the 1979 Seiko range, available NOW from Tempus. Continuous display of hours, minutes, seconds, day, date, month. Displays past and future calendars from 1930 to 2009.

Flashing reminder for important dates in the coming 12 months.

R.R.P. £130 **£104**

NEW FB011
R.R.P. £135
£104

FK009
R.R.P. £55
£44

NEW FH003
R.R.P. £165
£125

BORIS Communicating Chess Computer. One of the world's most advanced portable chess games. NO TV required. **£199**

CASIO FREE! Spare batteries worth up to £1.95 with calculators below. (On request with order)

NEW

QL-10 CIGARETTE LIGHTER/CALCULATING ALARM CLOCK

Soft piezoelectric system gas lighter. 6-digit LCD clock, ± 15 seconds/month. Permanently prog. calendar (1901-2099). Two alarms plus countdown alarm/timer. Dual time zone. Calculator, with time/date calculations. K, %, √, ½ × 2¾ × 4 inches. 3.6oz. 18 months battery. Pouch.

Prov. price **£39.95**

(RONSON electronic lighters, 10% off)

AQ-1000 CALCULATING ALARM CLOCK PLUS 3-WAY STOPWATCH

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

Our Price £21.95

CQ-81 CALCULATING ALARM CLOCK. Plus 2 Alarm/Timers. 24 hour alarm and alarm/timers. 6 digit LCD clock. One year battery life. 1⅝ × 2¾ × 5 inches. (RRP £22.95) **£17.95**

CQ-2. Special Offer. Clock, calendar, 4 alarms, stopwatch. Time/Date calculator. (R.R.P. £39.95) **£16.50**
The INCREDIBLE FX-8000. 41 sc. funct., 1/100 sec. stopwatch, 2 × 5 alarm/timers. (£35.95) **£29.95**
MINI CARD CALCULATORS ⅛ × 3½ × 2⅛ ins
LC-78. Full memory, %, √, K **£16.95**
FX-48 Math. Card. Full Scientific with S.D. **£19.95**
ST-24 Card Time. 24-hour stopwatch (or clock). 2 Alarm/Timers. Calculator as LC-78 **£19.95**
ALL Casio scientifics. Lowest prices
ST-1. Four way stopwatch **£24.95**

CARTRIDGE T/V GAMES

OPTIM Coronet 600 **£48.50**
Cartridges from £9.95
FAIRCHILD TIMEBAND Grandstand **£119.95**
Cartridges from £12.50
ATARI Video Computer System **£169.95**
The very best available to date!
Cartridges from **£14.95**

★ SPECIAL INTRODUCTORY OFFER

TWO FREE extra cartridges worth £29.90 with Atari

WATCH BATTERIES 65p each D.I.Y. KIT 35p

THIS MONTH'S ★ STAR BUY

NEW

CHRONO

Net, lap and 1st and 2nd place times from 1/100 second to 6 hours. Stainless steel case 7.8mm thick. Mineral glass face. Water resistant to 100 feet. 12 months+ battery life. Available soon.

Just announced CASIO 46CS-27B ALARM/CHRONOGRAPH

6 digits. Hrs, mins, secs AM/PM and day; and day, date, month, year. Optional 12 or 24 hr. clock. 24 hrs. alarm. Optional hourly Chime.

Prov. price **£74.95**

NEW

CASIO PQ-7

TRAVEL ALARM CLOCK
Battery-powered quartz alarm clock with repeat feature. Countdown alarm/timer. 1/10 second stopwatch. Constant LC Display. Nightlight. 1 year batteries. 4¾ X 1¼ × ½ inch. 1.6oz. **For car, caravan or boat.** (£24.95) **£19.95.**

SOLAR powered watches — so called. We won't sell them. Send us a S.A.E. and we will tell you why not.

CBM Giant 4 digit. 5 functions. Light.

9503 (£15.95) Chrome Bracelet
9502 (£14.95) Gilt Strap
£9.95
1803 (right) **ALARM**

6 digits, 6 functions, plus backlight and alarm setting. **5-minute snooze facility** (£28.95) **£22.95**

NEW

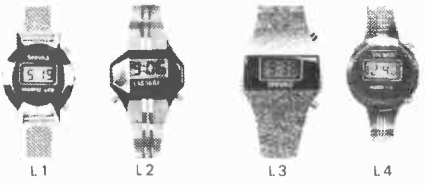
THE INCREDIBLE FX-8000

43 Scientific funct. 1/100th sec Stopwatch. Five Alarm/Timers, sequentional (self-clearing) or repeat. 2 level parenthesis. Memory. Deg. Rad. Gra. Standard deviations. Fractions. Sexagesimal. Rect./Polar convert. LCD. 1300 hr batteries. ¼ x 2¾ x 5¾. 2.7 oz.

RRP £35.95
£29.95

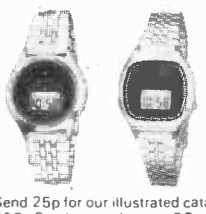
LADIES' LCD WATCHES

5 functions, backlight. Gold or Silver finish **(please specify).**
Dress Watch. Round, Milanese bracelet. **L1 £14.95**
Cocktail Watches. Integral bracelet. 3 styles **£18.95**



L1 L2 L3 L4

CASIO LADIES' LCD WATCHES



7 + 2 functions
27CL-15B
Round (Left)
(£35.95)
£29.95

27CL-17B
Stopwatch
(£49.95)
£39.95

Send 25p for our illustrated catalogue. Price include VAT and P&P. Send your cheque, PO or phone your credit card no. to —

CASIO QUALITY

All CASIO watches have a calendar display, night illumination, mineral glass and stainless steel cases, water resistant to 100 ft (except sports watches — 66).

SPORTS WATCHES

F-100
Left, 9.45 mm
(£29.95)
£24.95

52QS-14B
Right 8 mm
(£44.95)
£34.95

Up to **25 functions.** Net, lap and **first and second place** times to 1/100th sec. F-100. Resin case, strap 52QS-14B. S/S encased version and bracelet.

4 DIGIT WATCHES (except World Time). Hours, minutes, ten seconds, seconds by flash, am/pm. Day, date, month. Stopwatch. Dual time (except 31QR-20B)

31QR-20B Left, 4 digit (£35.95) **£29.95**

51QR-19B, 6 digit (£44.95) **£34.95**

6 DIGIT WATCHES (except Sports and Alarm). Hours, minutes, seconds, day **OR** Hours, minutes, date, day, ten seconds, seconds by flash. Day, date, month, year. Selectable 12 hour (with am/pm) or 24 hour clock.

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

54QS-15B
6 digit
(£54.95)
£44.95

CHRONOGRAPH. 6 digits as above, with stopwatch measuring net, lap and 1st & 2nd place times from 1/100 sec to 6 hrs. Dual time facility.

45CS-22B
Chronograph
Left, 6 digit (£69.95)
£54.95

29CS-11B
World Time (£84.95)
£69.95

WORLD TIME WATCH. The time in ten capitals plus one optional time. Instant summertime correction. Hrs, mins, 10 secs, secs by flash. Perpetual calendar, day, date, month. Running digital seconds display.

ALARM WATCHES

25CR-16B
Round (£74.95)
£54.95

25CS-16B
Square (£84.95)
£69.95

Hours, mins, seconds (or hrs, mins, date) day, am/pm. Day, date, month, year. 24 hr. alarm, on/off indicator.

ULTRA SLIM DRESS WATCHES (Not 24 hour)

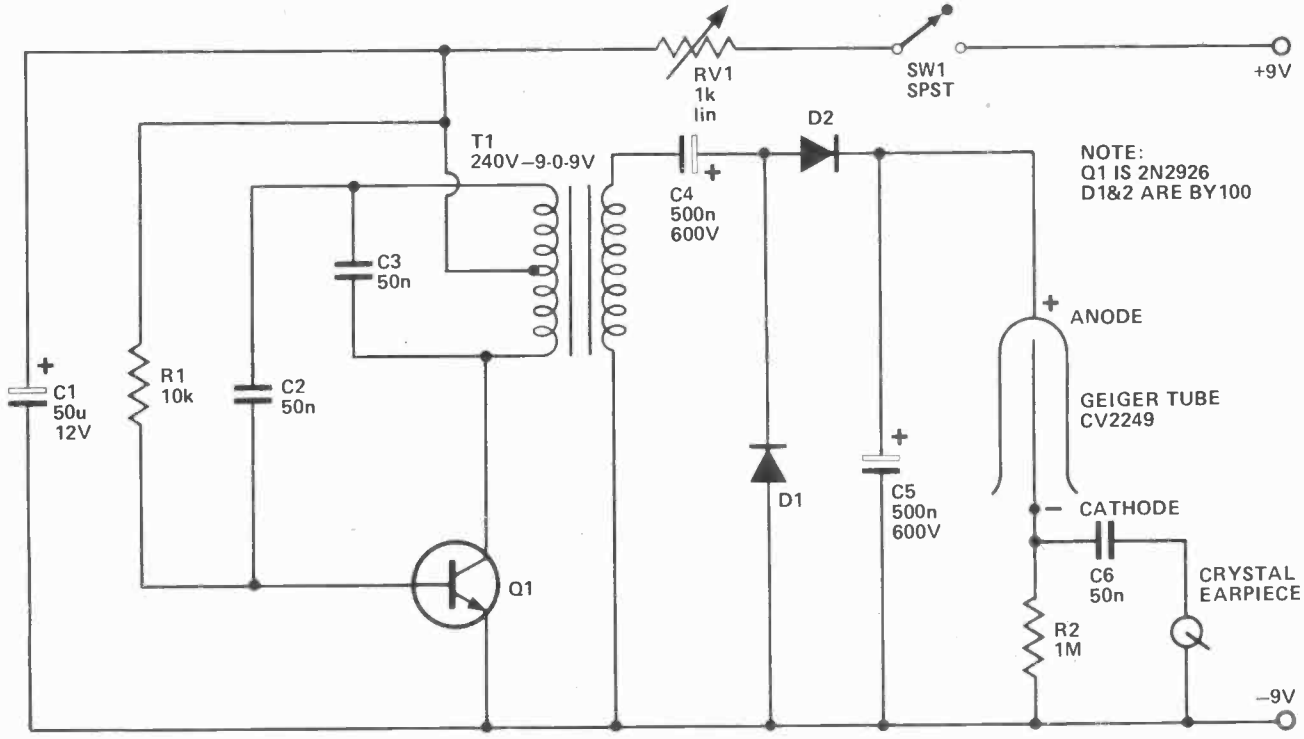
53CS-18B
Left, 4 digit (£74.95)
£59.95

49CS-25B
6 digit (£84.95)
£69.95

Not illustrated. 53CS-19B, 4 digit barrel shaped. **£64.95.** 49CS-24B, 6 digit (£79.95) **£64.95.** 53CGS-17L Gold plated, on strap (£84.95) **£69.95.**

TEMPUS

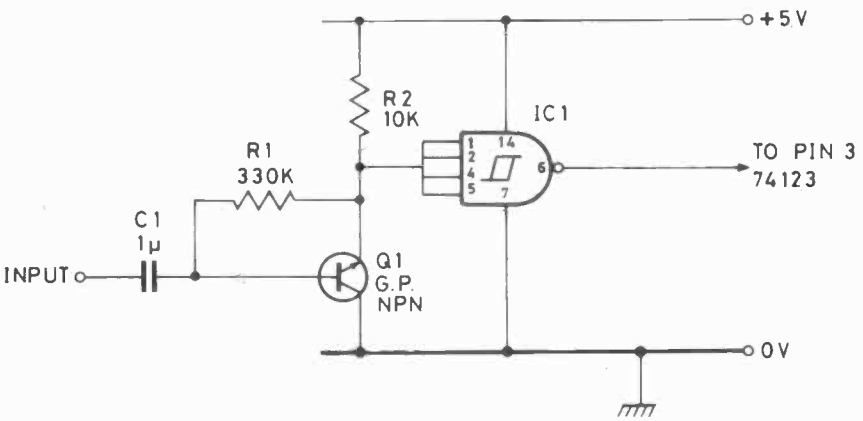
Dept. ETI, Talk of the Town
19/21 Fitzroy Street
Cambridge CB1 1EH. Tel. 0223 312866



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.

SERVICE TRADING CO

WHY PAY MORE?!

MULTI RANGE METERS **Type MF15A.** A.C./D.C. volts 10, 50, 250, 500, 1000. Ma. 0-5, 0-10, 0-100. Sensitivity 2000V. 24 ranges, dimensions 133 × 93 × 46mm. Price **£7.00** plus 50p P&P (**£8.10** inc. VAT & P).

TRIAC.

Raytheon tag symmetrical Triac. Type Tag 250/500v. 10 amp 500 piv. Glass passivated plastic triac. Swiss precision product for long term reliability **£1.25** P&P 10p (**£1.46** inc. VAT & P) (inclusive of date and application sheet). Suitable Diac **22p.**

0 to 60 MINUTES CLOCKWORK TIMER.

Double pole 15 amp 230AC. Contacts (no dial). **£1.50.** P&P 30p (**£1.94** inc. VAT & P). N.M.S.

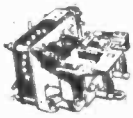
MERCURY SWITCH

Size 27m x 5mm. 10 for **£5.00,** P&P 30p. total VAT **£5.72.** Min. quantity 10. N.M.S.

230 VOLT AC FAN ASSEMBLY

Powerful continuously rated AC motor complete with 5 blade 6½" aluminium fan. New reduced price **£3.00** P&P 65p (**£3.94** inc. VAT & P). N.M.S.

21-WAY SELECTOR SWITCH with reset coil



The ingenious electro mechanical device can be switched up to 21 positions and can be reset from any position by energising the reset coil. 230/240v. A.C. operation. Unit is mounted on strong chassis. Complete with cover. Price **£5.50** P&P 75p (**£6.75** inc. VAT & P). N.M.S.

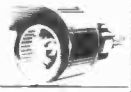
VORTEX BLOWER AND VACUUM UNIT

Dynamically balanced totally enclosed 9 rotor with max. air delivery of 1.5 cubic metres per min. Max. static pressure 600mm W.G. Suction or blow from 2 side-by-side 37mm I.D. circular apertures fitted to base of unit. Powerful continuously rated 115v.a.c. motor mounted on alloy base with fixing facilities. Dimensions: Length 22cm x width 25cm x height 25cm.

These units are ex-equipment but have had minimum use. Fully tested prior to despatch. Price **£12** + £1.50 P&P (**£14.58** inc. VAT & P). Suitable transformer for 230/240v.a.c **£6** + £1 P&P (**£7.56** inc. VAT & P).

CENTRIFUGAL BLOWER

24V DC Blower Unit M.F.R. USA made 24V DC 8 amp blower that operates well on 12V 4 amp DC producing 30 cu ft min at normal air pressure. Maximum housing dia 110mm, depth inc motor 75mm, nozzle length 19mm, dia 22mm. Ideal for cooling mobile equipment, car, caravan, etc. **£4.50** P&P 75p (£5.67 inc).



Smith type FFB 1606 022 220/240V AC Aperture 10x4½cm overall size 16x14cm. Price **£3.75** P&P 75p (incl VAT **£4.86**). Other types available. S.A.E. for details. N.M.S.

MINIATURE UNISELECTOR

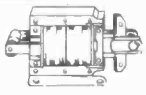
12V 11 way 4 bank (3 non-bridging, 1 homing). **£2.50** P&P 35p (**£3.08** inc. VAT & P).

N.M.S.

MICRO SWITCHES

Sub min lever m/switch type MML46. 10 for **£2.50.**
Type 3 115M 906T 10 for **£2.50** post paid (**£2.70** inc. VAT & P).
BF lever operated 20a c/o mf. Unimax USA. 10 for **£4.00** plus 50p P&P (min. order 10) (**£4.86** inc. VAT & P).
D.P. C/O lever m/switch, mfg. by Cherry Co., USA. Precious metal, low resistance contacts. 10 for **£2.50,** P&P 30p. Total inc. VAT **£3.02** (min 10). N.M.S.

NEW HEAVY DUTY SOLENOID



Mfg. by Magnetic Devices. 240V AC. Operation approx. 10lb. pull at ⅜" (intermittant rating). Price **£4.00** P&P 60p (**£4.96** inc. VAT).
N.M.S.

Pye Eyther 240V AC Solenoid. Approx 1lb pull, ¼" travel intermittant rating. Price **£1.00** P&P 20p (£1.30 inc VAT & P)
N.M.S.

Insulation Testers 500 Volts price in brackets **£53.78** (Not £57.78)

240V AC SOLENOID OPERATED FLUID VALVE

Rated 1 p.s.i. will handle up to 7 p.s.i. Forged brass body, stainless steel core and spring. ½ in. b.s.p. inlet outlet. Precision made. British mfg.
Price **£3.50** Post 50p (**£4.32** inc. VAT & P)
N.M.S.

PARVALUX 230/250V a.c. MOTOR

Type SD18 240v AC reversible 30 rpm 50lbs inch
Price **£15.00** P&P £1.50 (**£17.82** inc. VAT). N.M.S.

INSULATION TESTERS (NEW)

Test to I.E.E. spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L. 8 in. W. 4 in. H. 6 in. weight 6½lb.
500 VOLTS 500 megohms
£49.00 Post 80p (**£57.78** inc. VAT & P)
1000 VOLTS 1000 megohms
£55.00 Post 80p (**£60.26** inc. VAT & P)
SAE for leaflet.

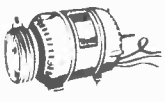
VARIABLE VOLTAGE TRANSFORMERS

INPUT 230 v. A.C. 50/60
OUTPUT VARIABLE 0/260v. A.C.
BRAND NEW. All types.
200W (1 Amp) fitted A/C volt meter **£14.50**
0.5 KVA (Max. 2½ Amp) . . **£17.00**
1 KVA (Max. 5 Amp) **£22.50**
2 KVA (Max. 10 Amp) **£37.00**
3 KVA (Max. 15 Amp) **£45.50**
5 KVA (Max. 25 Amp) **£74.00**
10 KVA (Max. 50 Amp) . . . **£168.00**
17 KVA (Max. 75 Amp) . . . **£260.00**
Carriage extra

LT TRANSFORMERS

0-10v-15v at 3 amp. (ex new equip) **£2.50** P&P 50p (**£3.24** inc. VAT)
13-0-13v at 1 amp **£2.50** P&P 50p (**£3.24** inc VAT)
25-0-25v at 2½ amp. **£4.50** P&P 75p (**£5.67** inc. VAT & P)
0-4v/6v/24v/32v at 12 amp. **£15.00** P&P £1.50 (**£17.82** inc. VAT & P)
0 6v/12v at 20 amp **£13.50** P&P £1.50 (inc. VAT **£16.20**)
0 -12v at 20 amp. or 0-24v at 10 amp **£12.00** P&P £1.50 (**£14.58** inc. VAT & P)
0-6v/12v at 10 amp **£8.25** P&P £1.25 (inc. VAT **£10.26**)
0-6v/12v/17v/18v/20v at 20 amp. **£16.50** P&P £1.50 (**£19.44** inc. VAT & P)
0-10v/17v/18v at 10 amp. **£10.00** p&p £1.40 (inc. VAT **£12.31**)
Other types in stock; phone for enquiries or send sae for leaflet.

ROTARY VACUUM AIR COMPRESSOR & PUMP



Carbon vane oil free vacuum pump and compressor. Approx. 20 inch vacuum, 10 PSI at 79 CFM. Powered by 110V a.c. 1.8 amp Parvalux motor fitted with additional shaft at rear, suitable light loads. Inc. capacitor **£14.00** P&P £1.50 (**£16.74** inc. VAT + P&P)
Suitable transformer for 230/240V a.c. operation **£5.00** P&P £1.00 (**£6.48** inc. VAT + P&P)
N.M.S.

BLOWER/VACUUM PUMP

3 phase A.C. motor. 220/250v or 380/440v, 1,425 rpm ⅓ hp cont. Direct coupled to William Allday Alcosa carbon vein blower/vacuum pump. 0.9 cfm 8 hg. Price **£22.00** P&P £2.00 (**£25.92** inc. vat +p).
N.M.S.

STROBE! STROBE! STROBE!

HY-LIGHT STROBE KIT Mk. IV

Latest type Xenon white light tube. Solid state timing and triggering circuit. 230/240 volt A.C. operation. Speed adjustable 1-20 f.p.s. Designed for large rooms, halls, etc. Light output greater than many (so called 4 Joule) strobes. Price **£19.00** post £1 (**£21.60** inc. VAT & P). Specially designed case and reflector for Hy-Light **£8.80** Post £1.00 (**£10.58** inc. VAT & P).

ULTRA VIOLET BLACK LIGHT FLUORESCENT TUBES
4ft. 40 watt £8.70 (callers only). **2ft. 20 watt £6.20.** Post 75p (£7.51 inc. VAT + P). (For use in stan bi-pin fittings.) Mini **12in. 8 watt £2.80.** Post 35p (£3.40 inc. VAT + P.). **9in. 6 watt £2.25.** Post 35p (£2.81 inc. VAT + P.). **6in. 4 watt £2.25.** Post 35p. (£2.81 inc. VAT + P.)
Complete ballast unit. Either 6, 9 or 12" tube 230v A.C. op. **£3.50.** Post 45p (£4.27 inc. VAT + P.). Also available for 12v D.C. op. **£3.50** plus P&P 45p (£4.27 inc. VAT & P).
400w UV lamp and ballast complete. **£31.50.** Post £3. (£37.26 inc. VAT + P.). 400w UV lamp only **£11.25.** Post £1.20 (£13.45 inc. VAT + P.)

SQUAD LIGHT

A new conception in light control. Four channels each capable of handling 750 watts of spotlights or dozens of small mains lamps. Seven programs all speed controlled plus flash modulation, effectively giving 14 different displays. Makes sound-to-light obsolete. Completely electrically and mechanically noise free.
Price only **£60.00** plus 75p P&P (£65.61 inc VAT)
S.A.E. (Foolscap) for further details.

WIDE RANGE OF DISCO LIGHTING EQUIPMENT

S.A.E. (Foolscap) for details.

XENON FLASH GUN TUBES

Range of Xenon tubes available from stock. S.A.E. for full details.

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Wide range of AC and DC relays available from stock. Phone or write in your enquiries.

230/240V A.C. Relays: Arrow. 2 c/o. 15 amp **£1.50** (**£1.84** inc. VAT & P)
T.E.C. open type 3 c/o. 10 amp **£1.10** (**£1.40** inc. VAT & P). Omoron or Keyswitch 1 c/o. 7 amp **£1.00** (**£1.30** inc. VAT & P)

D.C. Relays: Open type 9, 12V 3 c/o 7 amp **£1.00** (**£1.30** inc. VAT & P). Sealed 12V 1 c/o 7 amp octal base. **£1.00** (**£1.30** inc. VAT & P). Sealed 12V 2 c/o 7 amp octal base. **£1.25** (**£1.56** inc. VAT & P). Sealed 12V 3 c/o 7 amp 11-pin. **£1.35** (**£1.67** inc. VAT & P). 24V Sealed 3 c/o 7 amp 11-pin **£1.35** (**£1.87** inc. VAT & P) (amps = contact rating). P&P on any Relay 20p.
Other types available — phone for details. N.M.S.

Diamond H heavy duty A.C. relay 230/240V a.c. two c/o contacts 25 amps res at 250V a.c. **£2.50** P&P 50p. (**£3.24** inc. VAT + P&P). Special base **50p.**

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ACCOUNT CUSTOMERS MIN. ORDER £10.00

GEARED MOTORS

100 R.P.M. 115 lbs. ins.!!

115 lb. ins., 110 volt, 50Hz, 2.8 amp, single phase, split capacitor motor. Immense power. Continuously rated. Totally enclosed. Fan cooled. In-line gearbox. Length 250mm. Dia. 135mm. Spindle Dia. 15.5mm. Length 115mm. ex-equipment tested **£12.00** Post £1.50 (**£14.58** inc. VAT & P). Suitable transformer 230/240 volt £8.00 Post 75p (**£9.45** inc. VAT & P).
R&T

GEARED MOTORS

28 r.p.m., 20lb. inch 115v.a.c. Reversible motor.
71 r.p.m. 10 lb. inch. 115v.a.c. Reversible motor.
Both types similar to above drawing. Price either type **£4.75** + 75p P&P. (**£5.94** inc. VAT + P&P)
Supplied with transformer for 240v a.c. operation **£7.25** + P&P £1 (**£8.91** inc. VAT + P&P)
N.M.S.

FRACMO MOTOR

56rpm 50lbs inch 240vAC reversible. 0.7 amp sharplength 35mm. dia. 16mm. weight 6 kilos 600 grams. Price **£15.00** P&P £1.50 (**£17.82**).
N.M.S.

PARVALUX MOTOR TYPE S.D.2

12v D.C. shunt 1/30th ph motor. Continuously rated 4000 rpm. Price **£10.00,** P&P 75p (**£11.61** inc. VAT + P). N.M.S.

CROUZET 230V A.C.

2 R.P.M. synchronous, brand new **£2.90,** P&P 30p (**£3.46** inc. VAT).
N.M.S.

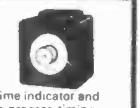
CITENCO

FHP motor type C 7333/15 220/240V AC 19 rpm reversible motor, torque 14.5 kg. Gear ratio 144:1. Brand new incl. capacitor, our price **£14.25** + £1.25 P&P (**£16.74** inc. VAT & P).
N.M.S.

REVERSIBLE MOTOR 230V A.C.

General Electric 230v A.C., 1,600 r.p.m., 0.25 amp. Complete with anti-vibration mounting bracket and capacitor. O/A size 110mm × 90mm. Spindle 5/16 dia. 20mm long. Ex-equipment test **£3.00.** Post 50p (**£3.78** inc. VAT & P).

RODENE UNISET TYPE 71 TIMER



0-60 sec. 230V a.c. operation. Incorporating a lapsed time indicator and repeat facilities. A precision motorised timer ideal for process timing, photography, welding, mixing, etc. Price **£6** P.&P. 60p. (£7.13 inc. VAT & P). N.M.S.

METERS (New) — 90mm DIAMETER

A.C. Amp., Type 62T2. 0-1A., 0-5A., 0-20A. **A.C. Volt.** 0-15V., 0-300V. **D.C. Amp.,** Type 65C5. 0-2A., 0-10A., 0-20A., 0-100A. **D.C. Volt.** 0-15V., 0-30V. All types **£3.50** ea. + P&P 50p. (**£4.32** incl. VAT), except 0-100A. D.C., price **£5.00** + 50p P&P (**£5.94** incl. VAT).

'VENNER TYPE' ERD TIME SWITCH

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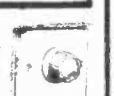

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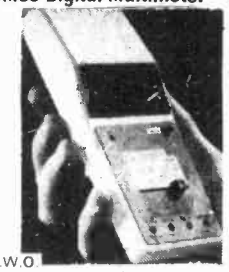

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AC126	0.17	BC119	0.25	BC207	0.10	BCY58	0.20	BF194	0.06	BU208-02	1.75	2N1671B	2.20		
AC127	0.16	BC125	0.15	BC209B	0.09	BCY71	0.13	BF194A	0.07	BU406	3.60	2N1711	0.20		
AC127K	0.23	BC125B	0.16	BC212A	0.10	BCY72	0.13	BF195	0.06	BUY69A	6.75	2N1893	0.25		
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		
AC128/178	0.42	BC137	0.15	BC237	0.15	BD123	0.60	BF196	0.06	BUY70A	5.00	2N2060	1.00		
AC141Z	0.18	BC138	0.30	BC237A	0.16	BD126	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	0.28	BC238	0.15	BD133	0.48	BF224	0.18	MPS6523	0.27	2N2222	0.18		
AC176	0.16	BC142	0.20	BC238B	0.16	BD135	0.30	BF253	0.18	MPSA06	0.90	2N2222A	0.20		
AC187	0.50	BC147	0.06	BC238C	0.18	BD136	0.30	BF254	0.18	MV5053	0.72	2N2270	0.39		
AC187K	0.55	BC147B	0.07	BC251A	0.15	BD137	0.30	BF255	0.18	NKT214	0.25	2N2368	0.10		
AC188K	0.55	BC148	0.06	BC251B	0.17	BD138	0.30	BF257	0.16	NKT224	0.25	2N2484	0.16		
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	BF333	0.25	OC36	1.00	2N3117	1.00		
AD149	0.65	BC157A	0.07	BC261A	0.10	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		
AD162	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		
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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	0.85	2N4448	1.50		
ASY73	0.30	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	ZN3448	0.30	2N5172	0.25		
ASZ16	0.60	BC173B	0.07	BC546	0.10	BF123	0.20	BSX52	0.33	ZN404	0.45	2N5245	0.30		
ASZ17	0.60	BC174B	0.07	BC547	0.11	BF125	0.20	BSY20	0.21	ZN524	0.48	2N5296	0.40		
AU103	0.90	BC177A	0.12	BC547A	0.11	BF127	0.20	BSY25	0.30	ZN526	0.48	2N5458	0.25		
AU107	1.00	BC177B	0.12	BC547B	0.11	BF137	0.21	BSY26	0.30	ZN527	0.48	2N5496	0.60		
AU110	0.90	BC178B	0.12	BC547C	0.11	BF152	0.15	BSY27	0.30	ZN665	3.50	2N5670	0.65		
AU210	0.90	BC179	0.12	BC548A	0.11	BF154	0.15	BSY29	0.54	ZN705	0.10	2N5826	0.55		
BC107	0.06	BC182A	0.09	BC548B	0.11	BF157	0.37	BSY39	0.15	ZN706	0.10	2N6123	0.85		
BC107A	0.07	BC182B	0.09	BC548C	0.11	BF158	0.15	BSY52	0.33	ZN706A	0.11	2S003	0.75		
BC107B	0.07	BC183A	0.09	BC549A	0.11	BF167	0.25	BSY54	0.38	ZN708	0.12	2S303	0.90		
BC108	0.06	BC183LA	0.09	BC549B	0.11	BF173	0.20	BSY56	0.36	ZN1039	0.15	2S304	0.90		
BC108A	0.07	BC183LB	0.10	BC550	0.11	BF174	0.20	BSY60	0.36	ZN1059	0.15	2S305	0.90		
BC108B	0.07	BC184	0.08	BC557	0.11	BF177	0.25	BSY84	0.30	ZN1101	0.15	2S323	1.00		
BC109	0.06	BC184L	0.09	BC557A	0.11	BF178	0.25	BU105	1.08	ZN1102	0.15	2S732	1.00		
BC109B	0.07	BC184LB	0.10	BC557B	0.11	BF179	0.25	BU105-04	1.08	ZN1132	0.20				
BC109C	0.07	BC186	0.19	BC557C	0.11	BF180	0.20	BU108	1.80	ZN1304	0.50				
BC113	0.12	BC187	0.19	BC558	0.11	BF181	0.20	BU126	1.00	ZN1305	0.50				
BC114	0.15	BC204	0.08	BC558A	0.11	BF182	0.20	BU133	1.75	ZN1307	0.50				
BC116	0.13	BC204B	0.09	BC558B	0.11	BF183	0.20	BU204	1.30	ZN1309	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	ST2	0.14	1N5408	0.20
BA111	0.98	BB110G	0.45	BY187	1.30	BYX10	0.35	MR502	0.75	1N4001	0.04	1N5450A	6.75
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	0.45	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	OK13	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	SAA7008	10.15	SN76110N	1.50	TAA630	8.55	TBA510Q	2.50	TBA720	5.10	TCA270Q	3.60
CA3065	1.50	SAS560	2.75	SN76131N	2.00	TAA630S	5.10	TBA520	2.50	TBA720A	5.10	TCA270S	2.25
CA3089E	7.88	SAS570	2.75	SN76226N	3.15	TAA661A	1.70	TBA520Q	2.50	TBA720AQ	2.10	TCA270SQ	3.40
CA3900	4.50	SBA7508	6.75	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	0.90	TCA830	3.10
MC1303L	1.50	SL414A	4.85	SN76533N	2.70	TAD100	1.35	TBA540Q	2.25	TBA800Q	2.85	TDA440	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	SL9018	8.50	SN76550N	1.80	TBA120AS	1.50	TBA550Q	3.80	TBA810S	1.10	TDA1327B	2.85
MC1307P	2.85	SL9178	10.70	SN76660N	0.80	TBA120S	2.70	TBA560	6.45	TBA820	0.80	TDA1330	1.60
MC1310P	1.00	SL1310	5.65	SN76665N	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	SLG046	2.60	TAA310	3.15	TBA281	4.70	TBA560CQ	3.00	TBA920Q	3.50		
MC1330P	1.25	SN76003N	2.50	TAA329	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	TBA440S	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	.65	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	.48	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	.80	4033	1.40	4053	.88	4078	.20	4520	1.10
4010	.50	4021	.88	4035	1.10	4055	1.00	4081	.20		
4011	.15	4022	.86	4040	.90	4060	1.00	4082	.20		
4012	.15	4023	.20	4041	.80	4066	.35	4502	.90		
4013	.35	4024	.68	4042	.75	4068	.20	4507	.62		

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 1K= 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 in 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 1¼ cut-out

F.S.D.	ORDER CODE	PRICE
1mA	M1	5.50
500mA	M500	5.50

ORDERING

Orders despatched by return of post. Payment with order please add 20p for p & p with orders under £5 otherwise carriage free. No other charges — just send prices shown. Enquiries please send s.a.e. Government departments and educational institutions just send official order. Mail order only.
Export orders welcome.

NORMAN INSKIP
90 Charles Street Greenhithe, Kent
Tel: Greenhithe (0322) 844985

15—240 Watts!

HY5
Preamplifier

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

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

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

SPECIFICATIONS:

INPUTS: Magnetic Pick-up 3mV. Ceramic Pick-up 30mV. Tuner 100mV. Microphone 10mV. Auxiliary 3-100mV. Input impedance 47kΩ at 1kHz.

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

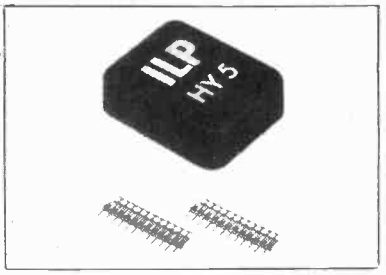
ACTIVE TONE CONTROLS: Treble ± 12dB at 10kHz. Bass ± at 100Hz.

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

OVERLOAD: 38dB on Magnetic Pick-up. SUPPLY VOLTAGE ± 16-50V.

Price £6.27 + 78p VAT. P&P free.

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



HY30
15 Watts into 8Ω

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

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

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

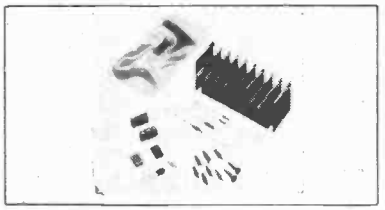
SPECIFICATIONS:

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

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

SUPPLY VOLTAGE ±18V.

Price £6.27 + 78p VAT. P&P free.



HY50
25 Watts into 8Ω

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

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

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

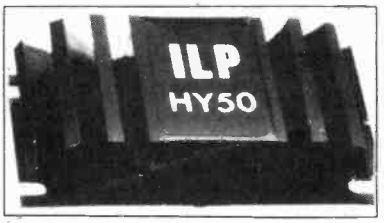
SPECIFICATIONS: INPUT SENSITIVITY 500mV.

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

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

SUPPLY VOLTAGE ± 25V. SIZE 105 50 25mm.

Price £8.18 + £1.02 VAT. P&P free.



HY120
60 Watts into 8Ω

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

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

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

SPECIFICATIONS:

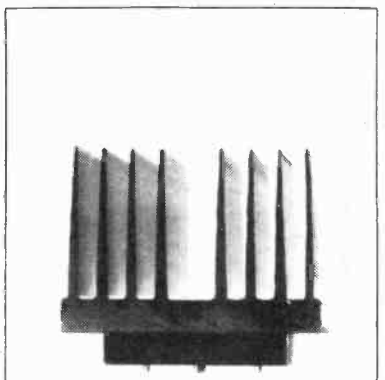
INPUT SENSITIVITY 500mV.

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

SIGNAL/NOISE RATIO 90dB. FREQUENCY RESPONSE 10Hz-45kHz –3dB. SUPPLY VOLTAGE ±35V.

Size 114 x 50 x 85mm.

Price £19.01 + £1.52 VAT. P&P free.



HY200
120 Watts into 8Ω

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

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

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

SPECIFICATIONS:

INPUT SENSITIVITY 500mV.

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

SIGNAL/NOISE RATIO 96dB. FREQUENCY RESPONSE 10Hz-45kHz – 3dB. SUPPLY VOLTAGE ±45V.

SIZE 114 x 100 x 85mm.

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HY400
240 Watts into 4Ω

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

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

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

SPECIFICATIONS:

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

SIGNAL/NOISE RATIO 94dB. FREQUENCY RESPONSE 10Hz-45kHz – 3dB. SUPPLY VOLTAGE ±45V.

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

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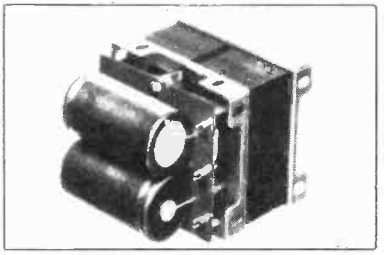

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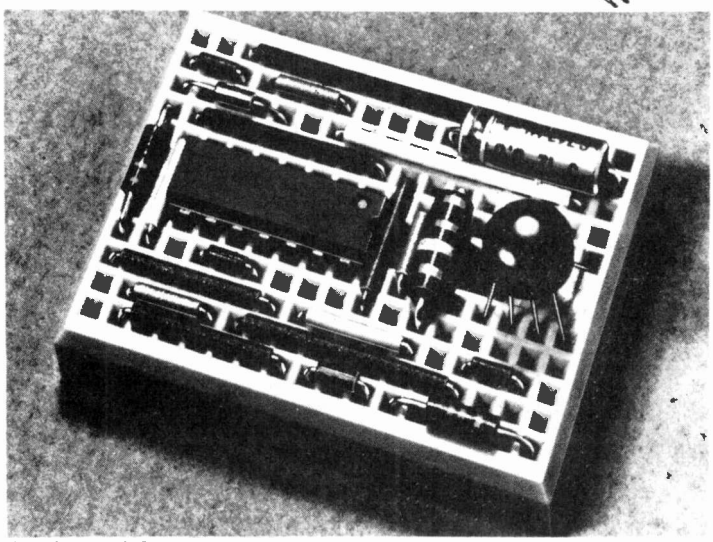

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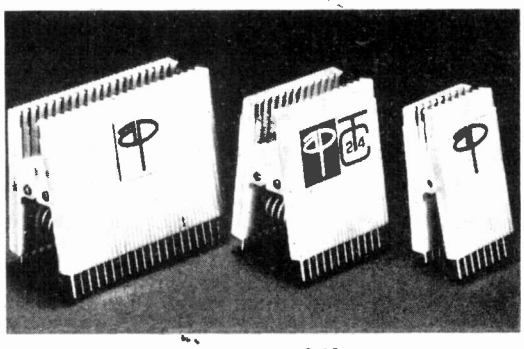

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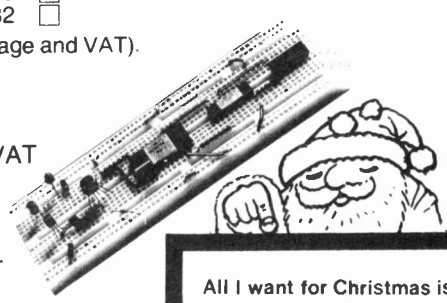

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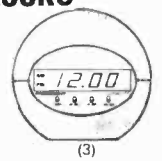

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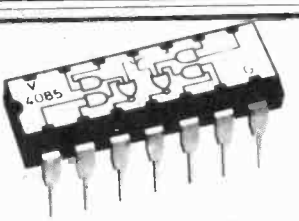

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