

# **electronics today**

INTERNATIONAL

AUGUST 1980 60p



**ETI**  
**SPECIAL REPORT-**  
**EMP....THE END OF CIVILISATION?**  
**Nuclear Facts The Government Hasn't Told Us**

**100W MOSFET Amplifer Project**

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**20 Car Circuits To Build**

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**Video Buyer's Guide**

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**Ultrasonic Alarm**

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

# TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

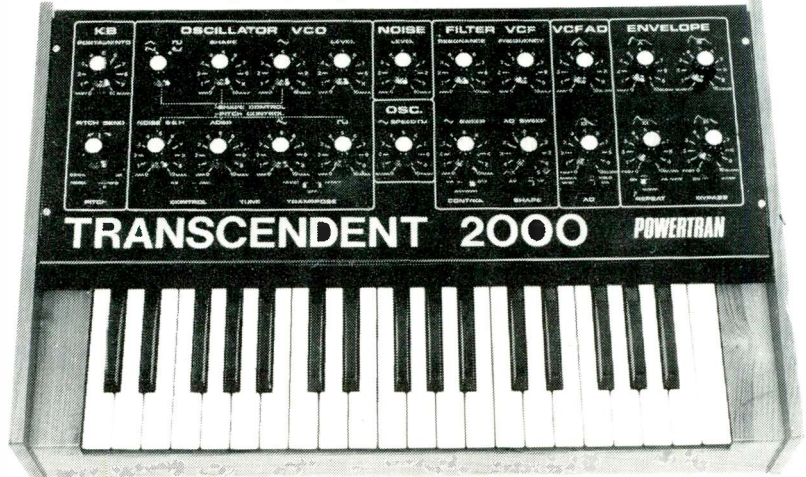
All kits also available as separate packs (e.g. P.C.B. component sets, hardware sets, etc.)  
Prices in FREE CATALOGUE

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 affective 7 octave range. There is portamento, pitch bending, a VCO with shape and pitch modulation, a VCF with both low and high pass outputs and a separate dynamic sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features. The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or 1/2% metal trim) 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 fibreglass 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 many times the price!

**COMPLETE KIT  
ONLY  
£168.50 + 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)

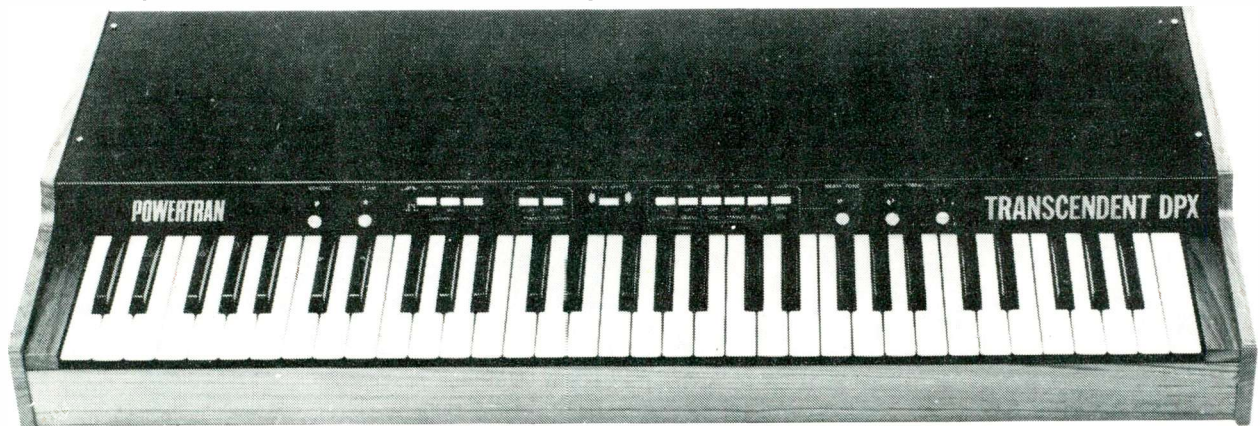
**INCREASED CAPACITY AT OUR BIG NEW FACTORY  
MEANS MANY PRICES DOWN! ALL OTHERS FROZEN!**

**WE'VE MOVED!  
NEW FACTORY UP!  
PRICES DOWN!**

# TRANSCENDENT DPX

**DIGITALLY CONTROLLED, TOUCH SENSITIVE, POLYPHONIC, MULTI-VOICE SYNTHESIZER  
ANOTHER SUPERB DESIGN BY SYNTHESIZER EXPERT TIM ORR — PUBLISHED IN ETI**

The Transcendent DPX is a really versatile new 5 octave keyboard instrument. There are two audio outputs which can be used simultaneously. On the first there is a beautiful harpsichord or reed sound — fully polyphonic, i.e. you can play chords with as many notes as you like. On the second output there is a wide range of different voices, still fully polyphonic. It can be a straightforward piano or a honky tonk piano or even a mixture of the two! Alternatively you can play strings over the whole range of the keyboard or brass over the whole range of the keyboard or should you prefer — strings on the top of the keyboard and brass at the lower end (the keyboard is electronically split after the first two octaves) or vice versa or even a combination of strings and brass sounds simultaneously. And on all voices you can switch in circuitry to make the keyboard touch sensitive! The harder you press down a key the louder it sounds — just like an acoustic piano. The digitally controlled multiplexed system makes practical touch sensitivity with the complex dynamics law necessary for a high degree of realism. There is a master volume and tone control, a separate control for the brass sounds and also a vibrato circuit with variable depth control together with a variable delay control so that the vibrato comes in only after waiting a short time after the note is struck for even more realistic string sounds.



Cabinet size 36.3" x 15.0" x 5.0" (rear) 3.3" (front)

**COMPLETE KIT ONLY £299.00 + VAT!**

To add interest to the sounds and make them more natural there is a chorus/ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects. As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing etc., etc.)

Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet.

The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc. — even a 13A plug — you need buy absolutely no more parts before plugging in and making great music! When finished you will possess an instrument comparable in performance and quality with ready-built units selling for over £1,200!

**POWERTRAN**

**ORDERING INFORMATION AND MORE KITS  
INCLUDING THE BLACK HOLE ON PAGE 8**



# electronics today

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## PROJECTS

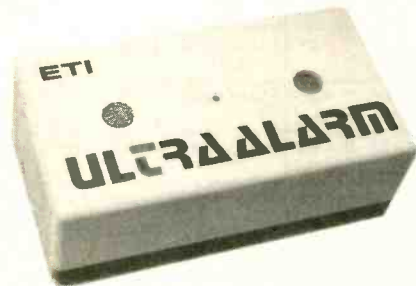
- 100W AMPLIFIER 64 Its MOS and its the best.
- LOGIC TESTER 73 Simple and versatile testing aid.
- VCA MODULE 78 Superb sound shaper.
- ULTRASONIC ALARM 86 Doppler out the burglars.
- CAPACITANCE METER 93 Measuring up to your capabilities?
- FOIL PATTERNS 100 Building begins here.

## INFORMATION

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- ETIPRINTS 98 The only way to get board.



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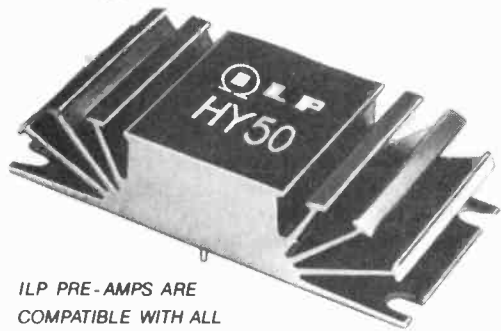
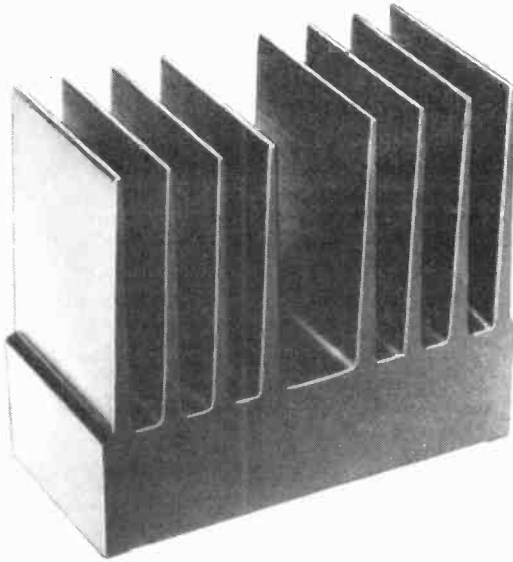
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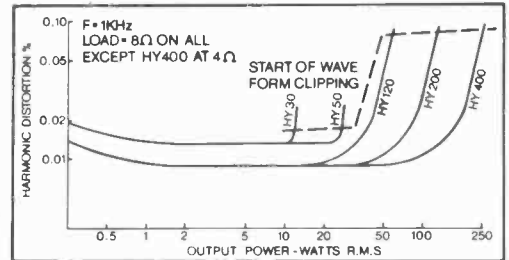
# Simply ahead..



ILP PRE-AMPS ARE  
COMPATIBLE WITH ALL  
ILP POWER AMPS AND PSUs

## POWER AMPLIFIERS

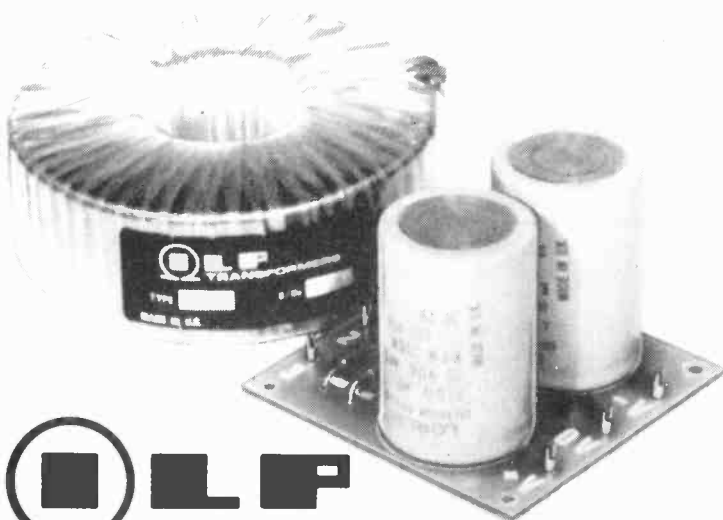
ILP Power Amplifiers are encapsulated within heatsinks designed to meet total heat dissipation needs. They are rugged and made to last a lifetime. Advanced circuitry ensures their suitability for use with the finest loudspeakers, pickups, tuners, etc. using digital or analogue sound sources.



Model	Output Power R.M.S.	Distortion Typical at 1KHz	Minimum Signal/Noise Ratio	Power Supply Voltage	Size in mm	Weight in gms	Price + V.A.T.
HY30	15 W into 8 Ω	0.02%	100 dB	-20 0 +20	105x50x25	155	£6.34 + 95p
HY50	30 W into 8 Ω	0.02%	100 dB	-25 0 +25	105x50x25	155	£7.24 + £1.09
HY120	60 W into 8 Ω	0.01%	100 dB	-35 0 +35	114x50x85	575	£15.20 + £2.28
HY200	120 W into 8 Ω	0.01%	100 dB	-45 0 +45	114x50x85	575	£18.44 + £2.77
HY400	240 W into 4 Ω	0.01%	100 dB	-45 0 +45	114x100x85	1.15Kg	£27.68 + £4.15

Load impedance - all models 4 Ω - ∞  
Input sensitivity - all models 500 mV  
Input impedance - all models 100K Ω  
Frequency response - all models 10Hz - 45 KHz - 3dB

## POWER SUPPLY UNITS



AVAILABLE ALSO FROM WATFORD ELECTRONICS, MARSHALLS AND CERTAIN OTHER SELECTED STOCKISTS.

ILP Power Supply Units with transformers made in our own factory are designed specifically for use with ILP power amplifiers and are in two basic forms - one with circuit panel mounted on conventionally styled laminated transformer, for smaller PSU's - in the other, for larger PSU's, ILP toroidal transformers are used which are half the size and weight of laminated equivalents, are more efficient and have greatly reduced radiation.

PSU 30 ± 15V at 100mA to drive up to 12 x HY6 or 6 x HY66 £4.50 + £0.68 VAT

THE FOLLOWING WILL ALSO DRIVE ILP PRE-AMPS

PSU 36 for 1 or 2 HY30's £8.10 + £1.22 VAT

PSU 50 for 1 or 2 HY50's £8.10 + £1.22 VAT

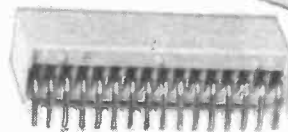
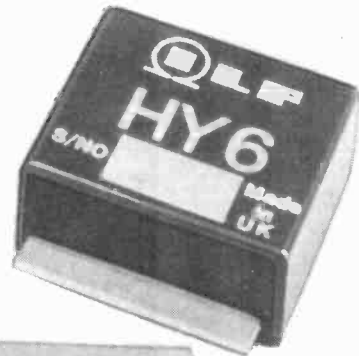
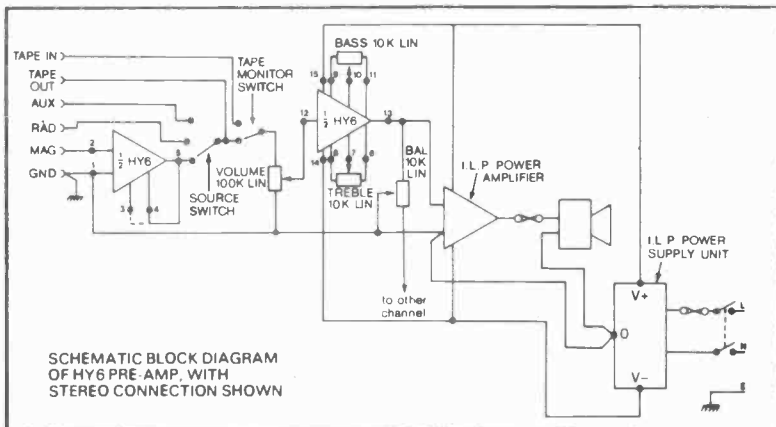
PSU 60 with toroidal transformer for 1 HY 120 £9.75 + £1.46 VAT

PSU 70 with toroidal transformer for 1 or 2 HY 120's £13.61 + £2.04 VAT

PSU 90 with toroidal transformer for 1 HY 200 £13.61 + £2.04 VAT

PSU 180 with toroidal transformer for 1 HY 400 or 2 x HY 200 £23.02 + £3.45 VAT

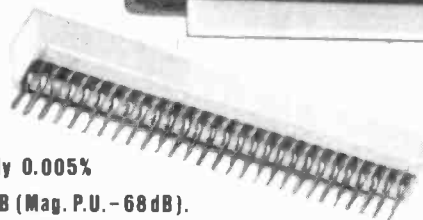
# this time with two new pre-amps



## HY6 mono HY66 stereo

When ILP add a new design to their audio-module range, there have to be very special reasons for doing so. You expect even better results. We have achieved this with two new pre-amplifiers - HY6 for mono operation, HY66 for stereo. We have simplified connections, and improved performance figures all round. Our new pre-amps are short-circuit and polarity protected; mounting boards are available to simplify construction.

Sizes - HY6 - 45 x 20 x 40 mm | HY66 90 x 20 x 40 mm Active Tone Control circuits provide  $\pm 12$ dB cut and boost. Inputs Sensitivity - Mag. PU - 3mV Mic - selectable 1-12mV All others 100mV Tape O/P - 100mV Main O/P - 500mV: Frequency response - D.C. to 100kHz - 3dB



### HY6 mono

£5.60

+ VAT 84p

### HY66 stereo

£10.60

+ VAT £1.59

Connectors included

B6 Mounting Board  
78p + 12p VAT

B66 Mounting Board  
99p + 15p VAT

- LOW DISTORTION - Typically 0.005%
- S/N RATIO - Typically 90 dB (Mag. P.U. - 68 dB).
- HIGH OVERLOAD FACTOR - 38 dB on Mag. P.U.
- LATEST DESIGN HIGH QUALITY CONNECTORS.
- REQUIRE ONLY POTS, SWITCHES, PLUGS AND SOCKETS.
- COMPATIBLE WITH ALL ILP POWER AMPS AND PSUs.
- NEEDS ONLY UNREGULATED POWER SUPPLY  $\pm 15$ V to  $\pm 50$ V.

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**ELECTRONIC CAPACITORS:** (Values are in  $\mu$ F) 500V: 10.5p; 47.78p; 250V: 100.65p; 33V: 0.47, 1.0, 1.5, 2.2, 3.3, 4.7, 5.6, 10, 15, 22, 33, 47, 56, 100, 150, 220, 250, 330, 470, 560, 1000, 60p; 40V: 3.3, 8p; 100, 120, 220, 330, 85p; 470V, 85p; 35V: 10, 33, 7p; 330, 470, 33p; 25V: 10, 22, 47, 100, 150, 160, 220, 250, 15p; 470, 250, 35p; 1500, 40p; 220V, 45p; 330V, 77p; 470V, 85p; 15V: 10, 47, 7p; 100, 125, 8p; 220, 330, 14p; 47, 20p; 1000, 1500, 30p; 220V, 30p; 10V: 10, 7p; 640, 12p; 100, 16p.

**TAG-END TYPE:** 450V: 100p; 180p; 70V: 470, 165p; 64V: 330, 150p; 250V: 110p; 50V: 4700, 150p; 330V: 185p; 220V: 99p; 40V: 15, 600, 390p; 100, 130p; 400, 92p; 3300, 98p; 2500, 90p; 30V: 4700, 110p; 25V: 1500, 195p; 640, 120p; 470, 100p; 330, 80p; 220, 60p.

**POLYESTER CAPACITORS:** Axial lead type.  
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 9p; 18n, 10p; 22n, 33n, 11p; 47n, 68n, 14p; 100n, 17p; 150n, 22n, 24p; 330n, 47n, 41p; 680n, 48p; 1p, 64p; 2p, 2, 82p.

**160V:** 10n, 12n, 39n, 100n, 150n, 220n, 11p; 330n, 47n, 19p; 680n, 1p, 2p, 2.2p, 3.3p, 4.7p, 5.6p, 10p, 15p, 20p; 22n, 22p; 47n, 26p; 100n, 38p; 470n, 53p; 1p, 1.75p.

**POLYESTER RADIAL LEAD CAPACITORS: 250V:**  
10n, 15n, 22n, 27n, 33n, 47n, 68n, 100n, 7p; 150n, 10p; 220n, 330n, 13p; 470n, 17p; 680n, 19p; 1p, 2.2p; 1.5, 30p; 2, 2, 34p.

**TANTALUM BEAD CAPACITORS**  
35V: 0.1uF, 0.22, 0.33, 0.47, 0.68, 1.0u, 2.2uF, 3.3, 4.7, 25V: 10, 20V: 6.8, 16V: 2.2, 4.7, 10, 15p; 16V: 2.2p, 28p, 47, 100, 50p; 220, 80p; 10V: 1.5, 2.2p, 3.3p, 4.7p; 100, 35p; 5V: 4.7p, 6.8, 10, 20p; 3p; 10, 20p.

**MYLAR FILM CAPACITORS**  
100V: 0.001, 0.002, 0.005, 0.01uF 7p  
0.015, 0.02, 0.04, 0.05, 0.056uF 8p  
0.1uF, 9p, 50V, 0.47uF 12p

**CERAMIC CAPACITORS 50V**  
Range: 0.5pF to 10,000pF  
0.015uF, 0.022uF, 0.033uF 5p  
0.047uF, 5p; 0.1uF, 0.2uF 7p

**SILVER MICA (Values in pF) 3.3, 4.7, 6.8, 10, 12, 18, 22, 33, 47, 56, 68, 75, 82, 90, 100, 120, 150, 220, 11p each**  
25, 27, 30, 33, 36, 39, 40, 45, 50, 56, 60, 68, 75, 82, 90, 100, 120, 150, 220, 26p each

**POLYSTYRENE CAPACITORS:**  
10pF to 1nF 6p; 1.5nF to 4.7nF 10p

**MINIATURE TYPE TRIMMERS**  
2.5-6pF, 3-10pF, 10-40pF 22p  
5-25pF, 5-45pF, 60pF, 88pF 30p

**COMPRESSION TRIMMERS**  
3-40pF, 10-80pF, 25-190pF 30p  
100-500pF 45p, 400-1250pF 58p

**GAS & SMOKE DETECTORS**  
TGS 812 & 813 415p; Socket 30p

**JACKSONS VARIABLE CAPACITORS**  
DILCON 0.2 365pF with slow 100/300pF 205p motion Drive 450p  
500pF 250p 0.2008/176 350p

**RF CHOKES**  
1uH, 4.7, 10, 22, 33, 47, 100, 200, 470, 750, 1mH, 2.5, 5, 10, 30p each  
43mH, 10, 60p each

**VEROBOARD** 0.1, 0.15, 0.1 (copper clad) (plain)  
2 1/2 x 3 1/2" 58p 51p 42p  
2 1/2 x 5" 68p 62p 42p  
3 1/2 x 3 1/2" 77p 86p 65p  
3 1/2 x 5" 204p 229p 150p  
4 1/2 x 1 1/2" 240p 229p 150p  
3 1/2 x 1 1/2" 240p 229p 150p  
3 1/2 x 1 1/2" 345p 210p

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

**FERRIC CHLORIDE**  
1lb bag Anhydrous 125p + 35p P&P

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

**COPPER CLAD BOARDS**  
Fibre Single Double-SRBP  
Glass sided sided 9.5" x 8.5"  
6" x 6" 80p 110p 95p  
6" x 12" 150p 195p

**OIL PLUGS (Headers)**  
14 pin 35p; 16 pin 40p; 24 pin 85p;  
40 pin 285p

**Soldercon pens: 100 55p; 500 250p.**

## TRANSISTORS

AC125 35p	BC212 9	BF198 16	MPSU56 60	ZTX503 15	2N3442 140	BCY78 86
AC126 25	BC212L 9	BF199 29	MPU131 40	ZTX504 25	2N3663 14	BD112 95
AC127 22	BC213 9	BF200 40	OC26 170	ZTX505 25	2N3702 10	BD158 60
AC128 20	BC214 9	BF242A 24	OC28 120	ZTX550 25	2N3703 10	BD206 110
AC141 27	BC214L 10	BF245 24	OC35 125	40311 60	2N3704 10	BD222 65
AC142 28	BC237 10	BF258A 50	OC41 125	40313 125	2N3705 10	BDY56 170
AC176 25	BC238 10	BF258 48	OC42 125	40316 65	2N3706 10	BDY60 140
AC188 26	BC307B 12	BF259 28	OC44 55	40324 91	2N3707 11	BF184 25
ACY16 60	BC327 12	BF451 29	OC70 35	40326 52	2N3709 11	BF245 24
ACY18 60	BC328 15	BF336 35	OC71 28	40338 105	2N3710 10	BF323 32
ACY19 60	BC337 12	BF337 32	OC72 35	40343 43	2N3711 10	BF325 38
ACY20 53	BC338 12	BF59A 30	OC74 50	40361 45	2N3712 195	BFY81 99
ACY21 40	BC441 27	BF59 25	OC75 45	40382 42	2N3713 288	BSX29 45
ACY22 60	BC461 27	BF739 25	OC76 36	40467A 95	2N3819 20	BSY78 75
ACY28 60	BC477 35	BF84 24	OC77 36	40468 60	2N3820 45	BSY26 40
ACY39 80	BC516 38	BF84 24	OC81 75	40468A 70	2N3822 130	MJ490 90
ACY41 39	BC517 35	BF84 24	OC82 50	40488 95	2N3823 130	MJ170 130
AD149 75	BC547 10	BF881 24	OC84 48	40411 280	2N3824 70	MJ180 130
AD157 42	BC548 10	BF881 24	OC84 48	40411 280	2N3825 90	MU131 45
AD162 42	BC549C 10	BF881 24	OC84 48	40411 280	2N3826 90	MU131 45
AF114 60	BC556 15	BF881 24	OC84 48	40411 280	2N3827 150	TI59 50
AF115 60	BC557 10	BF881 24	OC84 48	40411 280	2N3828 150	TI59 50
AF116 60	BC558 10	BF881 24	OC84 48	40411 280	2N3829 150	TI59 50
AF117 60	BC559 10	BF881 24	OC84 48	40411 280	2N3830 150	TI59 50
AF118 75	BCY30 80	BF881 24	OC84 48	40411 280	2N3831 150	TI59 50
AF119 75	BCY34 75	BF881 24	OC84 48	40411 280	2N3832 150	TI59 50
AF120 75	BCY35 75	BF881 24	OC84 48	40411 280	2N3833 150	TI59 50
AF178 75	BCY39 78	BF881 24	OC84 48	40411 280	2N3834 150	TI59 50
AF186 50	BCY39 78	BF881 24	OC84 48	40411 280	2N3835 150	TI59 50
AF239 42	BCY40 48	BF881 24	OC84 48	40411 280	2N3836 150	TI59 50
AS221 60	BCY42 14	BF881 24	OC84 48	40411 280	2N3837 150	TI59 50
BC107 10	BCY45 50	BF881 24	OC84 48	40411 280	2N3838 150	TI59 50
BC108 10	BCY70 14	BF881 24	OC84 48	40411 280	2N3839 150	TI59 50
BC108 12	BCY71 15	BF881 24	OC84 48	40411 280	2N3840 150	TI59 50
BC108 12	BCY72 158	BF881 24	OC84 48	40411 280	2N3841 150	TI59 50
BC108 12	BCY72 158	BF881 24	OC84 48	40411 280	2N3842 150	TI59 50
BC109 10	BD112 95	BF881 24	OC84 48	40411 280	2N3843 150	TI59 50
BC109 12	BD124 115	BF881 24	OC84 48	40411 280	2N3844 150	TI59 50
BC109 12	BD131 42	BF881 24	OC84 48	40411 280	2N3845 150	TI59 50
BC109 12	BD132 42	BF881 24	OC84 48	40411 280	2N3846 150	TI59 50
BC109 12	BD133 42	BF881 24	OC84 48	40411 280	2N3847 150	TI59 50
BC109 12	BD134 42	BF881 24	OC84 48	40411 280	2N3848 150	TI59 50
BC109 12	BD135 30	BF881 24	OC84 48	40411 280	2N3849 150	TI59 50
BC109 12	BD136 30	BF881 24	OC84 48	40411 280	2N3850 150	TI59 50
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BC109 12	BD149					



# CHROMATHEQUE 5000



Panel size 19.0" x 3.5". Depth 7.3"

This versatile system featured as a constructional article in ELECTRONICS TODAY INTERNATIONAL has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe all the lights at a speed dependent upon music level or front panel control or use the internal digital circuitry which produces some superb random and sequencing effects. Each channel handles up to 500W and as the kit is a single board design wiring is minimal and construction very straightforward.

Kit includes fully finished metalwork, fibreglass PCB controls, wire, etc. — Complete right down to the last nut and bolt!

# POWERTRAN

## 5 CHANNEL LIGHTING EFFECTS SYSTEM

COMPLETE KIT

ONLY

£49.50 + VAT!



### DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO 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%.

Above 2 kits are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet, cable, nuts, bolts, etc and full instructions—in fact everything!

All kits also available as separate packs (eg PCB, component sets, hardware sets etc). Prices in our FREE CATALOGUE.

Matching Tuners. See our FREE CATALOGUE



### T20+20 20W STEREO 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.

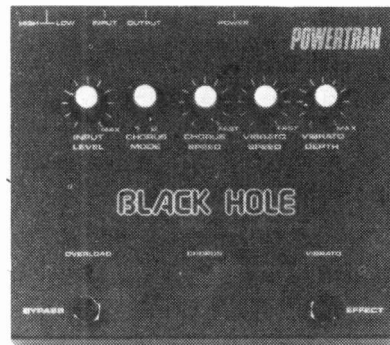
# BLACK HOLE

## MUSIC EFFECTS DEVICE AS FEATURED IN ELECTRONICS TODAY INTERNATIONAL.

The BLACK HOLE designed by Tim Orr, is a powerful new musical effects device for processing both natural and electronic instruments, offering genuine VIBRATO (pitch modulation) and a CHORUS mode which gives a 'spacey' feel to the sound achieved by delaying the input signal and mixing it back with the original. Notches (HOLES), introduced in the frequency response, move up and down as the time delay is modulated by the chorus sweep generator. An optional double chorus mode allows exciting antiphase effects to be added. The device is floor standing with foot switch controls, LED effect selection indicators, has variable sensitivity input, has high signal/noise ratio obtained by an audio compander and is mains powered — no batteries to change! Like all our kits everything is provided including a highly superior, rugged steel, beautifully finished enclosure.

COMPLETE KIT ONLY £49.80 + VAT (SINGLE DELAY LINE SYSTEM)

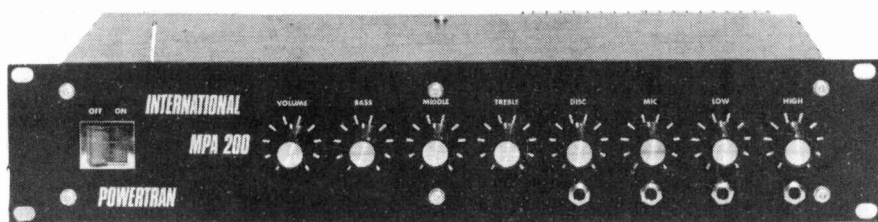
De Luxe version (dual delay line system) also available for £59.80 + VAT



# MPA 200 100 WATT (rms into 8Ω) MIXER/AMPLIFIER

Featured as a constructional article in ETI, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier. It features adaptable input mixer which accepts a wider range of sources such as microphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 200 is simplicity itself with minimal wiring needed making construction very straightforward.

The kit includes fully finished metalwork, fibreglass PCBs, controls, wire, etc. — complete down to the last nut and bolt.



Panel size 19.0" x 3.5". Depth 7.3"

COMPLETE KIT ONLY

£49.90 + VAT!

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

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# DIGEST

## Design Cadet

**R**acal-Redac has introduced an interactive PCB design aid which, they claim, should pay its way even if only five boards are designed every year.

The user selects the required component symbols, which are displayed on a VDU. The machine, called Cadet, then shows the shortest straight-line routes between the components. The operator can then move the components round to find the best position with Cadet checking for track crossover and automatically minimising inter-connection length.

Cadet can store designs on cartridges, from which Redac can produce artwork and a prototype PCB. The system (screen, keyboard, electronic tablet and stylus) enables a designer to produce three times the number of PCB designs possible manually.

Cadet costs £20,000 from Racal-Redac, Tewkesbury, Gloucestershire GL20 8HE.

## Rank Xerox, the first 21 years

**R**ank Xerox, the name synonymous with photocopiers, have just launched six new products to mark their 21st anniversary in the business. Twenty-one years ago, the 914, the world's first office copier, made its entrance. It still looks remarkably up-to-date. Indeed, a few are still in service.

The new models amply demonstrate that Rank Xerox make more than photocopiers. The 485 is a facsimile transceiver capable of transmitting documents all over the country (the world!) along the telephone lines, overcoming the expense and time involved in sending documents by post. Moreover, it's fully compatible with its forerunner, the 400.



The 850 word processing system is a step up from its predecessor, the 800. The 800 is capable of typing out 350 words a minute as a straightforward playback typewriter and can store its input on magnetic card or tape. The 850 will also display the text line by line (on a display on the typewriter itself) or page by page on a VDU.

Even their new photocopiers are not just copiers. During a demonstration one model took a few dozen pages of text, turned each one over, copied it and returned it, in order, to a collection tray. The number of copies selected were then fed to a sorter and even stapled, if necessary.

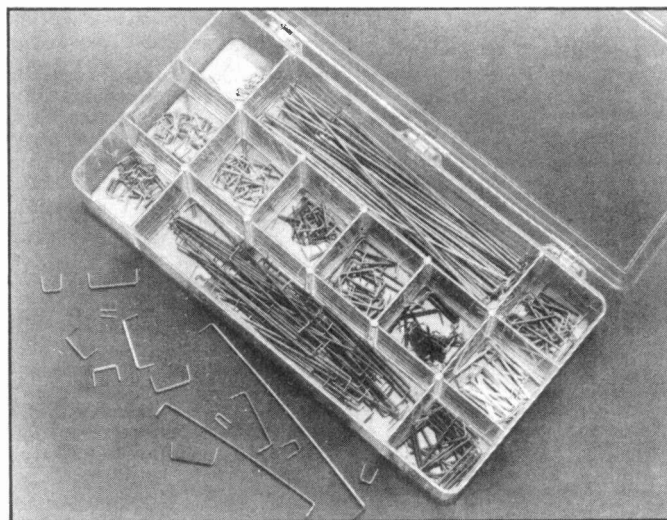
Xerox are now working with the Digital Equipment Corpora-

tion and Intel to develop the Ethernet network. This will link most of the electronic information equipment of tomorrow's office together, from a mainframe computer or a micro to a word processor to an intelligent copier to a data terminal, etc. Ethernet will allow information exchange at ten million bits per second. Global information exchange should be complete with Xerox's work, with its subsidiary Western Union International, on satellite communication via the Xten network.

Happy birthday Rank Xerox.

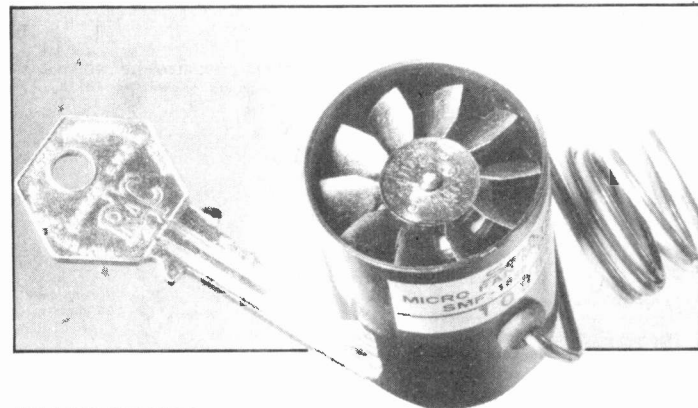
## Fan-Tastic

**I**nspectron Limited of Foundry Lane, Horsham, West Sussex have announced their high performance, sub-miniature fan using a coreless motor, designed mainly for cooling electronic equipment. The fans are available to operate on 12 or 5 V DC with which fan motor speed is approximately 14,500 RPM, with an air flow of about 450 litres/minute. Current consumption is 150 mA and operation is virtually noiseless. The total weight of the fan is 56 g and two types of mounting are available; plain cylindrical for small ducts and rubber fixing brackets, and a flange fitting type for fitting direct to bulkheads or other flat surfaces.



## High Jump

**T**he new model WK-1 wire jumper kit from CSC gives an easy means of linking up electronic components and circuits on test sockets, bus strips or solderless breadboard systems. The kit contains pre-cut, pre-stripped and pre-formed lengths of solid insulated wire (AWG 22) in 14 colour-coded lengths from 0.1 inch to 4 inches. Each length of wire has additional 0.25 inch ends bent at 90°. Twenty-five pieces of each length are supplied with a plastic compartmented case and the price is £5 excluding VAT plus postage and packing from Continental Specialties Corporation, Shire Hill Industrial Estate, Saffron Waldon, Essex CB11 3AQ.



## Thin Time for Watches

**A** new addition to the Concord Delirium range of wrist-watches caused quite a stir at the Basle Fair. The Concord Delirium IV is the first watch to break the 1 mm barrier. It's 0.98 mm thick.

The Swiss design team have achieved the super thin profile by using a new battery (the world's smallest), a new motor and quartz tuning fork and microprocessor controlled time-setting. Accuracy

is quoted at ten seconds per month. The new battery, only 0.8 mm thick, should power the watch for more than a year.

If, as the Director of Concord Watch Company believes, 'thinness always serves as an indicator of technical superiority in the watch industry' the Delirium IV should be hard to beat. However, we don't as yet have any news of the price. With a solid gold backplate and face (not to mention the world's smallest battery) this is one watch you won't throw away when the battery lies down and dies.

*It's faster and more thorough than classroom learning: you pace yourself and answer questions on each new aspect as you go. This gives rare satisfaction - you know that you are really learning and without mindless drudgery. With a good self-instruction course you become your own best teacher.*

**Understand Digital Electronics**

In the years ahead digital electronics will play an increasing part in your life. Calculators and digital watches mushroomed in the 1970's - soon we will have digital car instrumentation, cash cards, TV messages from friends and electronic mail. After completing these books you will have broadened your career prospects and increased your knowledge of the fast-changing world around you.

**DIGITAL COMPUTER LOGIC AND ELECTRONICS £7.00**

This course is designed as an introduction to digital electronics and is written at a pace that suits the raw beginner. No mathematical knowledge is assumed other than the use of simple arithmetic and decimals and no electronic knowledge is expected at all. The course moves painstakingly through all the basic concepts of digital electronics in a simple and concise fashion: questions and answers on every page make sure that the points are understood.

Everyone can learn from it - students, engineers, hobbyists, housewives, scientists. Its four A4 volumes consist of:

- Book 1** Binary, octal and decimal number systems; conversion between number systems; conversion of fractions; octal-decimal conversion tables.
- Book 2** AND, OR gates; inverters; NOR and NAND gates; truth tables; introduction to Boolean algebra.
- Book 3** Positive ECL; De Morgans Laws; designing logic circuits using NOR gates; dual-input gates.
- Book 4** Introduction to pulse driven circuits; R-S and J-K flip flops; binary counters; shift registers; half-adders.

**DESIGN OF DIGITAL SYSTEMS £12.50**

This course takes the reader to real proficiency. Written in a similar question and answer style to Digital Computer Logic and Electronics, this course moves at a much faster pace and goes into the subject in greater depth. Ideally suited for scientists or engineers wanting to know more about digital electronics, its six A4 volumes lead step by step through number systems and Boolean algebra to memories, counters and arithmetic circuits and finally to an understanding of calculator and computer design.

- 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, exclusive-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 programme structure.
- Book 6** Central processing unit (CPU); memory organization; character representation; program storage; address modes; input/output systems; program interrupts; interrupt priorities; programming; assemblers; computers; executive programs; operating systems and time sharing.

**Flow Charts and Algorithms**

are the essential logical procedures used in all computer programming and mastering them is the key to success here as well as being a priceless tool in all administrative areas - presenting safety regulations, government legislation, office procedures etc.

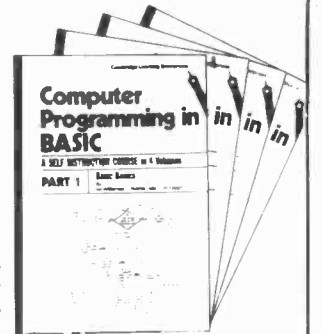
**THE ALGORITHM WRITER'S GUIDE £4.00**

explains how to define questions, put them in the best order and draw the flow chart, with numerous examples.



**Microcomputers are coming - ride the wave! Learn to program.**

Millions of jobs are threatened but millions more will be created. Learn BASIC - the language of the small computer and the most easy-to-learn computer language in widespread use. Teach yourself with a course which takes you from complete ignorance step-by-step to real proficiency with a unique style of graded hints. In 60 straightforward lessons you will learn the five essentials of programming: problem definition, flowcharting, coding the program, debugging, clear documentation. Harder problems are provided with a series of hints so you never sit glassy-eyed with your mind a blank. You soon learn to tackle really tough tasks such as programs for graphs, cost estimates, compound interest and computer games.



**COMPUTER PROGRAMMING IN BASIC £9.00**

- Book 1** Computers and what they do well; READ, DATA, PRINT, powers, brackets, variable names; LET; errors; coding simple programs.
- Book 2** High and low level languages; flowcharting; functions; REM and documentation; INPUT, IF... THEN, GO TO; limitations of computers, problem definition.
- Book 3** Compilers and interpreters; loops, FOR...NEXT, RESTORE; debugging; arrays; bubble sorting; TAB.
- Book 4** Advanced BASIC; subroutines; string variables; files; complex programming; examples; glossary.

**THE BASIC HANDBOOK £11.50**

This best-selling American title usefully supplements our BASIC course with an alphabetical guide to the many variations that occur in BASIC terminology. The dozens of BASIC 'dialects' in use today mean programmers often need to translate instructions so that they can be RUN on their system. The BASIC Handbook is clear, easy to use and should save hours of your time and computer time. A must for all users of BASIC throughout the world.

**FORTRAN COLORING BOOK £5.40**

"If you have to learn Fortran (and no one actually wants to assimilate it for the good of the soul) buy this book. Forget the others - this one is so good it will even help you understand the standard, dense, boring, unintelligible texts." *New Scientist*.

**A. N. S. COBOL £4.40**

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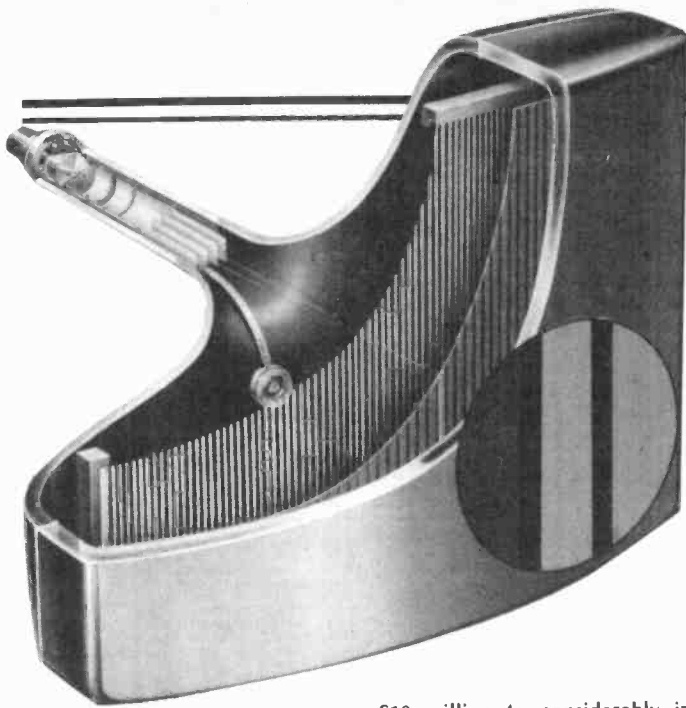
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## In the Tube

Sony (UK) Ltd. has just received the Queen's Award for export for its Bridgend manufacturing plant which produces 125,000 Trinitron television sets per year, 50% of which are exported. Bridgend employs over 720 people and this factory already represents a £10 million investment for Sony. They have now decided to invest a further

£10 million to considerably increase their production facilities at Bridgend which will include a 27" picture tube manufacturing plant, the first in Europe (the other one outside Japan is in San Diego). The workforce will be increased to around 1,000 and production is expected to be 150,000 a year once the new annexe is completed in 1982. This means that a possible 90% of components for Trinitron sets manufactured in Bridgend will be supplied from Great Britain.

## Army Exhibition

Four Plessey businesses will be exhibiting a wide range of equipment at the British Army Equipment Exhibition in Aldershot on June 23-27. Plessey Avionics and Communications will display their complete range of multi-combat radios and a selection of other defence communications products. There will be over 50 Plessey tactical radios in use or on display at the exhibition, either on Plessey stands or incorporated in other manufacturers' vehicle displays as working vehicle systems. Plessey Aerospace will show a wide range of military engine-driven generator sets ranging from 0.3 kW DC for battery charging applications up to 20 kW for communications equipment. Plessey Radar will exhibit products primarily concerned with upper air observations and windfinding radar. Plessey Defence Systems, formed in 1979, has current projects including the 'Ptarmigan' Tactical Trunk Communications System and 'Wavell', a military ADP system for battlefield command and control, a staff cell mock-up of which will be featured at the indoor site together with a cine-film. Both these systems have been developed for the British Army.

## Flying High

Part of the Civil Aviation Authority's £100m re-equipment programme has now been finalised. It is for the replacement of the radar systems for the National Air Traffic Services, the total cost of which is estimated to be £24.5m, 30% of which will be met by the Ministry of Defence and at the conclusion of the programme more than half the total value will have been contracted or sub-contracted to British firms.

Delivery of the new radars are required progressively from 1981 to 1983. The timing of the setting up is critical if the National Air Traffic Services are to provide an effective and safe air traffic service. The radars currently in use need to be replaced as they are not compatible with the radar data processing systems in use and being developed by the London Air Traffic Control Centre. If these radars are not replaced by 1983, there could be a situation where civil flights would have to be delayed, re-routed or cancelled and military flights adversely affected. £14.5m worth of contracts have already been placed and a further £10m are still to be let principally in the UK for buildings, radar towers and associated works.

## Pye on CB

Following the recent Government statement on CB Pye Telecommunications has just re-issued this statement, explaining the company's position.

"At a time when more and more interest is being shown in Citizens Band Radio (CB) and when more and more discussions and articles are appearing in the media, Pye Telecommunications Limited, Europe's largest supplier of Mobile Radio, feels that now is the appropriate time to make known its views on one aspect of C B .

In the event of H M Government deciding in favour of CB, Pye Telecommunications feels very strongly that the UHF frequency band would be the most appropriate.

The reasons for this recommendation are:

- (1) UHF is more suitable for the high population density of the UK.
- (2) Use of narrow deviation FM modulation at UHF allows more users in less spectrum, due to increased re-use of

channels by the suppression of weaker signals — 'Capture Effect'.

- (3) The use of UHF prevents interference with Hi Fi, television, radio and other electronic devices.
  - (4) It would avoid the poor grade of service which results from congestion experienced on 27 MHz CB (USA) resulting from long range propagation ('Skip Effect').
  - (5) UHF will avoid harmonic interference into other users of the spectrum, Police, fire, ambulance services, etc.
  - (6) Selection of the UHF Band would avoid the problem of the re-allocation of existing users, which would make 27 MHz CB slow and costly to implement.
  - (7) UHF has predictable range and channel re-usability.
  - (8) UHF has high quality transmission and reception.
- If any confirmation of the points listed above is needed, one has only to look at Australia, where the introduction of UHF CB has established the above principles."

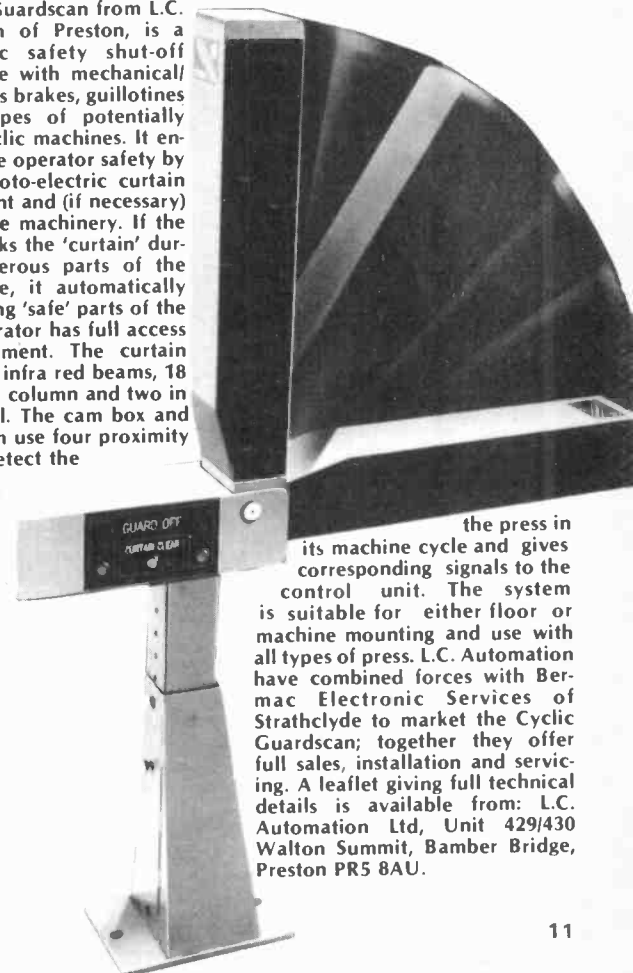
## Touch Dimmer (April 1980)

For size and availability we made R1 a 1W carbon type. If you find that this gets warm in use, replace it with a 2.5 W wire-

wound (or vitreous wirewound) type, but make sure the type you choose will fit before you part with any pennies.

## Safety First

The Cyclic Guardscan from L.C. Automation of Preston, is a photo-electric safety shut-off system for use with mechanical/hydraulic press brakes, guillotines and other types of potentially dangerous cyclic machines. It ensures complete operator safety by creating a photo-electric curtain across the front and (if necessary) the rear of the machinery. If the operator breaks the 'curtain' during the dangerous parts of the machine cycle, it automatically cuts off. During 'safe' parts of the cycle the operator has full access to the equipment. The curtain consists of 20 infra red beams, 18 in the vertical column and two in the horizontal. The cam box and the linear cam use four proximity switches to detect the position of



the press in its machine cycle and gives corresponding signals to the control unit. The system is suitable for either floor or machine mounting and use with all types of press. L.C. Automation have combined forces with Bermac Electronic Services of Strathclyde to market the Cyclic Guardscan; together they offer full sales, installation and servicing. A leaflet giving full technical details is available from: L.C. Automation Ltd, Unit 429/430 Walton Summit, Bamber Bridge, Preston PR5 8AU.

Table containing various electronic components and their specifications, organized into columns: TTLs by TEXAS, 93 SERIES, 74S SERIES, TRANSISTORS, MEMORIES, UART, CHARACTER GENERATORS, KEYBOARD ENCODER, TRANSFORMERS, SUPPORT DEVICES, BREADBOARDS, PROTOBOARD, IC TEST CLIPS, LINEAR I.C.s, VOLTAGE REGULATORS, OTHER REGULATORS, OPTO-ELECTRONICS, OPTO-ISOLATORS, LEDS, DISPLAYS, TRIACS PLASTIC, DIODES, THYRISTORS, HEAT SINKS, BRIDGE RECTIFIERS, LOUD-PEAKERS, LOW PROFILE DIL SOCKETS BY TEXAS, WIRE WRAP SOCKETS BY TEXAS, SUBMINIATURE SWITCHES, ANTEK SOLDERING IRONS, SPARE BITS, SPARE ELEMENTS, VEROBORDS, CRYSTALS, CONNECTOR PLUGS, COUNTERS, EDGEBOARD CONNECTORS, SPECIAL OFFERS (subject to stocks).

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## Invasion Of The Body Scanners

Siemens have introduced an improved version of their Viduson 735 ultrasonic body scanner. The Viduson 735 SM has a resolution of 4mm over the whole image. It uses an ultrasonic frequency of 3MHz and a parallel beam which penetrates to a maximum depth of 18cm.

Small structural features (inside organs, for example) can be displayed on the screen by a finely graded grey scale. This new system allows the wide dynamic range of echo signals to be adapted automatically to the pic-

ture tube characteristics, giving the optimum grey scale display. The picture is clearer and contours are sharper because small echoes can be suppressed by an adjustable signal threshold.

The system incorporates an electronic measuring device. Two marks can be positioned anywhere on the screen. The distance between them is then displayed digitally on the ultrasonic image. Thus, any long term change in the size of organs, for example, can be monitored over several scans, months apart perhaps.

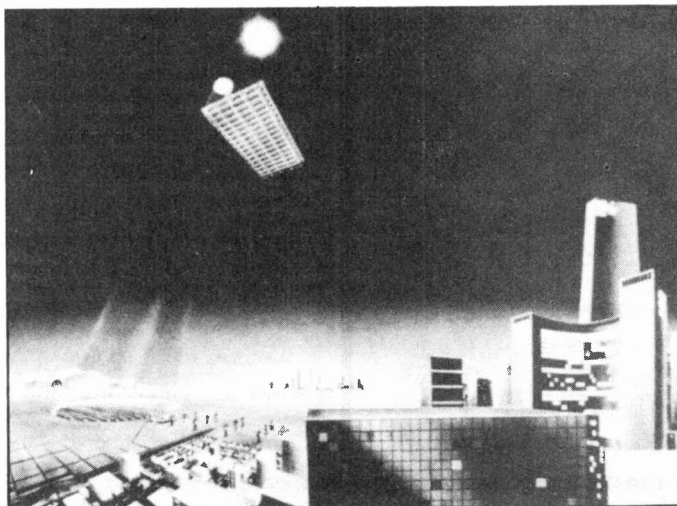
Budding Dr. Kildares can get more information on the Viduson 735 SM from Siemens Ltd, Siemens House, Windmill Road, Sunbury-on-Thames, Middlesex TW16 7HS.

## Sun Spots

The concept of harnessing solar energy to power the national grid is now showing signs of becoming a reality. The Department of Industry has funded a six month study into the implications of British Industry of such a project. ERA and Marconi Space are assisting British Aerospace in this, and RAE, Farnborough are representing the Department of Industry.

This concept is already receiving attention in the USA by NASA, the Department of Energy and the aerospace industry in general, through a 20 million dollar programme. Although this is an entirely American effort, international co-operation would be expected. The proposed satellite for harnessing the sun's energy would measure something like 5 km by 10 km, with a 1 km diameter phased array microwave antenna pivoted at one end of the surface to convert the electricity into microwave energy for transmission back to earth. The ground receiving antenna (rectenna) would convert the microwave energy back into electricity. The microwave beam would need to be designed to produce no harm-

ful effects outside the rectenna. This, including its surrounding safety zone could occupy an elliptical site of 150-230 square kilometers. The energy delivered would be in the region of 5000 MW. The implications of this idea extend beyond the aerospace industry, into the possibility that Britain, at least, could obtain part of its electrical supply from this system during the 21st century.

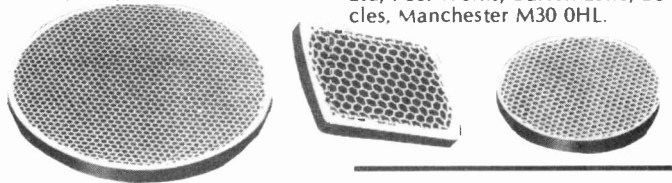


## Smart Heaters

A new type of heating element from Salford Electrical that can decide when it's too hot and regulate its temperature - and all without a single moving part. It isn't even microprocessor-controlled. It must be about the only thing that isn't these days, apart from Digest writers.

Designed for blown-air applications, PTC Honeycombe Heaters depend for their operation on the thermal properties of doped barium titanate, whose resistance increases sharply above a certain temperature - the switching temperature.

The elements are available in round or rectangular shapes, with a honeycombe structure to facilitate air flow over a large surface area. Electrical connection is made to electrodes coated onto the two flat surfaces.



## Drum Synth (June)

Three wire links are shown on the component overlay of the function board (p.89 Fig.9). The bottom link is an error and should not be fitted. Also the pad at the right hand end of the link (as seen on the component overlay) should be removed to stop it shorting the tracks on either side. The pad is also shown on the foil pattern and ETI PRINT, which will have to be corrected too.

The resistor numbering in Fig.7, p.88 is incorrect. R34-41 should be labelled R30-37. Resistor numbering on the circuit diagram, and parts list is correct.

Low initial resistance means rapid warm-up at switch-on. Air blown through the element reduces its temperature and, therefore, its resistance, which increases the input power. Thus the temperature of the block is maintained at the switching temperature. Heating power can be varied by controlling the air flow.

The two overwhelming advantages are safety (if the air flow stops, the heater limits itself to the switching temperature) and the elimination of radio frequency interference which occurs in conventional thermostatically controlled elements.

The new elements are available in a wide range of sizes, power ratings and switching temperatures. Further details of PTC Honeycombe Heaters from Salford Electrical Instruments Ltd, Peel Works, Barton Lane, Eccles, Manchester M30 0HL.

## Image Co-ordinator

There is an error on the component overlay shown in Fig.4 on page 72. On the top right edge of the board the power connections should read (from the top) 0V, -Ve, +Ve, to match the connections to the board shown in Fig.5 on page 73. The interboard connections are shown in the photograph on page 72.

## OK Cases

OK Machine & Tool's latest directory of packaging technology (catalogue of cases) recently reached us. The cases, by PacTec, come in over fifty models with all manner of variations available. They're made from impact-resistant ABS to stand up to rough treatment in service. Each case has a system of internal mounting bosses, vertical card guides and mounting rails with optional accessories available, producing a very flexible packaging system for your projects.

The range includes instrument cases with or without tilt stands, suitable for counters, timers, generators, etc. and a useful series of miniature cases, ideal for hand-held projects. Optional extras include ABS or metal front panels, special bezels and RFI shielding for the instrument cases and a belt clip, wrist strap and RFI shielding for the miniature cases.

For your free copy of OK's PanTec Catalogue, write to OK Machine & Tool UK Ltd., Dutton Lane, Eastleigh, Hants SO5 4AA.



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CAPACITORS				Miniature Low Value				Polyester Radial Leads				RESISTORS																							
Electrolytic Axial Leads -10% to +50% Tol.				Polystyrene, Axial, 1% Tol., >=63V DC Wkg. Ceramic Plate, Radial, Low K, 100V DC Wkg. Ceramic Plate, Radial, Med K, 100V DC Wkg. Ceramic Plate, Radial, High K, 63V DC Wkg.				Disposed Type, C280/352 Style Moulded Type, 10.2mm Pitch				Carbon Film, Fixed 0.25W, E24 Values, 10R-10M, 5% Tol. 0.25W, E12 Values, 10R-27K, 5% Tol.																							
µF	V.d.c.	16	26	40	63	µF	100	150	220	330	470	680	1000	1500	2200	20% Tol.	µF	352	380	470	560	680	820	1000	1500	2200	352	380	470	560	680	820	1000	1500	2200
1.0	16					1	100	150	220	330	470	680	1000	1500	2200	0.1	352	380	470	560	680	820	1000	1500	2200	0.1	352	380	470	560	680	820	1000	1500	2200

P.C.B. Components				C-MOS (BUFFERED)				74LS				LINEAR				SEMICONDUCTORS																															
Data: Pen. Blue Ink, Slow Drying				Order Code				Order Code				Order Code				Order Code																															
98	Pen 33PC			HEF4000	22	HEF4004	105	HEF4012	120	74LS00	19	74LS88A	106	74LS174	141	CA3046	84	IN914	5	2N3705	10	BC182L	12	BFX85	29	HEF4001	22	HEF4044	133	HEF4051	313	74LS01	19	74LS55	104	74LS273	119	CA3080E	77	IN4001	5	2N3773	297	BC184	11	BFY50	17

Plastic Boxes - Boss Industrial Mouldings				SWITCHES				MAINS TRANSFORMERS				VERO ELECTRONICS PRODUCTS			
Moulded Box and Close Fitting Flanged Lid ABS Base, C/W Brass Bushes, and Lid in Orange				Miniature Toggle - Honeywell				Secondaries may be connected in series or parallel to give wide-voltage range				2.5" x 5" 1" pitch Veroboard			
L112 W82 D31	99	Case B1M2003 OR	Order Code	SPDT	C/D/I	67	SW BA1011	0-4.5V, 0.4-5V Secondary	Trans 8VA	45	2.5" x 5" 1" pitch Veroboard (5)	85/Pack	200-2106C		

G.M.T. ELECTRONICS KITS				PUBLIC ADDRESS EQUIPMENT			
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TELETEXT DECODER + REMOTE CONTROL KIT (For wiring into existing television)				A56 50W AC/12VDC AMPLIFIER			
PAL ENCODER/MODULATOR KIT				A70 175W AC/24VDC PROFESSIONAL AMPLIFIER			
DOPPLER RADAR ALARM KIT				L78 20W WEATHERPROOF HORN SPEAKER, 8 OHM & LINE			
F. E. T. POWER AMPLIFIER OUTPUT MODULE KIT				L83 16W MEGAPHONE (SEPARATE MICROPHONE)			
ONE AMP POWER SUPPLY MODULE KIT - FIVE VOLTS				L110 40W CABINET SPEAKER 8 OR 16 OHMS (SPECIFY WHICH) (c/w black 'lynide' covering, metal corners and overall cover)			
ONE AMP POWER SUPPLY MODULE KIT - TWELVE VOLTS				M21 UNI-DIRECTIONAL ELECTRET CONDENSOR MIKE, 600 OHM			
MODEL INERTIA CONTROLLER MK I - SLOT RACER				M30 BALL WINDSHIELD DYNAMIC CARDIOD MIKE, 600/50K OHM			
MODEL INERTIA CONTROLLER MK II - TRAIN (HAND UNIT)				M104 SIX CHANNEL STEREO MIXER AND PRE-AMPLIFIER (accepts high and low imp mikes, and has RIAA input)			
MODEL INERTIA CONTROLLER MK III - TRAIN (CONSOLE UNIT)				M124 FLOOR TYPE MICROPHONE STAND, EXTENDS TO 60"			

# ETI NEXT MONTH

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## Survival

The time interval is getting shorter and the ladder higher. Your opponent has turned up the skill level to maximum — one tiny slip and you're gonna hit the bottom and hard. Can you make it to the top? Can you survive? Good game, Good game!

## Very Low Level Circuit Design

An absorbing article on the obstacles to be overcome at signal levels of a few microvolts and less. How do you minimise noise problems, when the amplitude of the noise is comparable to the amplitude of the signal? How about obtaining a decent gain without increasing hum pickup? An unusual and intriguing subject well explained.

## Digital Test Meter

If we told you that next month we are running what is probably the ultimate digital meter project would you believe us? Probably not — but try anyway, because its true! You name it, this box will measure it — accurately. Frequency, voltage, resistance, current etc etc. It has an LCD display and costs a lot less to build than you think.

Articles mentioned herein are in an advanced state of preparation. However, circumstances may dictate changes to the final contents.

# 555 APPLICATIONS

In this chapter from his new book, Jules H. Gilder provides twenty circuits for the motorist employing the ubiquitous 555 timer

Our thanks to Newnes Butterworth for their kind permission to reproduce this extract from their book. The chapter is shown exactly as it appears in the original and gives a good indication of the high standards throughout the book.

## 6.1 electronic ignition system\*

A capacitive-discharge automobile ignition system can be built with commonly available components. The system (Fig. 6-1) employs a 555 timer, which operates in an asynchronous square-wave mode, to drive the system's converter section. Thus, a common 6.3-V center-tap filament transformer of good quality can be used as the converter transformer. The rectified output of the converter transformer charges C2 to approximately 500 V dc.

When the points open, a positive-voltage pulse is coupled through R10, CR6, and C4 to the gate of the 2N4444 SCR. When the SCR fires, C2 discharges through the spark coil and starts to recharge with the opposite polarity. This polarity reversal provides a negative charge through R8 and CR8 to the SCR gate to prevent its retriggering after the SCR turns off.

When the points close, they discharge C4 through R9 and R10 so the SCR can be retriggered. The time required for this discharge provides delay to prevent erratic SCR firing caused by point bounce at high engine rpm.

This circuit is in actual use and has been bench-tested to an equivalent of 15,000 rpm on an eight-cylinder engine. With careful shopping, the entire system can be built for less than \$15.

## 6.2 voltage regulator†

A 555-type IC timer, in combination with a power Darlington transistor pair, can provide low-cost automotive voltage regulation. Such a regulator can even make it easier to start a car in cold weather.

\* Morgan, L. G., "Electronic Ignition System Uses Standard Components," *Electronic Design*, Nov 22, 1974, p. 198.

† Fusar, T. J., "IC Timer Makes Economical Automobile Voltage Regulator," reprinted from *Electronics*, Feb. 21, 1974; copyright © McGraw-Hill Inc., 1974. All rights reserved.

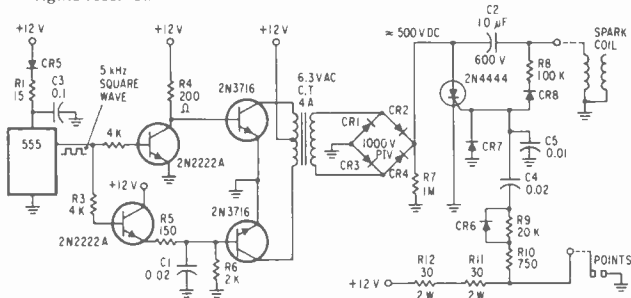
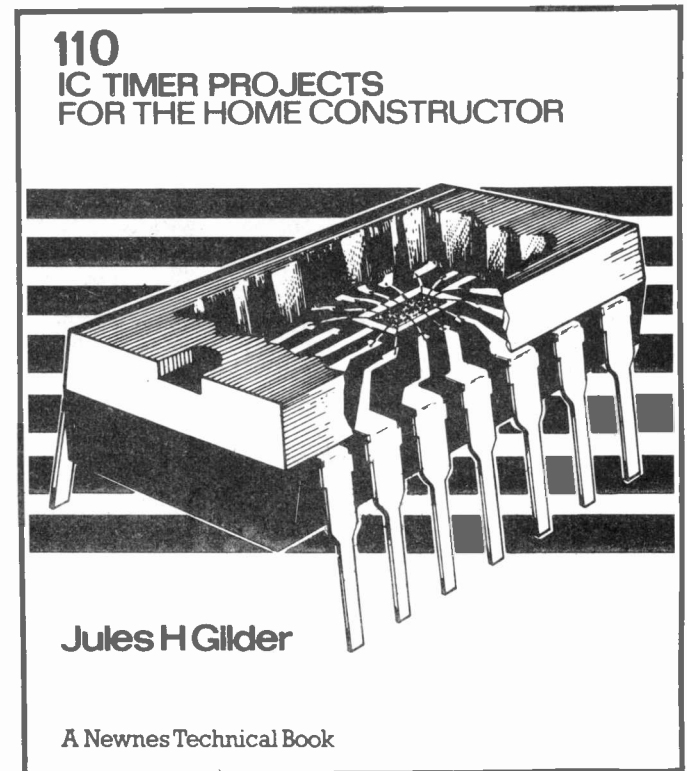


Fig. 6-1. Electronic ignition system.

As Fig. 6-2 shows, the circuit requires very few parts. The value of resistor R1 is chosen to prevent the timer's quiescent current, when the timer is off (output, pin 3, low), from turning on the Darlington pair.

If battery voltage becomes too low, the timer turns on, driving its output high and drawing a current of about 60 mA through resistor R2. This causes a sufficient biasing voltage to be developed across



resistor R1 and the Darlington turns on supplying the energizing current to the field coil of the car's alternator. Diode D1 suppresses the reverse voltage of the field coil when the Darlington pair is turned off.

The regulator's low-voltage turnon point is fixed by setting the voltage at the timer's trigger input (pin 2) to approximately half the reference voltage existing at its control-voltage input (pin 5). The high-voltage turnoff point is set by making the voltage at the timer's threshold input (pin 6) equal to the reference voltage at pin 6. At 77°F, the turnon voltage is typically 14.4 V, and the turnoff voltage is typically 14.9 V. These voltage levels, of course, should be set to match the charging requirement of a given car's specific battery-alternator combination.

The value of the reference voltage is established by the diode string D2 through D5; here, it is approximately 5.9 V. The output voltage has a negative temperature coefficient of -11 mV/°F.

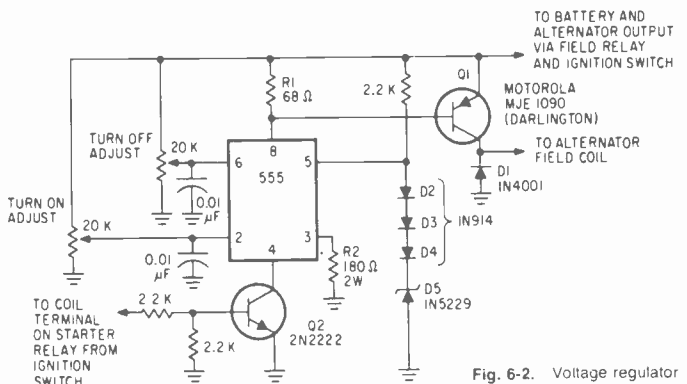


Fig. 6-2. Voltage regulator



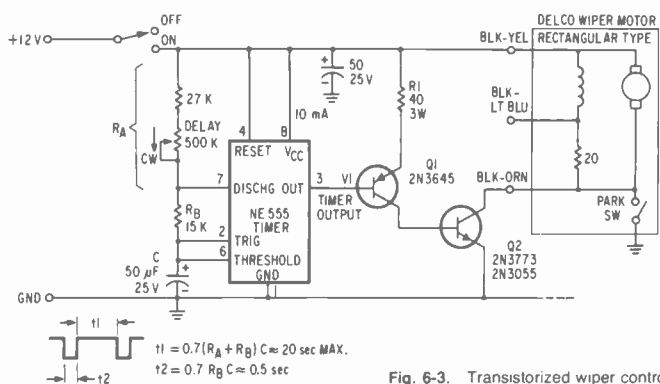


Fig. 6-3. Transistorized wiper control.

A transistor and a couple of resistors can be added to the circuit for better cold-weather starting. During starting, the transistor holds the timer in its off state lightening the load on the car's cranking motor. (And to prevent radio interference, a 10- $\mu$ F capacitor can be connected from the Darlington emitter to ground.)

### 6.3 transistorized wiper control\*

An all-solid-state automobile wiper-control circuit allows the windshield wiper to sweep at selected frequencies from once a second to once every 20 sec. The circuit (Fig. 6-3) uses one IC, two silicon transistors, and seven discrete components.

Circuit timing is determined by a 555-timer IC and its external parts,  $R_A$ ,  $R_W$ , and  $C$ . Transistor Q1 is switched on when V1 goes low, and npn transistor Q2 also turns on. The mechanical park switch takes over and conducts the motor current until one cycle of wiper motion is complete. At wiper park, the park switch opens and stops the wiper.

\* Galluzzi, P., "Circuit Provides Slow Auto-Wiper Cycling with One to 20 Seconds Between Sweeps," *Electronic Design*, Dec. 26, 1974, p. 108.

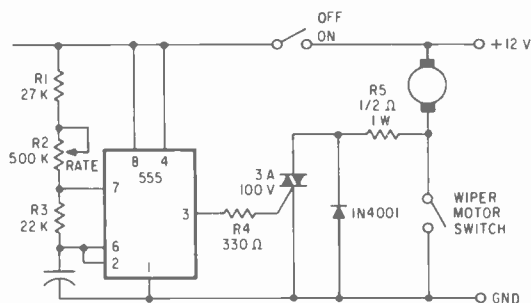


Fig. 6-4. Thyristor-switched wiper control.

Transistors Q1 and Q2 conduct for only about 0.5 sec. They do not conduct again until the next timer pulse. The delay between pulses is adjusted with the 500-k $\Omega$  delay resistor.

Resistor R1 limits the current into Q1 and the base of Q2. The peak collector current into Q2 is about 3 A. Since the duty cycle is normally very low, little heating occurs.

This circuit is in use on a GM-Delco rectangular-motor wiper system.

### 6.4 thyristor-switched wiper control

As in the previous circuit, the delay in this unit is adjustable from about 1-20 sec. The major difference between this wiper control (Fig. 6-4) and the earlier one is that this one uses a thyristor to do the switching. Like circuit 6.3, it is meant for cars in which the switch for the wiper motor breaks a connection to ground.

Diode D1 (1N4001) is included to prevent the back emf that is produced when the wiper opens at the end of a cycle from retriggering the thyristor and switching it on again without waiting for the delay. The diode can do this because it has a zener breakdown that is lower than that of the thyristor.

The addition of resistor R5 is to ensure that the current through the thyristor falls enough for it to switch off when the wiper contact closes. It may be necessary to increase the value of it a bit if this does not happen.

### 6.5 relay-switched wiper control

This wiper control (Fig. 6-5) is a more deluxe version of the two preceding ones. It uses a relay to perform the switching for the wiper and is meant for wiper motors whose switch breaks a connection to the

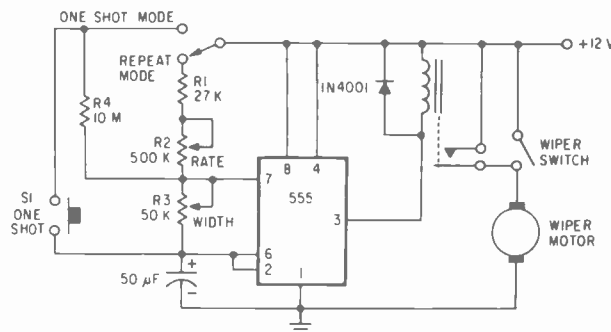


Fig. 6-5. Relay-switched wiper control.

positive supply rail (that could be changed by simply connecting the relay contacts to another spot).

The 555 astable drives a relay with a frequency that is adjustable by R2. A feature of this unit, which was not on the others, is that it has a variable-width control, so that the amount of time that the relay is on can be adjusted.

Another feature of this wiper control is that it offers two modes of operation: the normal cyclical mode and a one-shot mode. In the one-shot mode, the wipers can be activated for one cycle by pressing button S1 momentarily. If the button is not pressed again, in about 5.5 min the unit will itself activate the wipers for one cycle. This can serve as a reminder that it is still on.

### 6.6 seat-belt alarm

For those of you who like to wear seat belts in the car and have trouble convincing others that they should too, this circuit is ideal. It is an astable multivibrator whose output is connected to a power amplifier and a speaker (Fig. 6-6).

The loud wail that this circuit produces (about 5 W) should convince anyone to put on his seat belt, because that's the only way to stop it. It works like this: a magnetic reed switch that is normally open when there is no magnet near it is connected to the base of transistor Q1. So is R3. As long as the reed switch is open, R3 supplies current to the base of Q1 and turns it on. Q1 in turn permits current to flow to the astable circuit and the unit screams.

As soon as a magnet is brought near the reed switch, its contacts close, R3 is shorted to ground, Q1 turns off, and the oscillator turns off. All this takes place only if S2 is on, which occurs when someone sits in the seat. The reed switch and the magnet should be glued or

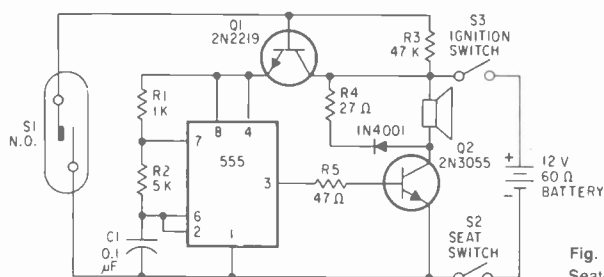


Fig. 6-6. Seat-belt alarm.

taped to the seat-belt buckle in such a way that when the seat belt is properly secured, they are in close proximity to one another.

### 6.7 seat-belt reminder

This circuit, unlike the previous one, does not force you to wear the seat belt when you are in the car. Rather, it reminds you that you should put it on, but obediently shuts up if you tell it to.

Once again, we see that the astable connection of the 555 is the one that comes in handy. Like the former circuit, this one (Fig. 6-7) uses a power amplifier on the output, to make sure you don't overlook the signal.

The hot lead for the circuit is connected to a point in the electrical system of the car that receives electricity only when the ignition switch is on. In most cars, a connection can be made to the supply lead for the radio. The ground lead for the timer circuit is connected to the anode

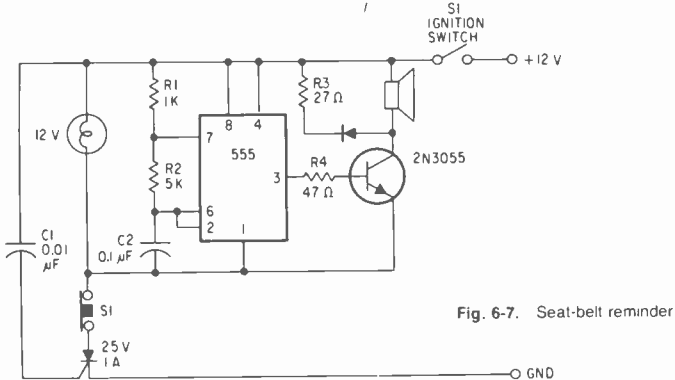


Fig. 6-7. Seat-belt reminder

of an SCR via pushbutton S1. As long as the SCR is not triggered, the oscillator will not operate.

However, when the ignition is turned on, a pulse passes through capacitor C1 to the gate of the SCR, because for an instant, the capacitor behaves as a short circuit. The capacitor, however, quickly charges up and will prevent further triggering of the SCR. In the meantime, the SCR has been turned on by the trigger pulse and it acts as a short circuit so that now the astable starts to oscillate. The astable will remain on until the SCR is turned off. This is done by simply pressing on the pushbutton switch for a moment, to break the circuit.

The lamp in the circuit can serve a dual purpose. First, it is there to insure that enough current flows through the SCR so that it will remain in conduction. If the current is too low, as it might be with the astable circuit alone, the SCR would be starved and would not latch. Second, if the lamp is part of the switch assembly for S1, then it will be very easy to locate the shutoff switch at night, when the interior of the car is dark.

### 6.8 low-battery alarm

What's the condition of your car battery? Is it low? Have you ever checked it? Chances are you cannot answer any of these questions satisfactorily. And if not, then you need this circuit. It is a low-battery indicator that will sound a tone when the voltage on your battery drops below 10 V.

As seen in Fig. 6-8, a zener diode is chosen whose zener voltage is equal to the low-limit voltage of the battery under test.

In this case, it was decided that if the car battery voltage dropped to below 10 V, the alarm should go off. So a 10-V zener was selected. With the zener connected as it is, 10 V is dropped across the zener and 2 V is placed on the junction of R1 and R2. This causes transistor Q1 to conduct, which in turn prevents Q2 from conducting, hence no alarm.

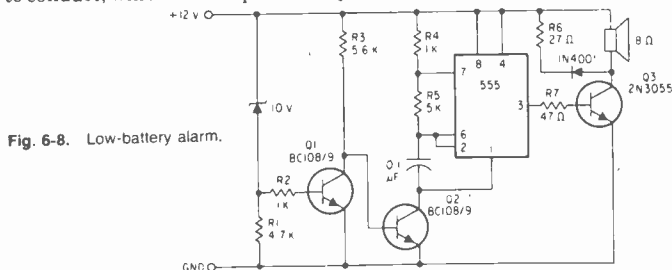


Fig. 6-8. Low-battery alarm.

However, if the voltage at the input to the circuit drops below 10 V, the zener diode will stop conducting and Q1 will turn off. This will cause Q2 to turn on, and will supply a ground return for the 555 oscillator, resulting in a tone being generated.

### 6.9 back-up alarm

Backing out of a long driveway can be dangerous, especially if there are small children around who cannot easily be seen. With this little circuit (Fig. 6-9), an audible warning tone will be sounded as soon as you put the car in reverse. The sound will stay on until you take the car out of reverse gear.

Basically, the device is an amplified oscillator whose output is used as the warning signal. For cars that have a separate set of back-up lights that turn on when the car is in reverse, connecting the unit to the car is extremely simple. In that case, the components inside the box are not needed and point A gets connected to the hot lead of the back-up lamp, while points B and C get connected together and are both connected to the chassis of the car (ground). Now whenever the car is put in reverse gear, the alarm, whose speaker should be mounted in the rear of the car so it can be heard, goes off.

But not all cars have separate back-up lights. Some of them turn on the blinker lights when the car is in reverse. In this case, the components in the box are needed and the circuit is constructed exactly as it appears in Fig. 6-9. In this case, points A and D are connected to the right and left rear blinker lights. Point A supplies power to the

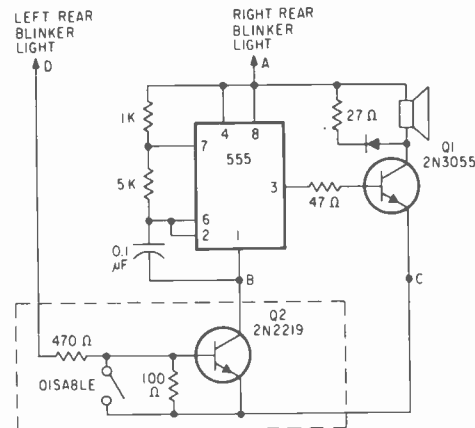
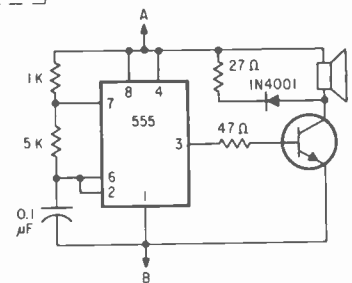


Fig. 6-9. Back-up alarm

Fig. 6-10. Turn indicator.



oscillator as normal and point D supplies power to the base of transistor Q2. This turns the transistor on and effectively shorts it to ground, causing the oscillator to work.

Remember, this happens only when both of the rear blinker lights are on at the same time. Thus, if your car has a hazard flasher that flashes the front and rear lights together, the back-up alarm will also turn on intermittently with the lights. To prevent this from happening, a disable switch has been included. This switch grounds the base of Q2 and prevents it from turning on.

### 6.10 turn indicator

Have you ever driven behind a person who had his turn indicator on but goes on for blocks on end without making a turn? It has probably happened to most of us at one time or another. The reason for this is that when the signal is turned on to indicate a lane change, or when one pulls away from the curb, the rotation on the steering wheel is not always enough to cause the mechanical return of the indicator switch. In addition, the clicking sound produced by the flasher inside the car is not always heard.

By using this circuit, which is very similar to the previous one, a loud flashing tone will be produced when the turn signal indicator is turned on, and turned off when the turn indicator goes off.

In the circuit shown in Fig. 6-10, point B is normally connected to the chassis of the car (for negative-ground cars). Point A has to get connected to a point that goes positive for each flash of the turn lights.

In some cars, where there is only one indicator light on the dashboard, it is only necessary to connect point A to the hot side of the light bulb. In most cars, however, there are two turn signal indicators on the dashboard. In that case, point A should be connected to one of the terminals on the flasher module that goes on with each flash.

## 6.11 headlight extinguisher

An automatic headlight extinguisher (Fig. 6-11) will allow you to turn off the car's ignition and still have a light to open the door by at night. After a predetermined period of time, which can vary from 10 sec to 1 min, the headlights will automatically shut off. Not only does this give you enough light to find your key in the dark, it also prevents you from accidentally leaving the lights on and finding a dead battery in the morning.

It operates like this. When the car ignition is turned on, current flows through resistor R3 and diode D1 to the relay. The relay then pulls in and makes it possible to turn on the headlights. When the ignition switch is turned off, a negative-going pulse is generated and applied to the trigger input of the timer (pin 2). Since the timer is configured to operate in the monostable mode, the pulse causes the output of the timer to go high for a period of time determined by  $t = 1.1(R1 + R2)C1$ . In this case, the pulse width is adjustable from about 10 sec to 1 min. The output of the timer is connected to the relay so the relay stays high for the additional period of time after the ignition is turned off.

It should be noted that the headlights will stay on only if the headlight switch is not shut off. In addition, you must remember to turn off the headlight switch the next morning, or you'll be driving around all day with your lights on.

## 6.12 light alarm

This alarm unit is a handy accessory to use with the headlight extinguisher in the previous section. As in most of the alarm-type

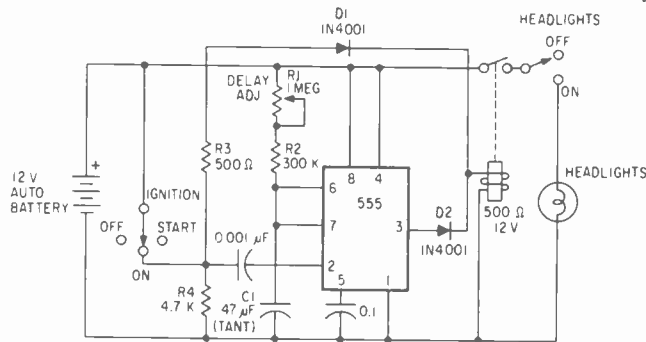


Fig. 6-11. Headlight extinguisher

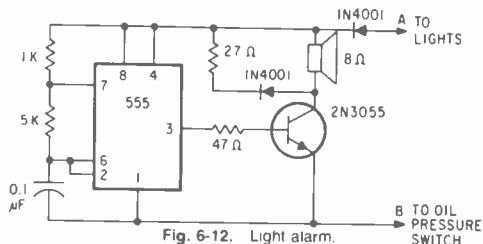


Fig. 6-12. Light alarm.

circuits, this one (Fig. 6-12) is composed chiefly of an amplified astable multivibrator. In addition, there is a diode in the positive power lead to protect the circuit from reverse voltages. Operation is very simple. When the ignition is on and the headlights are on, both point A and point B have +12 V applied to them, and the circuit has zero voltage drop across it so it does not operate.

When the ignition is turned off, however, the oil-pressure switch shorts to ground, and if the headlights are on, they supply power to the oscillator and a warning sound is generated.

## 6.13 automobile burglar alarm

With car theft on the rise, a good burglar alarm can be a useful thing to have. In Fig. 6-13 is a circuit for a simple alarm that uses a single 555 in the astable mode.

The alarm is connected to the already existing door switches that turn the dome light on when the door is opened. When the key switch, which is located on the fender of the car, is on, and one of the car doors is opened, a triggering voltage is applied to the gate of the SCR. This turns the SCR on and causes it to latch. The SCR thus applies power to the astable circuit, which oscillates at a frequency of about 1.5 Hz.

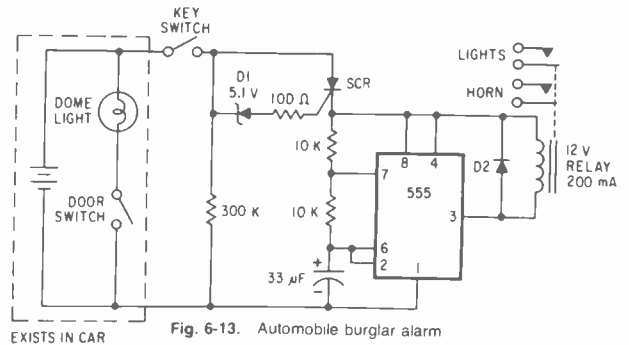


Fig. 6-13. Automobile burglar alarm

The output of the oscillator drives a relay. Diode D2 is used to prevent the timer from latching on due to the back emf generated by the relay coil. If a double-pole relay is used, the circuit can turn both the horn and the headlights on and off. The horn blowing will surely scare away any potential thief, and the flashing headlights will indicate to passersby which car is being tampered with.

The SCR is used to latch the circuit on so that, even if the thief closes the car door right away, the alarm will stay on until it is shut off with the key switch.

## 6.14 keyless burglar alarm

A big disadvantage of the alarm in the previous section is that it requires that a key switch be mounted outside of the protected area, generally on the fender of the car. But by adding another timer, or using a dual timer such as the 556, an alarm circuit can be built that can be armed with a hidden switch that is located somewhere inside the car.

What makes this possible is the second timer, which introduces a time delay before it arms the alarm. As long as you leave the car and close the door before this delay period expires, you'll have no problems.

This circuit (Fig. 6-14) requires that special switches be installed at each door, because it cannot use the existing one. All of the switches must be connected in series and are all normally closed when the doors are shut. The door switches short out the timing capacitor of T2. When one of the doors is opened, the short across C4 is removed and the

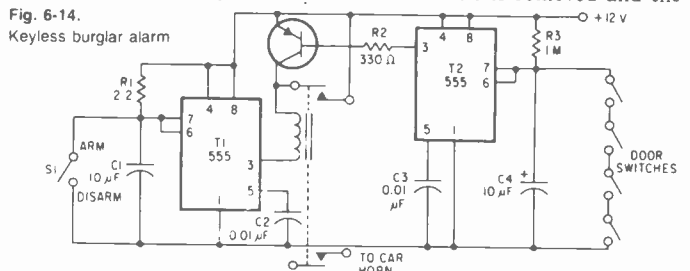
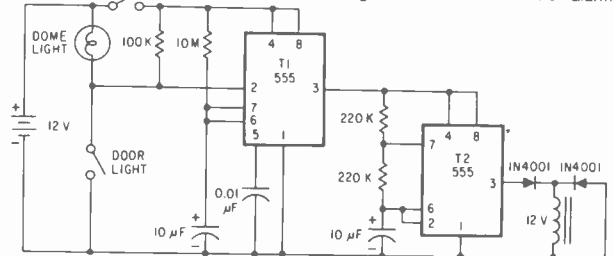


Fig. 6-14. Automatic shut-off alarm.



capacitor starts to charge up. This will take about 11 sec with the components shown. After 11 sec, the output voltage on pin 3 of T2 drops, and causes the transistor to turn on.

If the voltage at the output pin of T1 is low, the relay, driven by the transistor, will close. This does two things. It closes the contacts that are used to operate the car's horn and it also latches the relay on via a second set of contacts. Thus, the relay will remain on, and the horn will sound, as long as the output of T1 is low.

S1, the hidden switch, is used to arm and disarm the alarm and can be hidden somewhere inside the car. When S1 is closed, timing capacitor C2 is shorted and the voltage at the output of T1 is almost

at 12 V. Thus, the relay will not close when S1 is in this position. And if the alarm has been triggered, it may be silenced by closing S1.

To set the alarm, S1 is opened. You then have 25 ( $t = R1C1$ ) sec to close all of the doors before the horn will sound. On returning to the car, you will have 11 sec ( $t = R3C4$ ) to disarm the unit before the alarm sounds.

### 6.15 automatic shut-off alarm

A nice feature that neither the two previous alarm circuits has is automatic shutoff. This alarm (Fig. 6-15) uses two timers. T1 is set up as a monostable, which once triggered provides power to T2 for almost 2 min. T2 is set up as an astable that turns the relay on for 3 sec and off for 1, as long as it gets power from the monostable. After the monostable pulse ends, the alarm shuts off and is ready to be triggered again.

A big advantage of this circuit is that it uses existing door switches. And a key switch isn't absolutely necessary, although it does improve security. Here's how it works. S1 is the arming switch; it can be a key switch or simply hidden somewhere externally on the car. Once the alarm is triggered, it can only be shut off by opening S1. To turn the alarm circuit on, you get out of the car and lock all of the doors. Then turn on S1. Anyone who now opens a door will trigger the alarm, which will stay on for only 2 min unless the door remains open. In that case, the alarm continues to blow the car horn until 2 min after the door is shut or until S1 is opened.

### 6.16 engine immobilizer

An alarm alone is not sufficient protection from auto theft, especially if an experienced thief is involved. Generally, it's a good idea to have other obstacles in the way of the potential thief. One that is quite effective is an engine immobilizer.

Some immobilizers simply consist of a single-pole, single-throw (SPST) switch that is connected in parallel across the points in the distributor. When the switch is hidden, it does a fair job of making things difficult for a thief. But even they have discovered how to quickly recognize a switch of this type and can disconnect it in a matter of seconds.

But if the idea of an immobilizing switch is combined with a 555 timer, a good antitheft device can result. In Fig. 6-16 is the circuit of just such a device. The 555 is operated in its monostable mode, as a power-up monostable. That means it prevents power from being applied to the load until a certain time period ( $t = 1.1R1C1$ ) has elapsed.

For our immobilizer, the monostable is connected to the 12-V supply via an arming switch, and the ignition switch. If the arming switch is closed and the ignition is turned on, current will flow to the monostable. The instant the timing capacitor starts to charge up, the output of the 555 goes high. Since the relay, which is connected to the timer's high output, is also connected to the positive 12-V supply, there is no voltage drop across the relay and it remains inactivated. Thus, the relay contacts remain open and the engine can be started.

The output of the timer remains high for 30 sec and therefore the car can be started and will run fine, but for only 30 sec. At that point,

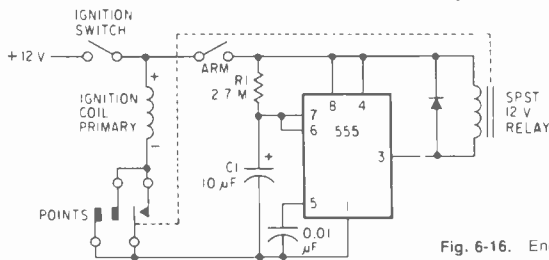


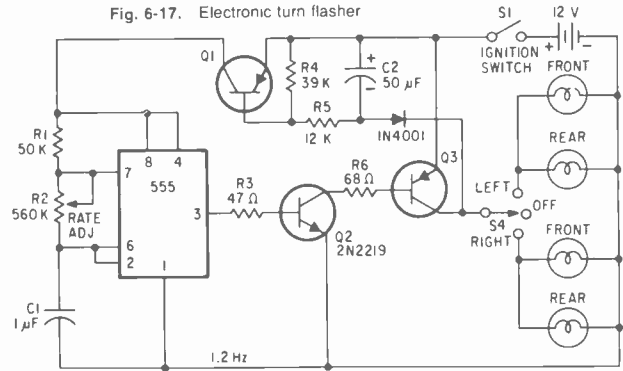
Fig. 6-16. Engine immobilizer

the output of the timer will go low again and the relay will turn on, shorting out the points and cutting off the ignition circuit.

If the car is restarted, it will again run for 30 sec and stop. After two or three tries, any thief will abandon this troublesome car for one that is easier to move.

### 6.17 electronic turn flasher

An all-electronic alternative to the conventional turn-signal flasher is shown in Fig. 6-17. It offers the advantage of having an adjustable flash rate via R2 and overall higher efficiency. The flashing



is produced by a 555 astable, but the most important part of the circuit is the circuitry that adapts the one-pole, three-position switch normally found in cars for operation with this circuit, which would ordinarily need a two-pole, three-position switch.

When the turn signal switch S2 is moved from the off position, it permits capacitor C2 to charge via the diode, and the base of transistor Q1 is held on via R5. This turns on Q1 and provides power to the astable. Q3 is prevented from discharging C2 by the diode.

As soon as the direction signal switch is returned to the normally off position, the bulbs stop flashing and shortly thereafter C3 becomes discharged and power is removed from the astable circuit.

### 6.18 light-up reminder

How often do you ride around in early evening and forget to turn your headlights on? If that happens to you, then this light-up reminder circuit is just what you need. By way of a flashing light in the car, it will tell you when the available light is low enough so that you should

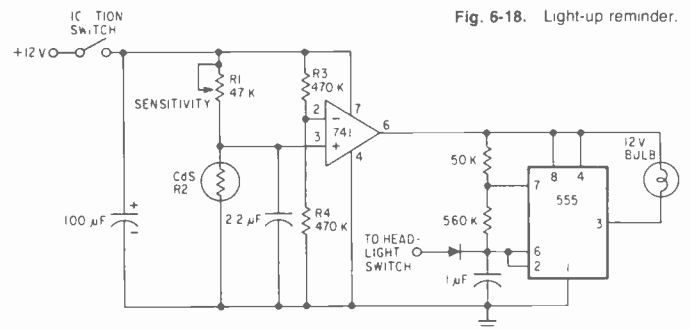


Fig. 6-18. Light-up reminder.

switch on your headlights. And, if you replace the astable circuit with a monostable and a relay, you can even have it turn the lights on for you automatically.

The circuit in Fig. 6-18 uses an operational amplifier as a comparator in a bridge circuit. R1 and R2 comprise one side of the bridge, while R3 and R4 make up the other. The inverting input of the op-amp is held at half the supply voltage by the R3/R4 voltage divider. The voltage at pin 3, the noninverting input, is determined by the R1/R2 divider. When the cadmium sulfide (CdS) photocell is brightly lit, its resistance is low and the voltage on pin 3 of the op-amp remains below that of pin 2. Under these conditions, the output of the op-amp will be a voltage that is very close to zero.

When darkness falls, the resistance of the CdS cell increases, thus raising the voltage at the noninverting input. When the voltage reaches the point where it is greater than the voltage on pin 2, the op-amp rapidly amplifies that small positive difference and produces a signal at its output that is close to 12 V. This is the signal that turns the warning circuit on.

The 555 timer is connected to the output pin of the 741 op-amp so that when its output goes high it receives power to cause it to oscillate. The oscillator can be used to drive a warning bulb, flashing it on and off.

Once you turn the lights on, you don't want the flashing light to bother you any more. This problem can be solved in one of two ways. Either you can place the photocell in such a way that it will be able to detect the light produced by the headlights as well as the ambient, or you can sense the voltage that is applied to the headlights.

# FEATURE: 555 Applications

Sensing the voltage is really quite simple. All that is necessary is to connect a diode to the junction of pins 2 and 6 and the timing capacitor. The anode of the diode gets connected to the light switch, so that when voltage is applied to the headlights it is applied to the anode as well. What this does is to keep the timing capacitor constantly charged, and prevents the 555 from oscillating.

## 6.19 bad-light indicator

Many times you can drive your car without ever knowing that one or more of your lights isn't working. After all, who checks lights unless it's time to have the car inspected? Not many people, because it means you have to go in the car and turn the lights on then run around the car to make sure they're all working. And if you want to check your brake lights, you have to get another person to help you. One of you has to step on the brakes, while the other checks to see if the lights are on.

Well, checking your car lights can now be as simple as turning a knob. With the circuit in Fig. 6-19, all you have to do to check out all the lights on the car is to sit in the driver's seat and select the proper photocell to connect into the circuit.

In this case, the 555 is being used as a comparator. The photocell array and R1 and R2 compose a voltage divider. If a light is good, it illuminates one of the photocells and the resistance of that cell will drop. This will cause the voltage applied to pins 2 and 6 to rise. R2 is adjusted so that the voltage rise is above  $\frac{2}{3}V_{cc}$ . When that condition is met, the output of the 555 goes low and the voltage drop across the LED is close to zero. The LED doesn't light.

When a lamp is bad, the resistance of the photocell will be high. This causes the voltage at pins 2 and 6 to drop below  $\frac{2}{3}V_{cc}$  and the output of the timer goes high, turning on the LED.

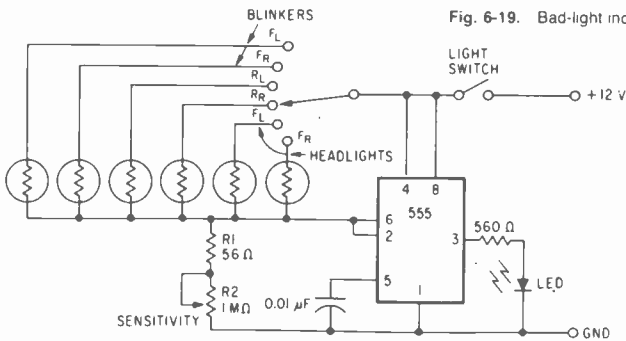


Fig. 6-19. Bad-light indicator.

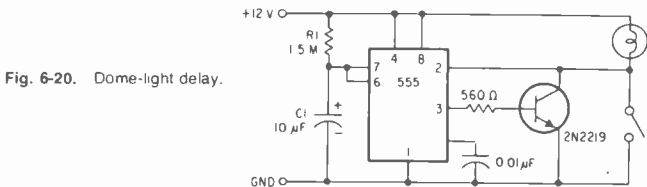


Fig. 6-20. Dome-light delay.

## 6.20 dome-light delay

By configuring a monostable multivibrator so that it drives the line it senses, you can make a little device that will come in very handy: a delayed-extinguish dome light. This will be useful when you enter your car at night and have to fumble around until you find the ignition keyhole.

The circuit in Fig. 6-20 will keep the dome light on for an additional 15 sec before it turns it off. The time delay is figured out just like it is for a conventional monostable. The output drives a transistor that is connected across the door switch of the car and also to the trigger input.

When the door is opened, the switch shorts to ground and turns the light on. At the same time, it applies a negative spike to the trigger input and starts the monostable cycle. The output of the monostable goes high and stays high for the period  $t = R1C1$ . The high output turns on the transistor, which keeps a short across the door switch and keeps the dome light on.

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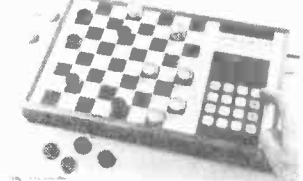
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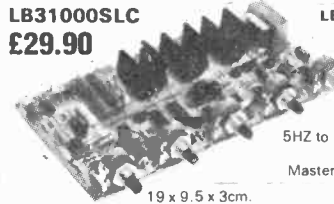
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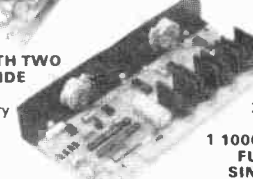
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# EMP (ELECTROMAGNETIC PULSE)

Nuclear war has never been a more real threat to humanity. Should the inconceivable occur — and an exchange take place — how well prepared are we in Britain to survive? This disturbing article from Graham Packer points out what appears to be a major weakness in Britain's defensive thinking.

Relations between the super-powers are deteriorating rapidly and with the ever growing 'nuclear club' of nations the possibility of such weapons being used in anger in the not too distant future is very real indeed.

It would appear that one major effect of such use is largely unknown by the general public and is, to say the least, being dealt with too lightly by the authorities. It is an effect that has catastrophic consequences for solid state communications and computing equipment and which could reveal any well laid plans to cope with "the Bomb" to be futile and mis-guided.

I, the author, am a freelance writer, principally upon the topics of communications and amateur radio. All the information has been gleaned from normal technical publications and text books and can be freely obtained by any member of the public who cares to look.

Besides the well publicised phenomena associated with the detonation of a nuclear device (i.e. blast, heat and light) there is the ELECTROMAGNETIC PULSE (EMP) to contend with. Since the first weapon trials in 1945 the 'radio flash', as it was then known, has been observed and documented. Only in recent years, however, have the full implications of the EMP become apparent. Damage to most radio, landline and computer equipment, up to a maximum range of 2500 k, from ground zero (the point of detonation), is not just possible, but *probable*.

## Mechanisms That Produce EMP

There are three situations where an EMP can occur at high enough strengths (See Fig. 1.) to be deadly to electronic communications.

1. A WEAPON BURST AT GROUND LEVEL OR BELOW 100 m ABOVE GROUND LEVEL.
2. A VERY HIGH AIR-BURST AT THE TOP OF THE ATMOSPHERE.
3. AN EXO-ATMOSPHERIC BURST

In cases 1 & 2 the EMP appears to be caused by Compton electrons, produced by the initial, high energy, gamma flux radiating from the point of detonation. These cause a vast outward current flow — the pulse of energy known as EMP.

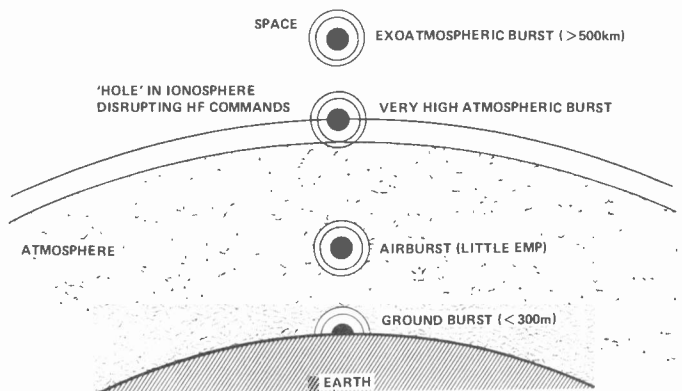


Fig. 1. The different methods of detonation of a nuclear device. Note that an airburst will maximise damage to surrounding environments physically but minimize EMP.

In the case of a ground burst an assymetric condition exists and the energy is radiated upwards in electromagnetic form, away from the ground.

If a very high air burst occurs the reverse happens (as there are electrons to be excited only in the atmosphere and not in space). In this case the electromagnetic energy is radiated downwards in a particularly crippling manner.

If the weapon is 'air-burst' however, (between 10 m & 10 km say) the outward current flow is symmetrical and almost self cancelling. Fortunately, from an EMP point of view anyway, air bursts are the most efficient militarily, maximising heat and blast, and would probably constitute the majority of strikes in a major nuclear exchange.

An exo-atmospheric blast at, say, 1000 km altitude is the 'worst case'. With no absorptive medium surrounding the device, the energy from the weapon, mainly in the form of gamma and X-rays, reaches the upper atmosphere over a wide area simultaneously. Interaction with the electrons there causes a vast pulse of energy to be radiated downward over a huge area. EMP with a vengeance.



## Effects Of The EMP

Neither the 1950 or 1957 issues of 'Effects of Nuclear Weapons' contain any reference to EMP. It is first mentioned in 1962 where a fairly brief description mentions that EMP is "of considerable interest". The 'interest' shown was in the results of the Johnstone Island exo-atmospheric test in 1958. This test produced failures to street lighting systems (presumably fed via overhead wiring) in Hawaii 1000 km away.

Unfortunately as the intensity of the effect was unexpected, no meaningful measurements of field strength were made.

Further tests were carried out and Fig.2 shows the field strengths to be expected from a one Megaton ground burst weapon, at various distances from ground zero.

Detonating that same weapon as an exo-atmospheric burst produces several thousand volts per metre over an area limited only by the curvature of the Earth! Figure 3 shows the areas in Europe that such a blast over the North Sea would encompass - producing widespread disruption to Europe's communications.

Whilst not violating any particular country's territorial integrity, (there being no blast or fall out associated with an exo-atmospheric blast) such a strike could well be a final 'sabre-rattling' exercise prior to commencement of more direct hostilities.

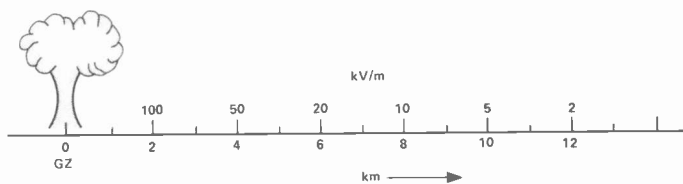


Fig. 2. The field strengths produced by detonating a one Megaton bomb. Remember too that a 20 Megaton warhead is very commonplace today - and to be expected in combat.

Of course Europe is not the only place that such a burst could be used and perusal of an atlas shows that there are other 'theatres' where an EMP could be generated such that 'innocent' countries (including perhaps the UK) would be subjected to its effect.

## Rise Time

Figure 4 compares EMP to lightning. By comparison lightning can be seen as a very sluggish phenomena indeed! Rise times of 20 ns ( $20 \times 10^{-9}$  seconds) have been reported, resulting in considerable energy up to several hundred of MHz. Radio amateurs and home computing enthusiasts need no reminding of the effects of large field strengths on their beloved electronics.

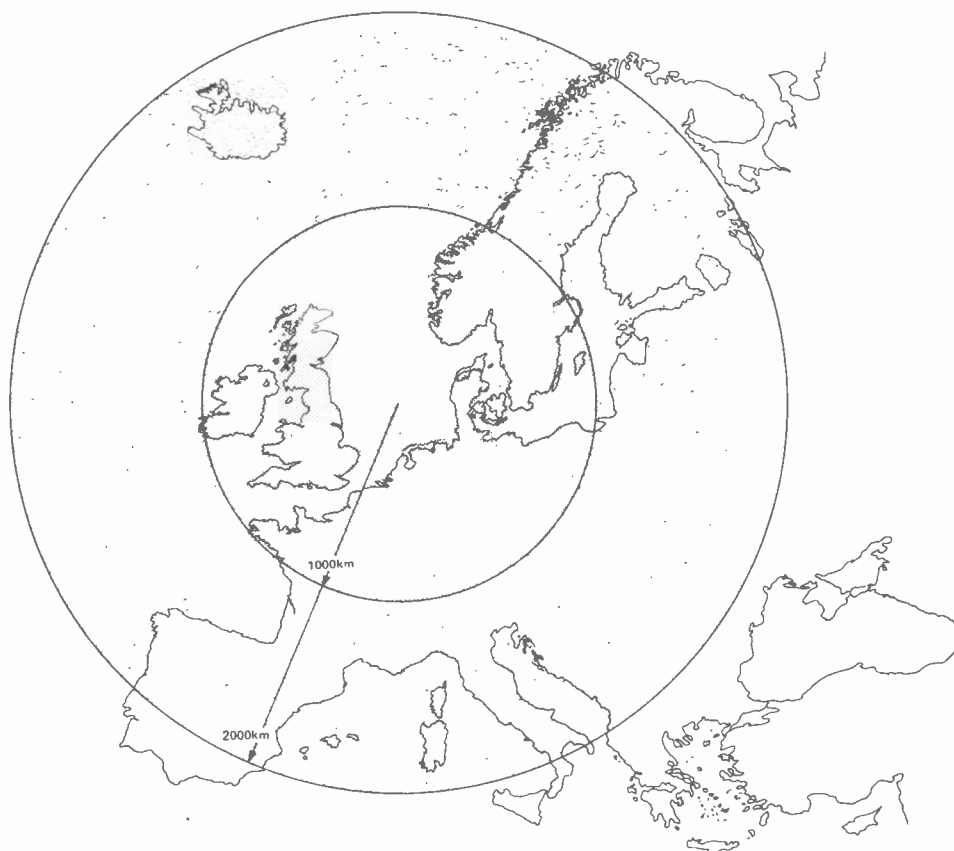


Fig. 3. A sketch of the European theatre, showing the level of effect from a one Megaton detonation over the North Sea. Such a blast does not actually infringe any single country's border integrity but affects all those shown.

The inner circle represents the radius of expected severe damage to equipment and the second circle is that within which some detrimental effect is to be expected.

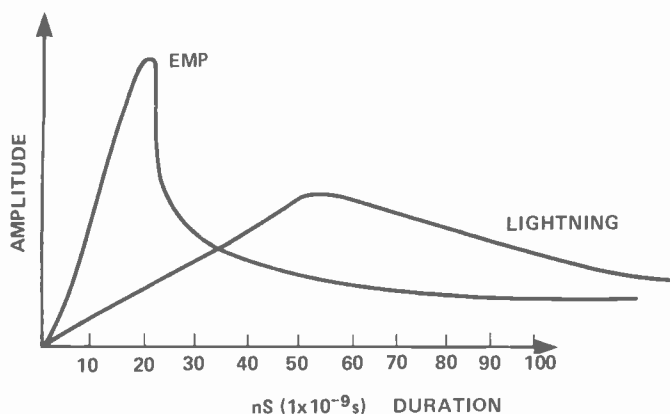


Fig. 4. Comparative rise-times of an EMP from a 1 Mt. bomb and an average lightning flash. Note that the EMP is many times faster.

Not for nothing do modern military receivers have POWER transistors and 2 W of local oscillator power present in the front ends! Don't entirely believe the sales talk about "large signal handling characteristics" that's just a spin off!

The interest shown in professional computer circles in 'line conditioners', 'transorbs' and RFI shielding has its roots in the military's requirements for protecting their data processing hardware.

## EMP Collectors

HF aerials are of course text-book EMP 'collectors' and the increased use of broadband mixers and power output stages place this equipment especially at the risk from EMP.

However VALVE equipment is substantially immune to EMP — or can at least withstand levels of field strength orders of magnitude greater than solid state — rumour has it there could still be a place for '19' sets in World War III! (Russian and Warsaw Pact forces still employ valve equipment in quantity.)

Telephone lines, extending overhead for several kilometers at a time, are extremely vulnerable. They are being increasingly terminated in electronic exchanges, or transistor amplifiers WHICH ARE NOT EXPECTED to survive an EMP. Exit telephone communication.

Overhead power-lines are likewise excellent aerials and although the transient nature of EMP is unlikely to damage motors, tungsten lamps etc. etc, many pieces of electronic equipment, domestic, amateur and professional will be destroyed.

Table 1 gives items that are expected to survive or succumb to an EMP attack and should be carefully studied for the implicit effect upon Civil Defence communication after nuclear attack.

## Radio Propagation

Little information seems to be available in the 'open' literature on radio propagation after a nuclear exchange. It is virtually certain that the ionosphere as we know it will be destroyed temporarily. The maximum usable frequency will probably be lowered dramatically (hence the vast low frequency, very low frequency and extremely low frequency military installations throughout the

TABLE 1

### EQUIPMENT NOT EXPECTED TO SURVIVE EMP ATTACK

1. Fluorescent lights.
2. HF transistor transmitters and receivers, especially broadband.
3. VHF mobile equipment with long whip aerials.
4. VHF broadcast-band receivers with aerials extended.
5. All landline communications, especially electronic telephone exchanges.
6. Land "repeaters", which account for 90% of radio communication.

### RELATIVELY IMMUNE EQUIPMENT

1. Tungsten lamps (or other filament).
2. Valve transmitters and receivers.
3. Electronic motors (NOT solid-state speed control)
4. Medium Wave portable with ferrite rod aerials.
5. SHF link equipment, AS LONG AS the feeder or waveguide does not conduct EMP to other parts of the equipment.

Study the table above carefully. It has far reaching implications. Ask yourself if a stable society could be set up, given the destruction of all viable long distance communications as a starting point.

world) and it is assumed that most satellite communications will cease. This will come about either as a direct result of the nuclear exchange, the 'satellite - killing' capability of the super-powers, or the 'neutralisation' of the satellite ground stations.

Conversely highly ionised patches could well result in sporadic 'E' beyond the wildest dreams of 2 m DX enthusiasts.

## Conclusions

From the preceding it may be seen that deliberate detonation of a nuclear weapon to maximise the EMP effect could and probably would occur in a future conflict. This could effect this country even if the U.K. was not directly involved in the conflict itself.

Some possible measures to counteract the effects of EMP are given in Table 2, although without concerted action at a high level, Britain will remain very vulnerable to this type of attack.

TABLE 2

- |    |   |
|----|---|
| 1. | Disconnect all electronic equipment from aerials and power sources during that period.                      |
| 2. | Use Radio equipment 'on sked' for the minimum possible time.  |
| 3. | Use high 'Q' ATU on HF or 'cavity' on VHF to reduce acceptance bandwidth to a minimum.                      |
| 4. | Earth all screens, coax outers etc. Treat as for massive TVI case.  |
| 5. | Solder reverse parallel diodes across receiver front ends as for normal burnout protection.                 |
| 6. | Keep a supply of spare vital components such as front end transistors, diodes etc. in a screened container. |
| 7. | Consider the use of VALVE radios!   |

## DEATH BY NEGLIGENCE? **I**t seems strange that such a potentially crippling product of nuclear warfare has received such little exposure to the public eye.

Much has been made of late, by both press and TV, of the Soviet superiority in conventional, and indeed nuclear, materials and the effect upon this country of employing such forces against the West. It is to be hoped that such debate will bring with it much needed increases in the defence spending of this country.

Our Civil Defense programme could be well described as minimal, with little or no interest until recently in improving it. Compared to countries such as Sweden, Switzerland and - more significantly - the USSR, our efforts are nothing short of laughable.

Picture now some highly probable effects of an EMP upon our already pitiful survival resources. Telephone communications will be knocked out in most, if not all, parts of the country. Landline and repeater equipment used for the majority of communications in Britain, will be destroyed or rendered inoperative. All double frequency radio communication (i.e. anything using repeaters) will be impossible. All VHF broadcast receivers, with aerials extended, and mobile VHF equipment will have their front-ends severely damaged. HF transistor and receiver units will no longer operate, especially the widely used broadband radio and radar equipment.

In essence then, electronic communication in this country will cease to exist in its present form once a blast which produces a significant EMP has taken place. This is not a temporary blackout - as popular opinion supposes - *but a widespread and immediate destruction of equipment*, which will take extensive repairs to correct. Difficulties such as this would normally cause will be compounded many times in a shattered and disjointed community desperately struggling to regain some cohesion in the face of hideous adversity.

Result? Small isolated groups will be unable to communicate effectively with each other. People alone in their houses, following government instructions - such as contained in the "Protect and Survive" leaflet, will be completely cut-off unless they have a *medium wave portable*, which was not in use at the time of the attack. VHF receivers will be dead and in need of extensive repair.

We have been through the government literature covering nuclear warfare and its effects. There is no reference anywhere to EMP. It seems from this angle as though this is yet another case of "head-in-the-sand" defense. If so, then it is simply not good enough and it will cost lives we can ill afford.

We have sent copies of this article to the Home Office, Ministry of Defense and even the Prime Minister's Office and await an answer to the vital questions posed herein. ETI will carry the full text of such a reply as soon as we receive it and a page is reserved in our next issue especially for this purpose. I have a cold certain feeling it will be blank.

**Ron Harris**  
Editor

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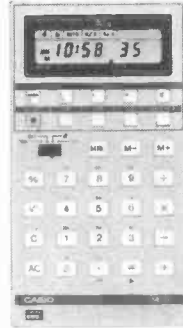
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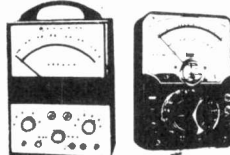
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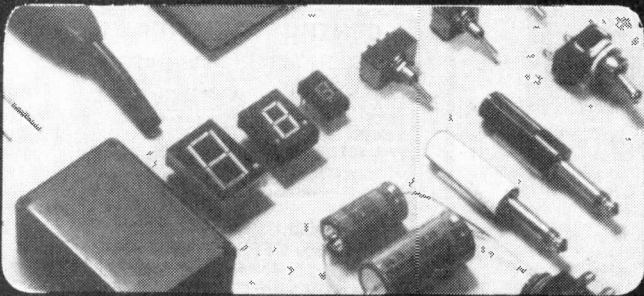
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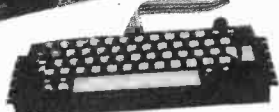
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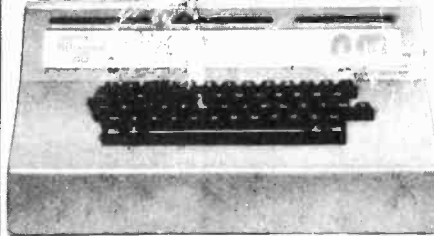
The input and output sides of the UART are independently switchable between any of the options — i.e. it is possible to have input on the cassette and output on the printer.

**PIO** There is also a totally uncommitted Parallel I/O (MK 3881) giving 16, programmable, I/O lines. These are addressable as 2 x 8 bit ports with complete handshake controls.

**Documentation** Full construction article is provided for those who buy a kit and an extensive software manual is provided for the monitor and Basic.

**Basic** The Nascom 2 contains a full 8K Microsoft Basic in one Rom chip with additional features like DEEK, DOKE, SET-RESET for simple programming.

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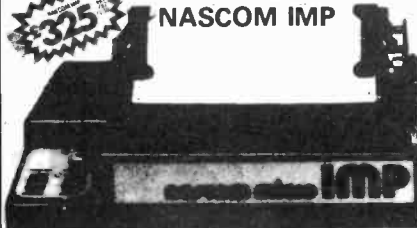
The MPU is the standard Z80 which is capable of executing 158 instructions including all 8080 code.



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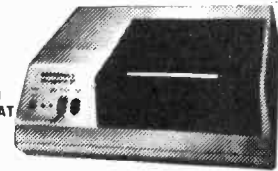
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# AUDIOPHILE

Opposite ends of the scale this month with a super-fi, super-heavy amp from JVC and a tiny portable player with hi-fi aspirations. Ron Harris reports.

I could tell it was going to be a *different* month right from the start. Two days gone since our last issue went to the printers at six-thirty on a Monday morning, and here I am, opening my flat door to the sight and sound of a little red-faced delivery man, sitting on a box barely smaller than him, perspiring freely and moaning in a high voice of the effect this job has had upon his hopes of an active married life.

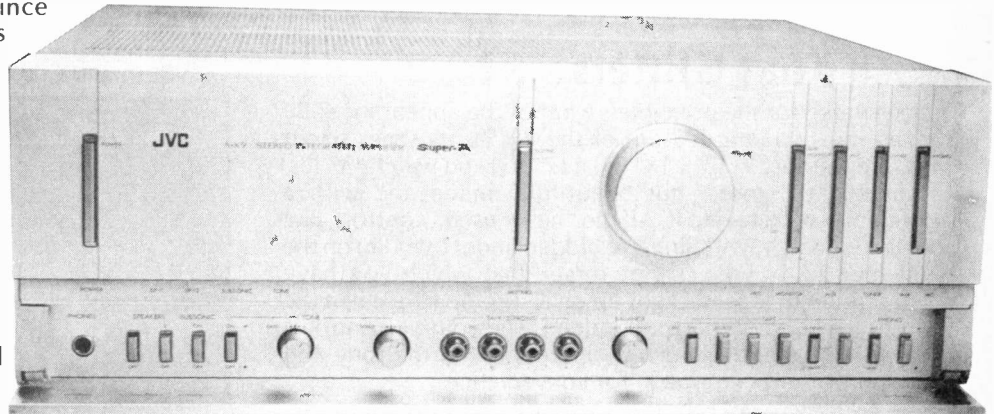
After placating said tradesman — palms crossed with silver make up for more than I thought — and dragging this huge piece of hernia hi-fi into my living room (I understood his problems more fully now), only to find the box sealed with a tape possessed of a higher tensile strength than steel, it began to look like this month and me were not destined to get on very well. A view reinforced very rapidly by the complete absence of tea from my kitchen. Six-thirty on a Monday is NO time to discover such things.

Hospitals should have special emergency units set up to deliver intravenous shots of Tetleys for moments like that. National Health, (what's left of it) take note.

## Super A or Eh!

It was two days and many cups of tea later that I finally obtained sound from the beast — a JVC A-X9 amplifier — having been held up slightly by the structural alterations required to sustain such mass. (Don't forget that what follows has all been made possible by that little man who sacrificed future generations in order that you may read this test report!)

The A-X9 takes its place at the head of JVC's new



amplifier range and employs their new variable bias circuit, which is claimed to allow class A operation at much higher powers than has hitherto been possible by increasing the efficiency of power transfer.

Normal class A amps — in which the output transistors are continually passing current — manage only about 25% efficiency. This would mean that a 100 W audio output requires some 300 W of heat to be dissipated. Great for musical evenings around the family heatsink in winter, but not a great deal of use otherwise.

Class B, on the other hand, runs around 75% efficient and the difference has meant that over 90% of output stages resting in hi-fi equipment cases today are either Class B or AB, the closely related derivative designed to defeat cross-over distortion.

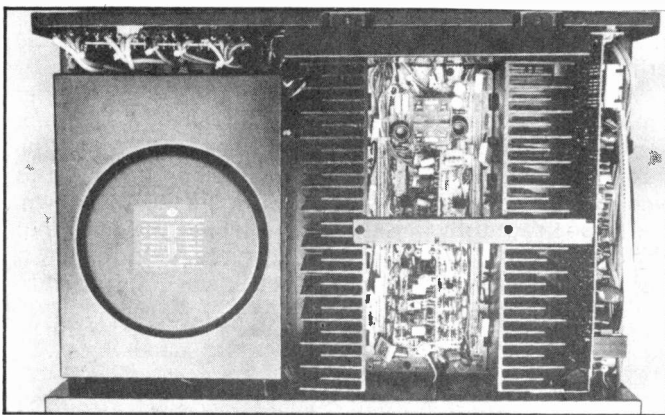
The major drawback of the currents is their liking for odd-harmonic distortion components, mainly generated by the switching on and off (or nearly!) of the output transistors. Class A has long been held as a potentially better method of amplification. But how to employ it, at a realistic power level, without inventing the portable infinite heatsink? Ah, there lies the rub!

JVC's solution is to make the bias circuit signal dependent. The output stage is run in Class A normally, but the bias current is reduced down to an absolute minimum when there is no signal present to be amplified. Resulting efficiency is claimed to be around 70%, making the use of Class-A viable for high powers.

## PSU 2, TIMO

Other refinements in the circuits include the use of a separate supply for the output stages and a tone control configuration which is in the feedback network of the POWER amp — as opposed to being a separate gain stage in the pre-amp.

In common with most Oriental designers, JVC have gone for an incredible power bandwidth — in this case



Note the massive PSU on the left and those huge heatsinks down the centre. This is one HEAVY amp.

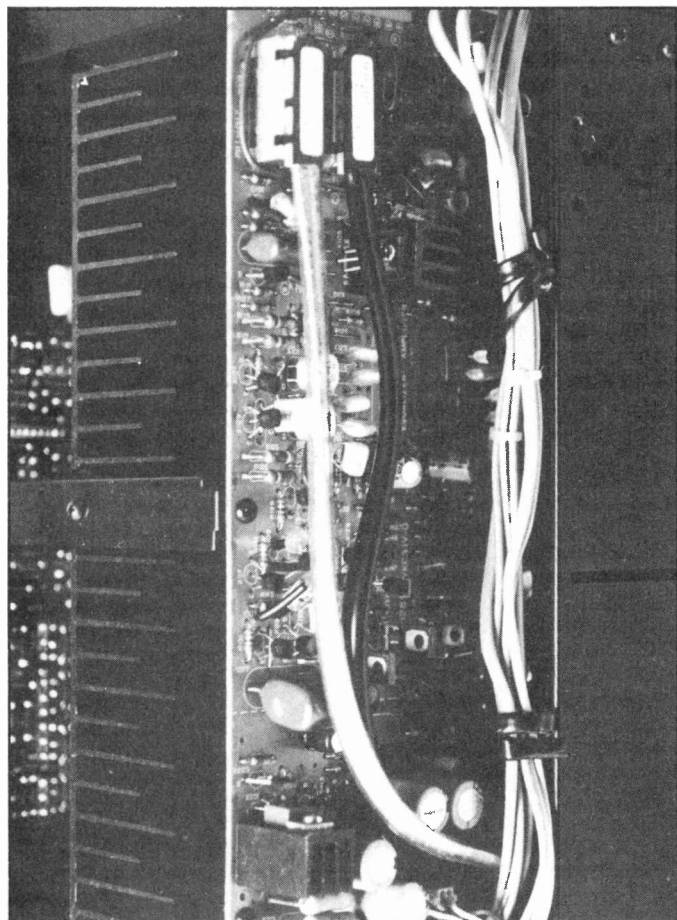
somewhere close to 200 kHz (maybe they can hear things we cannot?) and this coupled with ultra-fast slew-rate leads a claim of ZERO TID (transient intermodulation distortion). Either variety of cartridge type can be accommodated and a switch is present on the front panel to switch from the MM to MC (from moving-magnet to moving coil). This is a mechanical operation at the panel, with a flexible drive transferring the command to PCB mounted switches close to the input sockets.

Taping facilities are comprehensive with three sets of input sockets, one hidden on the front panel, with which you can record onto either deck from source, or other tape machine.

## All That Glitters . . . ?

So much for the principles, what of the appearance? By far the most striking feature of the A-X9 is its sheer size. It measures almost 9" (h) x 18" (w) x 17" (D) and weighs 37 lbs. Impossible to ignore, but beautifully made and with a confidently solid feel to it. All the "never used" controls, like tone and speaker switching, are hidden under that flap on the front, but so as you cannot forget that which you have operated, small legends light up on a chrome strip when the buttons are used. Very smart indeed. The volume control is nicely massive and smooth in operation and the tone and balance are "click-stopped" for convenience.

Overall the A-X9 is brilliantly made and a dream to use. No possible complaints there.

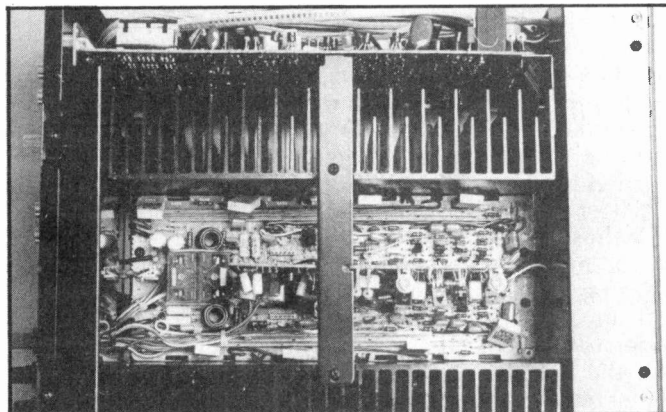


## . . . Is Not Gold?

Trying to measure performance on a machine like this is silly, it betters specification and/or measuring equipment on all parameters, so I give only a selection from the results below — chosen for reasons which I hope will become apparent.

Marvellous engineering this and I moved on to have a good long listen with interest. My usual limit first, measure later policy having been defeated by the logistics of moving a 37 lbs cube of metal around. . .

Frankly I was very, very disappointed. I had expected great things from the A-X9— judging by book covers I suppose, well built or not, and was let down. This machine retails at around £530, putting it in direct competition with a whole host of excellent British units — Lecson, Meridian, Quantum and Crimson, to mention but a few.



Close up of the highly complex variable bias circuit.

I auditioned the JVC directly against a Lecson ACI/AP3 II and the Quantum 102/204 combination reviewed last month. Both delivered a superior performance in my opinion. The JVC seemed to lack punch and masked mid-range detail sufficiently to be immediately identifiable in A-B comparisons.

The signal-to-noise was better with A-X9, on all inputs, and it performed much better with tape or tuner as a source. This tends to point the finger at the disc input rather than the clever power amplifier and a second test confirmed this.

## Slipped Disc?

I used the Quantum pre-amp as a "head amplifier" and fed the signal from this into the JVC's tape input, comparable with the Lescon set-up as reference. A different picture entirely now. Most of the missing detail is back and, allowing for the lower power output, a much more credible performance resulted.

Much as I would like to exonerate the main amplifier completely, I'm afraid I cannot do so. Overall the A-X9 is very 'edgy' on difficult signals, such as strings, and lacked the peak power 'headroom' to portray dynamics properly. At this price level, therefore, I must regretfully mark the A-X9 down.

It is so beautifully finished and presented, however, that provided you are not searching for absolute performance, it may well still appeal on ergonomic and engineering grounds.

Pickup amplifier board. The tubes carry a sliding metal strip which operates the moving coil/magnet selector, at the top centre of the PCB.





## Stowaway Where?

Something pretty neat — but weird. Did I not tell you it was gonna be one of those months? First the world's heaviest amp — now the world's *smallest* stereo cassette. Called the Stowaway, or TPS-L2, it comes from Sony (again) who claim to be selling them abroad with an ease which makes me think they're giving free photos of Felicity Kendal away with every machine. Put me down for a dozen.

I reproduce Sony's handout shot here for two reasons. Firstly because it is so awful as to be a model of how *not* to do these things. Secondly because I didn't get to attend the press launch with *Hot Gossip* and this is as good a way as any of exacting revenge upon Sony's PR.

The machine really is small ( $3\frac{1}{2} \times 5\frac{5}{16} \times 1\frac{7}{16}$  inches) and weighs well under a pound. The idea is to fit one to your belt, or use the carrying strap, thus obtaining a truly portable source good quality sound. Output is via those MDR-3 headphones of which I spoke a while back, resulting in a surprising sound quality. Intended source material is pre-recorded cassettes (no record facility) but the Stowaway is happy to play home recordings, as long as you use plain, ordinary non-chrome, non-metal tapes to do it.

## Head For Success

Sockets exist for two pairs of MDR-3's to be used simultaneously and there is even a method of communication between sets. A built-in microphone will pick up sound upon depression of the "Hot Line" button and quiet the music to relay what it hears to the users.

With the MDR-3's though, there is little need to use the microphone — once the music is muted you can hear perfectly well anyway.

Fast wind in either direction leaves the heads in place, so that you can skip back and forwards to find the bits you want. A definite pop facility. Tone control is a switch, you have it or you don't. (It's only a treble cut circuit).

Sound quality is undeniably good, in fact its in a different class entirely to any portable recorder you've ever heard up to now. Biasing for prerecorded tapes is the only thing they could have done and it works well. I tried making up some tapes, both on Sony AHF and TDK formulations and was returned good results from both.

## Winding Up

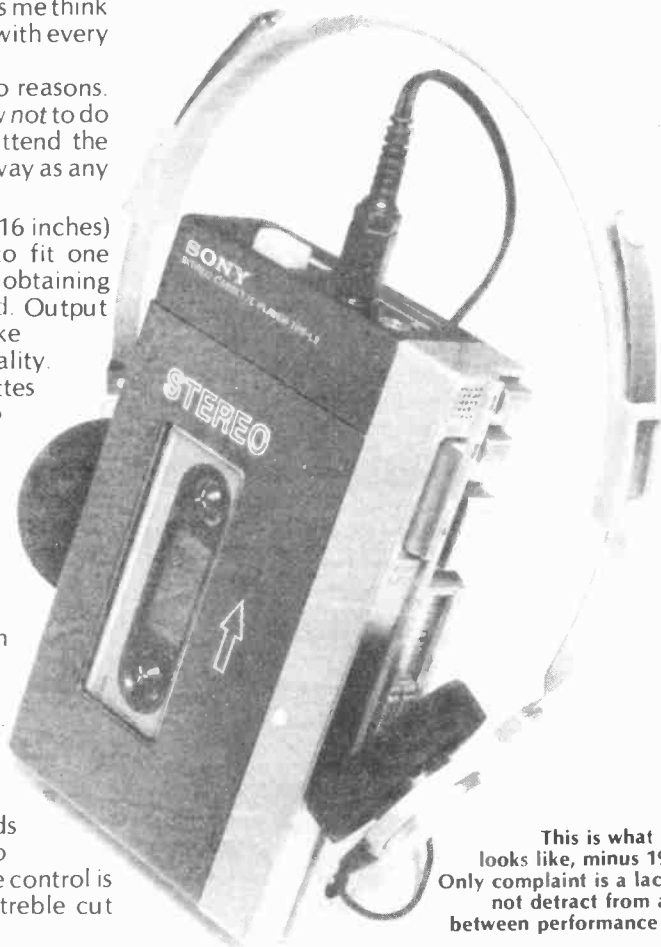
Frankly I can't see how this little thing can fail. Good quality sound anywhere you want it for around £90. Not a lot these days, if you say it quickly. Battery life is around three hours with standard cells and rechargeable packs are available, as are connectors to the mains and car batteries. Well thought out, you see.

The one I had on loan sat on my desk top playing away for hours, making me blissfully unaware of the clamorous call of telephone and outside world.

I think you're going to see a lot more of the Stowaway in the future — so next time someone bumps into you in the street have a look see if he's wearing MDR 3's before swearing at him — you could be wasting your breath.

**ETI**

Left: is this not the *worst* publicity photo you have ever seen? I'm convinced Sony did it on purpose it's so bad. In fact I think this deserves a good caption so I hereby declare the Second Audiophile Caption Contest open. The funniest caption to this photographic fiasco wins a year subscription to ETI. Please mark your envelope "Audiophile Contest" and send to our 145 Charing Cross Road address. Closing date is 31st August, 1980. Sharpen your wit (and pencils) and let's hear from you.



This is what the Stowaway really looks like, minus 1950's teen-age kitsch. Only complaint is a lack of Dolby B. Does not detract from a good compromise between performance size and price.

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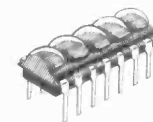
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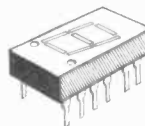


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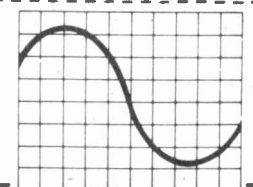
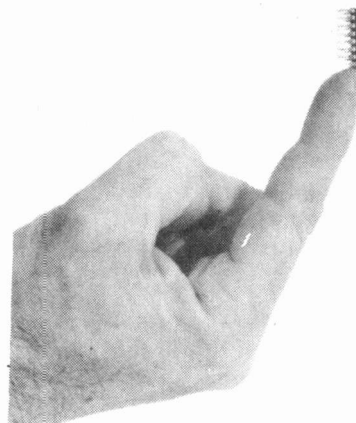
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# MICROFILE

. . . . And as Henry Budgett sinks slowly in the West, we wish a fond farewell to Microfile. It's the last one folks.

After a year or so of producing this monthly column Microfile is taking off for pastures new. This is the last time these articles will appear in this format. More later, but first the news. Seldom does a week or even a day pass without a new computer or allied peripheral appearing on the market. Some are destined to survive, others disappear without trace. We first heard news of the new Sharp hand-held system some months ago in the form of a typical murmur from the depths of a Press lunch. Reality has arrived rather sooner than we expected in the top pocket of a South African visitor to our offices. Here is a brief taster of what the machine has to offer plus a couple of photographs to tantalise.

## Sharp Pointed?

At first glance the PC 1211 looks not unlike a conventional pocket calculator, until you let your eyes roam the keys and find a full alpha set and several other definitely non-standard items like a 20 characters wide display. Inside are two very well packed PCBs, the three silver oxide cells and a piezo sounder that bleeps madly when you make stupid mistakes! Marks out of ten for packaging and useability are about 9½. Perhaps they could have made the key idents on the 'shifted' functions a little bolder.

The user has at his disposal a conventional four function calculator with the added bonus of a full Microsoft type BASIC and the capability to store the programs on cassette. The cassette cradle plugs into the left hand side of the machine and increases the length by about one third. This then connects directly to a conventional audio cassette. Program storage is slightly slow but adequate. One interesting point is that the system produces the sound of the data tones through the bleeper whilst loading or dumping — a good reassurance that at least something is happening.

The memory capacity is sufficient for about 1 to 2Ks worth of normal program, which is quite sufficient when looked at in terms of pure calculations, but the use of text in copious quantities is obviously going to reduce this.

## Pocketability

The unit comes complete with expansive notes, manuals and programming examples, apparently of better quality English than previously encountered from Sharp.

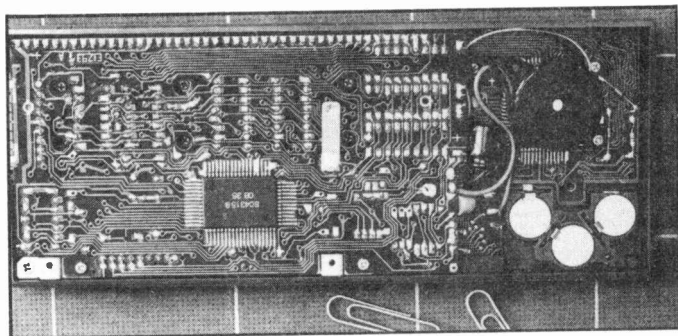
Some of the BASIC command set is totally unexpected on a machine of this size. You can write to and read from files on tape, you have all the usual scientific functions such as sines and logs, you have PRINT USING for neatly formatted displays and you even have a debug mode. By this time many of you will be thinking that this souped-up, hand-held version of your programmable calculator will cost you a fortune and why replace your calculator anyway?

The expected UK cost of the system, complete with



Sharp's PC 1211 — the shape of things to come?

the cassette cradle, is between £125 and £130 and they are to be launched onto the market in late July. This is far more than a grown-up programmable calculator, for one thing it can work interactively. This means that when you run your programs after a few months writing them you can quickly remember what it did. You can, after all, name your programs when you store them — just try doing that with a conventional programmable! It has been reported that the system took on, and beat, an HP 41C to the considerable chagrin of that August company — we didn't have time to test this claim but would love to try and run a "Benchmark" type trial between this, the TI 58/59, the HP 41C and the Casio 501/2.



The PC 1211's PCB. Sometimes it sits and thinks, sometimes it just sits.

Overall, then, it is a very impressive piece of kit, certainly another strong indication of the way that things are moving, with new customised chips taking over from boards full of TTL and CMOS, rather like a miniature version of the HP 85. The owner of the machine that we borrowed was a mining engineer who was mainly involved in electronic control design, etc and after three months of use he had yet to find a job that was too big to fit into its memory.

The question left in my mind is "If the calculator killed the slide rule stone dead will this do the same to the programmable market?". If that sounds a little strong just try it against one and see!

## Club Call

Some final entries into the list of computer clubs this month. Anyone into the TRS-80 and living in the North East of England might be interested in a new User Group. Acting as a sub-group of the Newcastle upon Tyne Personal Computer Society they hold meetings every third Wednesday in Room A 102 of the Polytechnic and cater for both the hardware and software enthusiast. Anyone interested in joining or receiving further details should contact Dr Stan Tetlow on Washington 462552 or Mr Barry Dunn on Stanley 30184.

Owners of the ZX80 may like to know of a National Users Club that has been formed. The main output will be a bi-monthly newsletter and a software bank as well as the provision of technical support. Membership fees have been set at £6 for the UK and £10 for overseas. Further information can be obtained from ZX80 Users Club, PO Box 159, Kingston upon Thames, Surrey KT2 5UQ, but please enclose an SAE.

## Video What?

Microfile is currently trying to achieve the impossible dream and get connected to Prestel. Why the impossible dream? Well, we've tried two sets and had the PO connection re-wired three times so far without a great deal of success! The story of our mis-fortunes carries on and on, but — eventually — we got connected. This tale of woe is by no means unique and is a very sad state of affairs. We do have a considerable lead in the Viewdata field in this country, two years of operational experience, but we appear to be in considerable danger

of throwing it all away because people won't buy something they can't rely on. It is not the fact that the database computers fail sometimes (you do generally have a spare anyway) but that the people who install the PO lines and the people who make the sets and, worst of all, the people who sometimes install the sets all talk different languages. The sooner the PO put together a crack team of engineers who understand the equipment and use them and only them to install the necessary equipment the better off we'll all be.

This country is, for once, leading the world in one area of computer-based technology. It would be a great shame to see that lead lost because no-one could rely on the competence of the people who come to fit it. You wouldn't, after all, ask a TV repairman to fix your washing machine or an electrician to install your central heating. No-one is knocking the concept of Viewdata, but it is in severe danger of strangling itself with its own telephone wires!

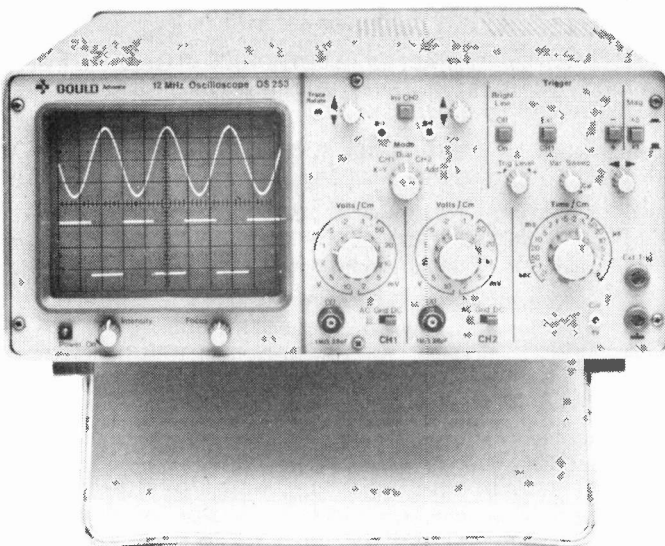
## 69999 PRINT"END":END

The death of this column has been stimulated by the production of a new series for ETI on the fundamentals of computers. It is intended to start next month with an article on how technology has developed to give rise to the micro and the whole series will be orientated towards the hardware. It is also hoped that the material will be followed by some constructional features based on the developing microprocessor technology. So, until next month under a new heading it's farewell from Microfile . . . . .

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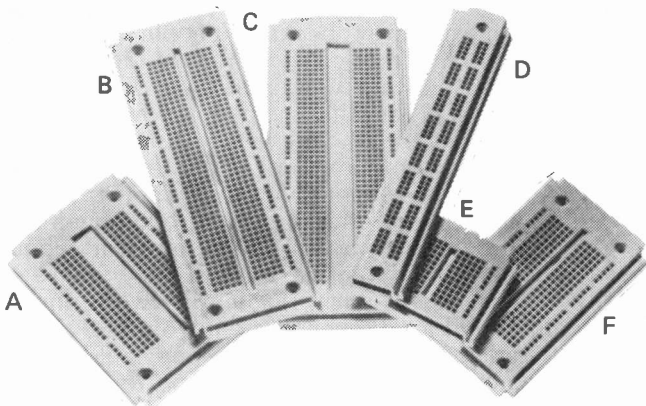
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- F EXP 350 270 contact points, ideal for working with up to 3 x 14 pin DIPS. **£3.15**
- G PB6 Professional breadboard in easily assembled kit form. **£9.20** (Not illustrated.)
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ETI AUGUST 1980

# TECH TIPS

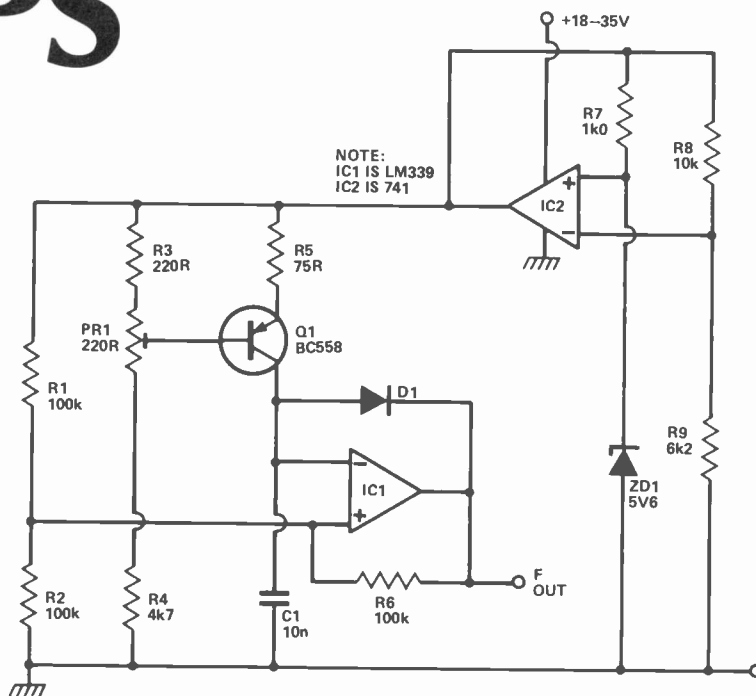
## Linear Temperature To Frequency Transducer

J.P. Macaulay, Crawley

This circuit provides a linear increase of frequency of 10 Hz/°C over 0-100°C and can thus be used with logic systems, including microprocessors.

The heart of the system is the temperature probe Q1 whose V<sub>be</sub> changes at 2.2 mV/°C. Since this transistor is incorporated in a "constant" current source circuit it follows that a current proportional to temperature will be available to charge C1.

The circuit is powered via the temperature stable reference



voltage supplied by the 741. Comparator IC1 is used as a Schmitt trigger, the output of which is used to discharge C1 via D1. To calibrate the circuit Q1 is immersed in boiling

distilled water and PR1 adjusted to give 1 kHz output.

The prototype was found to be accurate to within 0.2°C against a Comark thermocouple meter.

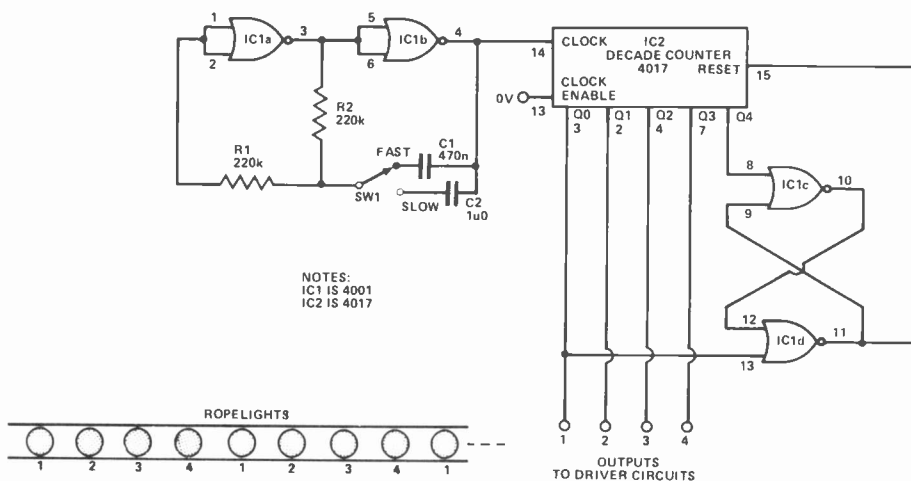
## Ropelights Sequencer

G.J. Phillips, Durham

This circuit produces signals for the "travelling lights" disco ropelights effect. IC1a and b are connected as a standard CMOS astable. The frequency and hence speed of the travelling lights can be selected by SW1.

The output of the astable is fed to the clock input of the CMOS decade counter IC2. This counter has the advantage of having a built-in decoder giving a logic 1 at each output in turn. Reliable reset is provided at the count of four by the bistable formed by IC1c and d.

Outputs 1,2,3,4 must be connected via drive circuits which can



be simply power transistors for low voltage lamps or triacs for series-connected mains operated lamps.

The outputs of the driver circuits are connected to the lamps in groups as shown.

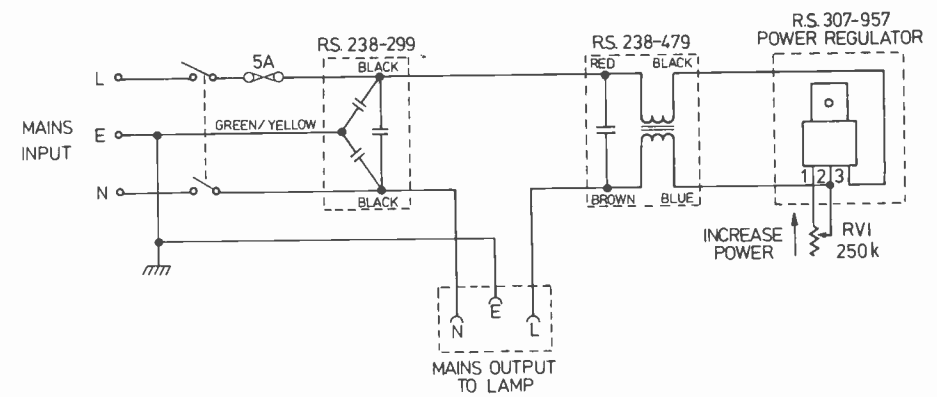
Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items. ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.

# Dimmer With RFI Suppression

D. Wedlake, Cardiff

The circuit shows how a mains power regulator can be used to control a 1 kW tungsten lamp with good radio interference suppression. It was built primarily for photographic applications but can be used with many other types of loads such as heaters or AC motors, providing the maximum rating is not exceeded. However, if used to control motors or any inductive loads, it will be necessary to connect a snubber network between terminals 2 and 3. A 100 R resistor in series with a 100 nF 250 V AC capacitor (eg RS 238-463) would be suitable.

The IC regulator used is a solid-state AC mains power three-terminal device which, when used with the external 250 k potentiometer, RV1, controls the power to the load by varying the phase angle of the applied AC potential. The typical control conduction angle is 0-155°



which corresponds to a maximum power transfer of approximately 98% for a resistive load. The graph shows how the output voltage varies with various values of RV1. When used at full load current, the device should be mounted on a heat sink having a thermal rating of 4°C/watt (eg RS 401-497). Alternatively, as the tab is electrically isolated, it may be fixed directly to the chassis for heat dissipation.

**Note that as the slider of RV1 is at Mains Potential the potentiometer should have an insulated shaft.**

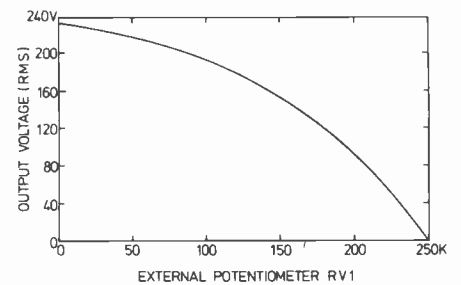
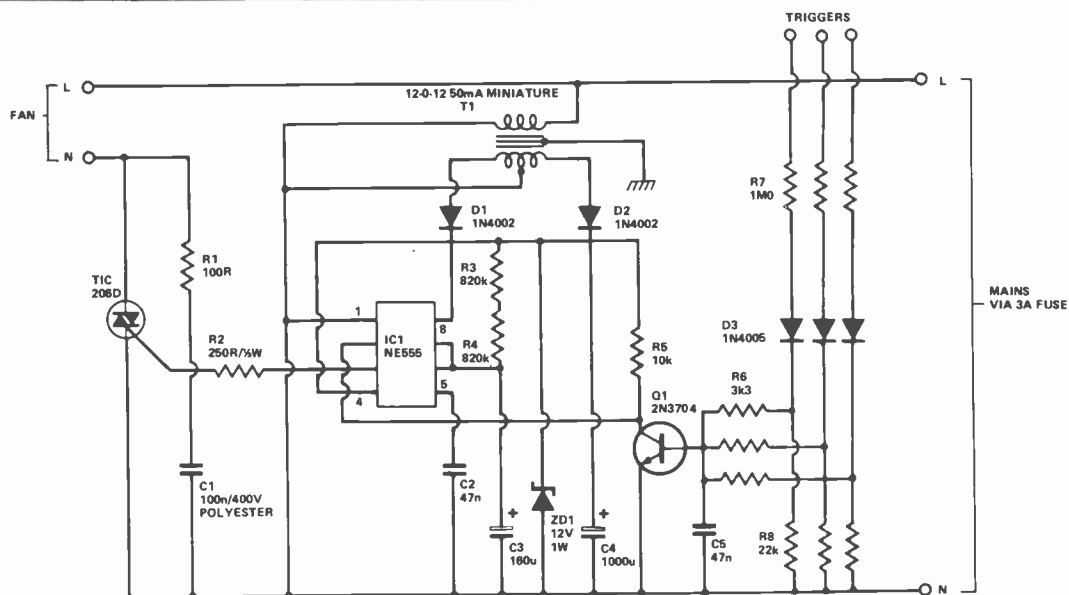


Fig. 2 Variation of output voltage with RV1 (input voltage = 240RMS)



# Extractor Fan Controller

B. Carrol, Aldershot

This timer is useful for controlling a bathroom extractor fan, if your family forgets to use it or leaves it

running indefinitely. The trigger or triggers are connected to the live side of one or more lights, which, when switched on, cause Q1 to conduct and trigger IC1. This is a monostable which gives a pulse period of about four minutes and its output gates the triac so that the fan runs. R1, C1 protect the triac against reswitching; C2, C5 protect against mains transients.

If the light is still on at the end of the timing period, the IC is retriggered, but, because C3 has not been fully discharged, the next pulse is less than four minutes. Thus, the fan runs for four minutes or the period the bathroom light is on plus two minutes, whichever is greater.

**Note: Careful insulation of the PCB from the case is necessary.**



# Super Bass Excavator

J.P. Macaulay, Crawley

The main problem with small infinite baffle speaker systems is that the bass response rolls off rather sooner than their larger brothers. This circuit overcomes this problem by boosting the deep bass response of the power amp driving the speakers. Certainly this is not an altogether new idea as regular readers of this magazine well know but this particular circuit does the job rather better than most and the audible improvement is well worth the time and money spent.

The circuit is based around the well known quad op amp LM324. This device contains four independent op amps of the 741 type. Before any purists hold up their hands in horror it should be noted that these are capable of delivering 2 V RMS of 20 kHz sine wave without slew rate problems and that is more than enough to drive

99.99% of all known power amps into clipping.

In order to overcome the crossover distortion problems of these op amps the output stage of each is biased into class A by R7 and R10. C1, C2, R3 and R6 form a Butterworth second order filter which removes any signals below 20 Hz thus preventing amplifier overload from record warp signals. R5 and C2 in conjunction with R8 and C4 produce a shelf in the circuit's response below the frequency determined by the reactance of the capacitors.

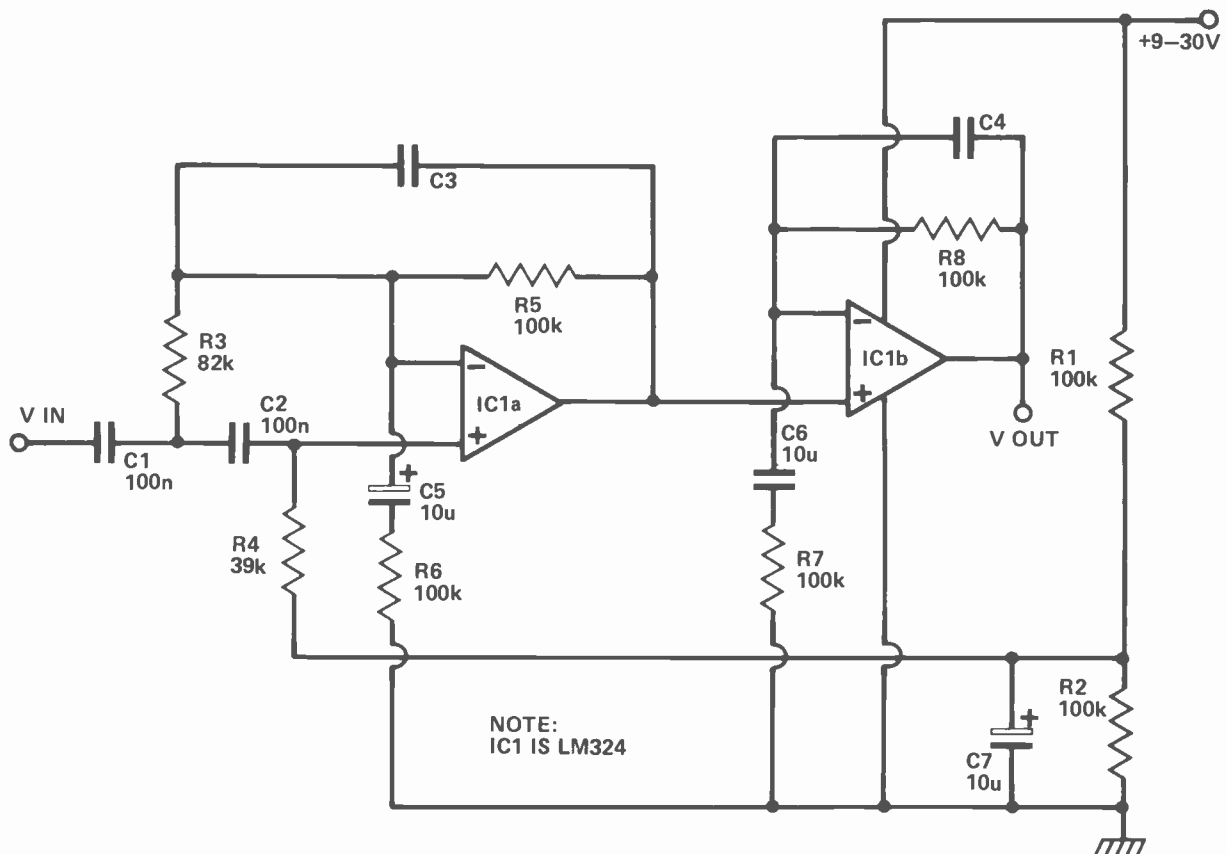
Now it so happens that the rate

of roll-off of infinite baffle enclosure is 12 dB per octave and the slope of the filters is the same. Thus, by the simple expedient of choosing the capacitor values to be equal in value and by matching the quoted -3 dB point of the speakers with the +3 dB values in the table one extends the lower -3 dB limit of the speakers by half an octave.

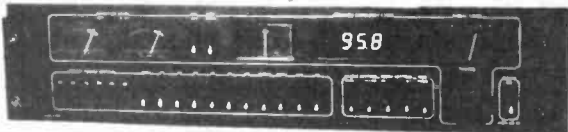
The device must be inserted between the pre and power amplifiers and has a unity gain except in the bass. The maximum gain has been set at 6 dB to prevent amplifier overload.

(+3 dB)

NEW CUTOFF -3 dB POINT	OLD CUTOFF -3 dB POINT	C3,C4
38 Hz	50 Hz	47 nF
45 Hz	60 Hz	39 nF
52 Hz	70 Hz	33 nF
60 Hz	80 Hz	27 nF
68 Hz	90 Hz	22 nF
75 Hz	100 Hz	18 nF



## Complete Audio/Tuner Kits



### Mk III FM Tuner series

Carriage for Mk III tuner £3 inc

The Mark III series FM tuner has been updated, and now includes a centre zero tuning meter as standard. The instruction manual has been meticulously revised, enabling easy assembly by constructors of various levels of experience - a preview copy may be purchased for £1.00.

Mark III A series 'Reference series' tuner modules .....£171.35 inc.  
Mark III B series 'Hyperfi' modules, with switched IF BW, pilot cancel decoder .....£198.95 inc.

A matching synthesiser unit will be made available later this year, and can be retrofitted to either version. All versions include digital frequency readout/clock, VU deviation meters, 6 preset stations, 10 turn pot manual tuning, toroidal PSU, output level adjustment, 110/240v AC input. Full alignment service available.

### Power Amplifier

Style and performance - with a real 'belt and braces' PSU design.

After a couple of preview comments, it seems that many of you are waiting to hear about the matching H MOSFET power amplifier for the Mk III tuner. Well, it's out at last - complete with twin toroidal PSUs for comfortable 80W RMS per channel, over 100W peak, but limited by thermal shutdown of the HMOS. 10W-100W log LED output peak indicator, DC offset protection and switch-on pause relay. AC or DC input coupling, direct or relay protected output terminals. The works. Only one version of this item: Complete kit .....£178.25 inc. Carr. £5.

### Preamplifier

More features and facilities, thanks to DC switching and control design

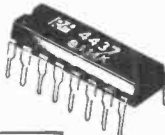
Previewing the most comprehensive audio preamplifier yet..... DC switching of 7 inputs, plus two tape in/out's. 2 low pass, 2 high pass active filters, genuine volume related loudness, 1dB channel matching, with DC volume, balance, bass and treble controls. Suitable for bus/remote control, tape dubbing, switched monitor etc. 80dB S/N+, THD -75dB or better. Pluggable PU equalization boards. tone control override. Price for complete unit about £149 ex VAT.

## Semiconductors

### Radio/Communications ICs

FOR COMPLETE LISTINGS - SEE OUR NEW PRICELIST

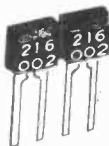
CA3089E	2.11	HA1197	1.61	SD6000	4.31
CA3189E	2.53	CA3123E	1.61	TDA4420	2.59
HA1137W	1.95	TDA1072	3.09	MC1330P	1.38
HA11225	2.47	TBA651	2.53	MC1350P	1.38
HA12412	2.81	TDA1090	3.51	KB4412	2.24
KB4420	1.95	TDA1220	1.61	KB4413	2.24
TBA120S	1.15	TDA1083	2.24	KB4417	2.53
KB4406	0.80	TDA1062	2.24	MC3357P	3.16



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A section from our PL:

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MVAM2	1.93	BB212 9v dual	2.25



### POWER MOSFETS

100W PA's made simple

Since pioneering the 100W complementary MOSFET technique - Hitachi have developed a range of output devices and drivers that ought to revolutionise opinions and attitudes towards the design of all LF amplification systems. We have a new 48 page application note (£1.50 inc) and complete sets of parts, modules and now the new complete PA system (see above).  
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Most CMOS is available in low volume - also LPSN. Standard linears and TTL OK.

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## Components

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### Piezo Sounders

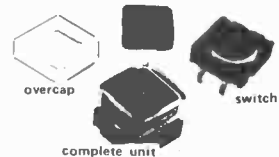
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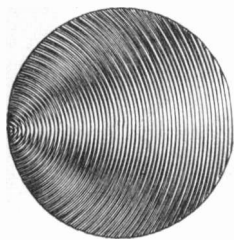
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I am interested in the TUSCAN Z80 based single board computer with S100 expansion and enclose a S.A.E. for further details.

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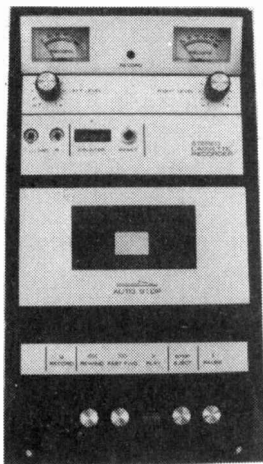
Telephone \_\_\_\_\_



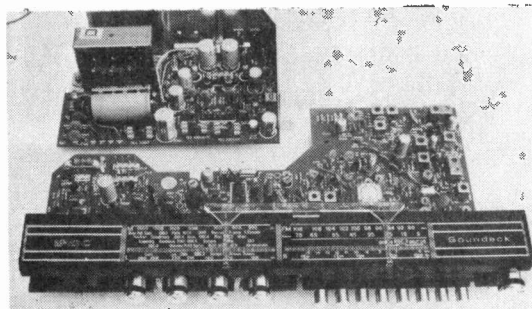
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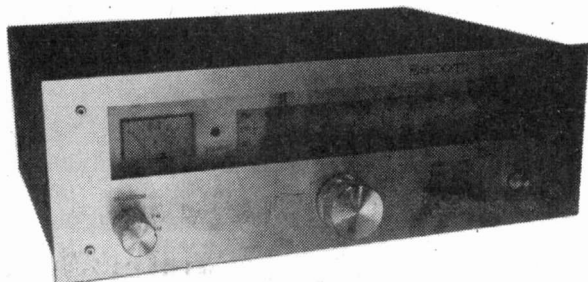


**STEREO CASSETTE TAPE DECK ASSEMBLY.** Comprising of a top panel assembly and tape mechanism coupled to a record/play back printed board assembly. For horizontal installation into cabinet or console of own choice. Brand new, ready built and tested. **Features:** Pause control, auto stop, 3 digit tape counter, illuminated twin VU meters with individual level controls, twin mic, input sockets, AC erase system, LED record indicator. (Separate power amplifier required.) **Input Sensitivity:** 6 MV (with level control set at max). **Input Impedance:** 47 kOhms. **Output Level:** To both left and right hand channels 150 MV. **Output Impedance:** < 10k. **Signal to noise ratio:** 45 dB nominal. **Power Supply Requirements:** 12V AC at 300M/A. **Connections:** All connections to the unit are via a wander lead terminated with a nine pin plug (socket provided). **Dimensions:** Top panel — 11½in x 6½in. Mechanism fits through a cut out 5¼in x 10½in. Clearance required under top panel 2¼in. Supplied complete with circuit diagram etc. **Price £30.50** plus £2.50 postage and packing.



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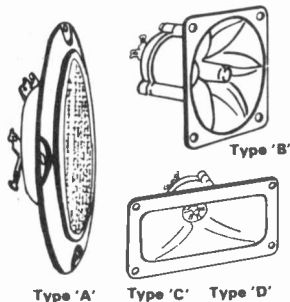
**Tape Sensitivity:** Output — typically 150 mV. Input — 300 mV for rated output. **Disc Sensitivity:** 100mV (ceramic cartridge). **Radio:** FM (VHF), 87.5MHz — 108MHz. Long wave 145kHz — 108kHz. Medium wave. 520kHz — 1620kHz. Short wave. 5.8MHz — 16MHz. **Size:** Tuner — 2¼in x 15in x 7½in approx. Power amplifier — 2in x 7½in x 4½in approx. 240V AC operation. Supplied complete with fuses, knobs and pushbuttons, and LED stereo beacon indicator. **Price £21.50** plus £2.50 postage and packing.



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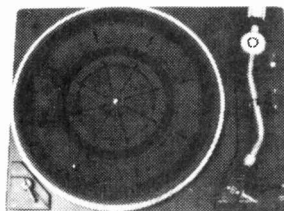
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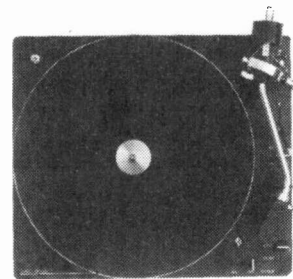
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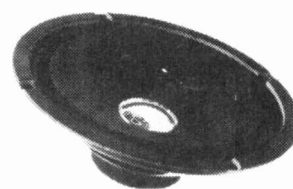
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# EDDY CURRENTS

A.S.Lipson brings you the life story of Eddy Current, last known to be circulating in the region of discs and transformers.

The branch of physics now known as electromagnetism can be said to have been born in 1819. It was in that year that Professor Oersted of the University of Copenhagen discovered that electricity and magnetism are related — that a current flowing in a conductor produces a magnetic field in the close neighbourhood of the conductor. Later, around the 1830s, the reverse effect — that an electrical current can be produced in a conductor by a changing magnetic field — was discovered simultaneously, and quite independently, by Faraday in England and Henry in America.

Both of these effects are used, for example, in the transformer; an alternating current in a coil creates a changing magnetic field, which, in turn, is used to produce an EMF (and hence a current, should a circuit be connected) in another coil. However, rather less people are aware of another, very closely related, and extremely interesting, effect — the phenomenon of eddy currents . . .

## What's In A Name

Magnetic fields are not usually quite as selective as we would like them to be. A changing magnetic field will not only produce an EMF in any coils in its vicinity, but it will also produce EMFs, and hence currents, in any conductor around — even any old lumps of metal that may be just hanging about. These currents don't actually go anywhere — they just circulate round and round within the conductors, like eddy currents in a liquid. Hence the name — eddy currents.

Since eddy currents are the result of induced EMFs in conductors and because resistances within conductors can be very small, the currents can on occasion be quite sizeable, and so the effects produced by them can be very significant. In fact, eddy currents are far more than just a scientific curiosity. Depending on exactly where they are, and what they are doing, they can be either a curse or a blessing. However you view them, though, they are an interesting phenomenon, and can produce some fascinating effects, not all of which are totally useless!

## Counting Your Blessings . . .

One of the more striking experiments on eddy currents is shown in Fig. 1a. A horseshoe magnet is suspended on a thread, above an aluminium disc which is itself free to turn about its centre. If the magnet is now spun round, the aluminium disc starts to rotate with it (although it never quite catches up with the magnet). Similarly, if you spin the aluminium disc, the magnet above it also starts to turn. This obviously cannot be due to ordinary magnetic effects — aluminium is non-magnetic, and if you try to pick up the disc with the magnet, you will find that you are unable to. It is apparent that something funny is going on. (No, air currents aren't dragging the disc round when the magnet rotates — you can put a sheet of paper between the two, and the effect still works!)

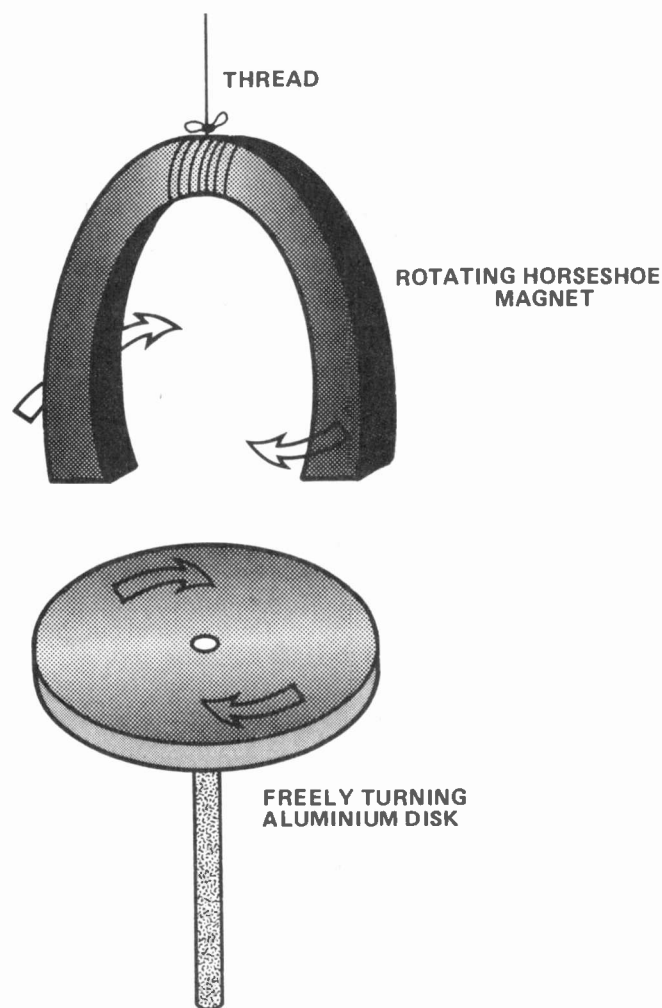


Fig.1a. The rotating magnet induces eddy currents in the aluminium disc .

## Field Study

The relative movement between the magnet and disc is inducing eddy currents in the aluminium. These, in turn, create other magnetic fields, and it is these that cause the magnet and disc to move together — the magnetic field of the magnet interacting with the fields caused by the eddy currents (sounds a bit like pulling yourself up by your bootstraps, but it's correct) An interesting follow-up to this experiment is to replace the disc with one cut as shown in Fig. 1b. The slots tend to get in the way of the eddy currents and prevent them from flowing, so such a disc is not dragged round so easily by a magnet (which is another way of showing that air currents don't do the work — the slots shouldn't make any difference to them). ➔

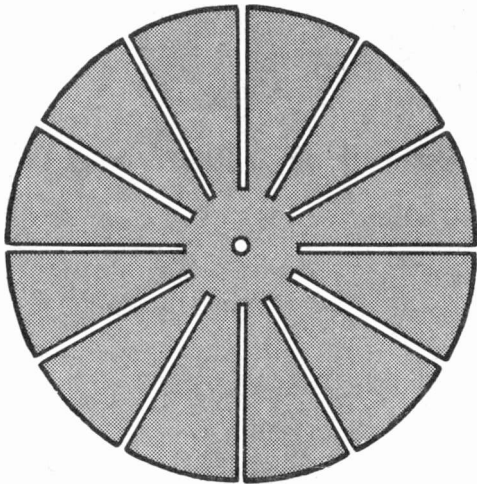


Fig.1b. If the disc in Fig.1a is replaced with one cut like this, the drag effect is greatly reduced, or even stopped.

Interestingly enough, this apparently insignificant effect actually has some practical application. It is used, for instance, in the normal car speedometer! The rotation of the wheels is transmitted, by various means, to a magnet, which itself rotates, with a speed proportional to that of the wheels. This rotating magnet induces eddy currents in an aluminium disc, (or its equivalent) and tries to drag it round. However, a spring is used to hold the disc, so it is unable to turn very far. The faster the car goes, though, the faster the magnet rotates, the greater the eddy currents, and the further round the aluminium disc is pulled. By attaching a little red or orange needle to this disc and seeing how far this needle rotates, we can work out how far the disc has turned, and hence the speed of rotation of the magnet. Thus, we find out the speed of the car. Yes, I wish I'd thought of it first, too.

## Cutting Your Losses

Besides being useful, though, eddy currents can also be very annoying. They could justly be called the transformer designer's nightmare. The transformer is, basically, two coils, close together. However, in the middle there's a dirty great lump of metal (the core) and it doesn't just sit there doing nothing, with all those magnetic fields about.

No prizes for guessing what happens. It might not seem that eddy currents in the transformer core would be much of a problem, but they are, for two main reasons. Firstly, the eddy currents mean a loss of power in the transformer and hence reduced efficiency. It stands to reason that if power is being used to drive currents around in the core, then that much less power is going to be available for use from the secondary coil. The second problem is no less serious, especially in large-scale transformers. The power being wasted in the core, driving eddy currents round, quite naturally ends up as heat, and consequently transformers are liable to get very hot. Indeed, large transformers, such as those on the national grid, may be oil-cooled, to prevent overheating.

It is obvious that, in transformers at least, eddy currents are not wanted. So what can be done about them? Well, if you've ever taken an old transformer apart for the wire, or even just out of curiosity (naughty, naughty), you will probably have noticed that the core is not just one solid lump; it is built up of flat metal laminations. This is not because they make the cores out of flattened baked bean tins. The laminations are separated by varnish or paper or some other insulator and this greatly increases the internal resistance of the cores, reducing eddy currents. Hence, both the loss of power and the unwanted heating are reduced.

Even the heating effect of eddy currents can be put to use, though. It is used in the production of pure crystalline samples of conductors like metals or semiconductors — germanium, for example. The impure sample of the material is passed, in a crucible, through a coil, which has passing through it a high frequency alternating current. The magnetic field produced by this current induces eddy currents in the specimen and the heating effect is great enough to melt it! As the sample passes through the coil, the molten zone within it is carried to one end (Fig. 2). Impurities within the sample are accumulated in the molten zone and hence get taken to one end of the specimen. This end is later removed. What is left is a very pure, crystalline sample of the substance. So eddy currents can be surprisingly useful!

## Footnote

There is one final point which must be at least mentioned in connection with eddy currents. This is the induction motor, an indispensable servant of industry. It depends for its operation on eddy currents... full explanation of that, though, is another story altogether.

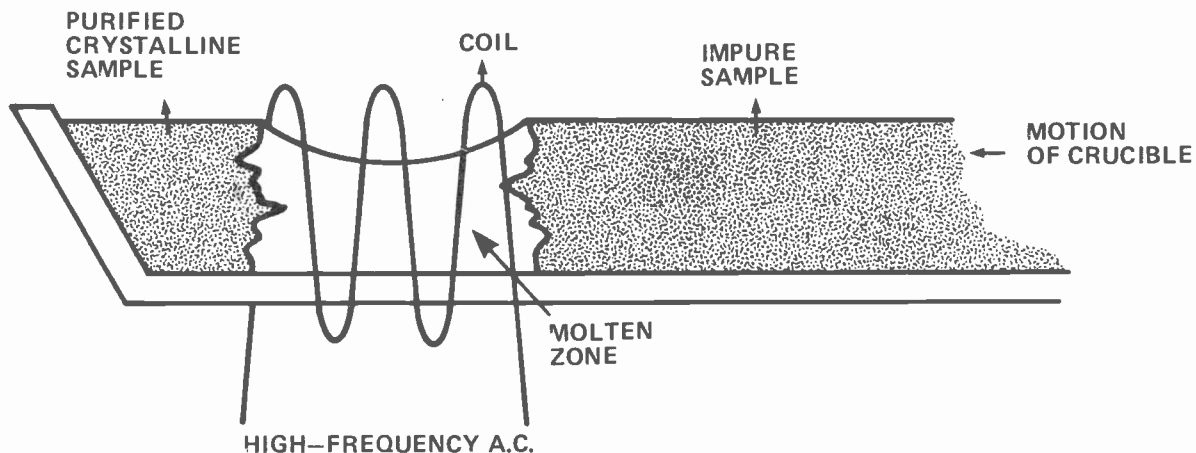


Fig.2. The heating effect of high frequency AC can be put to good use in semiconductor material manufacture.

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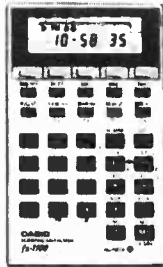
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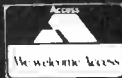
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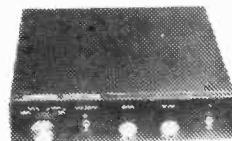
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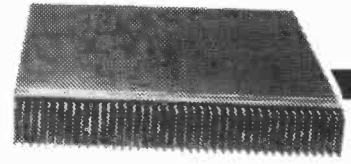
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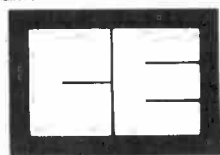
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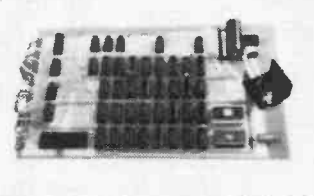
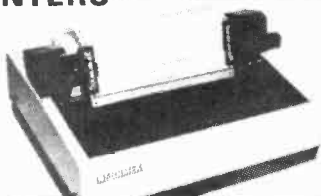
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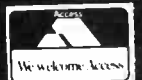
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# VIDEO TODAY



## Richard Dean, editor of Television and Home Video, takes a look at the history and future of Home Video.

In the beginning there was television — Baird and all that. After many years of either broadcasting live or filming off a 405-line monochrome TV monitor, television output was mostly a 'here now, gone later' medium, until Ampex came up with the Quadruplex format in 1956—still the prime system in broadcasting today. It used 2 in tape travelling at 15 IPS, 'chopped' by four rotating video heads, producing segmented picture tracks vertical to the tape motion.

From these humble beginnings we can wind swiftly on to the start of 'Home Video', scanning only briefly the rise and fall of the BBC's VERA (Vision Electronic Recording Apparatus) and the Nottingham Electronic Company's Telcan. Both of these British developments used fixed-head scanning as opposed to today's helical scan. Ironically Japan's Toshiba corporation and the German tape giant BASF have resurrected this technique in prototype — nowadays called LVR or Longitudinal Video Recording, (scheduled for production next year as a home video recorder).

The early seventies saw Sony's U-Matic format using  $\frac{3}{4}$  in tape encased in a plastic cassette. Although this was originally intended for the home market, various factors — the main one being cost — came into play, aiming the format toward the industrial sector, in which it holds an ubiquitous position today.

The first real domestic recorder came in 1972 with Dutch electrical giant Phillips' (helical scan) N1500 video cassette recorder. The machine contained the domestically essential timer — albeit a crude one — and an off-air tuner. For the first time viewers could programme a machine to record in their absence. The format was called VCR — logical at the time but destined to cause confusion as the term gained popularity as a general description for home video recorders.

### And Then There Were Six

VCR uses co-axially mounted spools containing  $\frac{1}{2}$  in tape and, as with all video recorders at the time, guard bands separated video tracks to prevent crosstalk. In 1977 Phillips'

pulled off another first — at least in Phase Alternation Line (PAL) territory — by introducing a longer playing version of VCR called VCR-LP (N1700 series machines). This increased the capacity of its coaxial cassettes from one hour on a VCR format machine to two and a half hours using a technique called “tilted azimuth recording”.

Phillips technique, patented by a Japanese professor in 1959, has the two heads in the recorder’s head drum tilted 14° relative to each other, or  $\pm 7^\circ$  from true azimuth.

This eliminated the need for guard bands with an attendant increase in tape capacity. All subsequent helical scan formats were to adopt this technique.

In 1978, PAL versions of Sony’s Betamax appeared, followed swiftly by JVC’s VHS (Video Home System) — attempts at a common Japanese format had by this time been abandoned. The final format was Grundig’s own variation of the Phillips’ VCR (which it had been manufacturing under licence), the SVR (Super Video Recorder). Betamax and VHS impressed the trade with their compact, co-planar cassettes and longer playing time (three and a half hours Betamax, three hours VHS).

Grundig’s SVR used the original Phillips VCR/VCR-LP cassette, but used a more critical tape formation to cope with a 4 hour capacity. The format didn’t catch on in the face of a ruthless marketing onslaught by VHS, and to a lesser extent Betamax and Phillips.

Grundig was already suffering from the saturation of its home market by TVs, and decided to combine with Phillips to combat the Japanese threat. Recently the fruits of their association, the Video 2000 (eight hours a side) co-planar cassette format has been launched onto the PAL market. During this combat Phillips’ original VCR format has ironically remained fairly intact — for the moment — because of its high initial penetration of education and institutional markets.

## And It Came To Pass . . .

But where does this leave us today? Certainly VHS has scored a major success in the world market, nowhere more so than in Britain where there are as many as 75% of users with VHS machines. Worldwide JVC seems to have persuaded a greatest number of manufacturers toward VHS.

But Sony remain hopeful. The recently launched, feature-packed, C7 is evidence of the company’s determination to win support from upgrading, as well as from first time buyers.

If you’ve been watching the video scene so far you may conclude that the last thing a manufacturer should contemplate is halving the scanned tape width. Well Phillips has managed to get away with it — borrowing a technique called Dynamic Track following (DTF) from the industrial sector.



The Sanyo VTC 5500P

DTF involves mounting the video heads on a piezoelectric crystal base and recording four guide tones — which are combined with the video information — over four video tracks in turn.

On replay, beat frequencies generated by either head mistracking, causes a microprocessor to output ‘up’ or ‘down’ pulses to the respective head bases. If both heads are hopelessly out, the transport servo is adjusted. In this way tracking accuracy — essential to such a compact system of storage — is guaranteed. Phillips’ claim that contemporary replay quality will be maintained. So far, nobody is prepared to refute this claim.

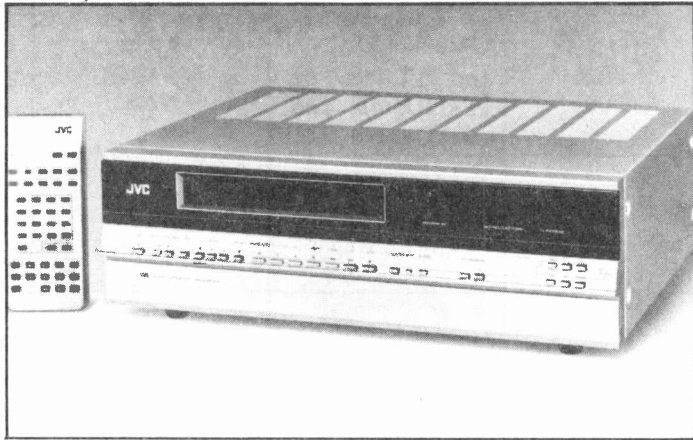
## Instant Replay

However, the future format war will be — as it is at this moment — fought on features

Here Phillips Video 2000 is in a good position, as fast wind with vision, slow motion and still frame are theoretically easy to perform with DTF.

Initial models from Phillips (VR-2020) and Grundig (V2 x 4) are not equipped with any of these features. Many





The JVC HR 7700E with full remote control.

observers see these first Video 2000 products as "too little, too late".

The Sony C7 was launched to the sound of £1 million worth of promotional trumpets; as the 'King Of The Format Jungle'. Its main claim to fame is the machine's feature repertoire, in particular the "cue and review" facility. This allows you to flip through a tape in forward (review) or rewind (cue), still in vision. The speed at which you can do this is inevitably reduced by the required intimacy of heads to tape — although Betamax format remains laced during winding modes — and on the C7 this varies from about x4 to x15 play speed, according to the diameter of the spool driving the tape.

Panasonic have used a new compact design to achieve lacing during winding modes, with the added elegance of a servo control on cue or review maintaining a constant x9 play speed.

## The Cold War

There's more to come from the VHS faction, however. Not only is Dolby B noises reduction being introduced to the format's soundtrack, but Panasonic's NV-7000 incorporates back space, or pre-roll, editing. This directly counters Sony's improvements in editing performance and indeed substantially surpasses it. While Sony has tightened up the gap tolerance in pause mode, Panasonic borrows a technique used on professional gear. When 'record' mode is selected, the tape is wound back 1½ seconds in real time. When pause is cancelled, the transport moves the tape forward at play speed in the usual way, but the servo 'listens' to the sync track on the edge of the tape and gets it in step with the incoming pulse chain. So when the original cue point is reached and recording begins, the picture instability is not just reduced, it is eliminated. This has far-reaching

implications for home movie makers and straightforward perfectionists alike.

In addition, VHS has a 4 hour tape waiting in the wings to combat Phillip's 4 hour capacity. The Betamax format uses thinner tape anyway, and so does not have the capability to pack more tape in without reducing tape thickness to a precariously low dimension.

## Strictly Off The Record

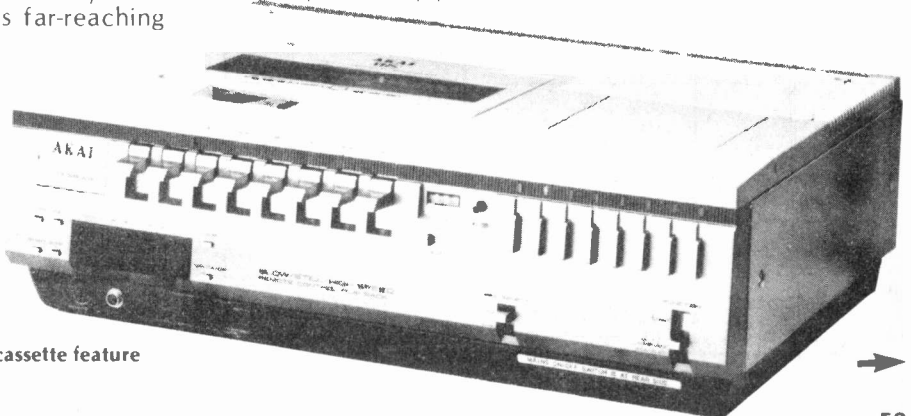
The first video disc to arrive on the scene is almost certain to be Phillips VLP. But following in its tracks will be JVC's VHD/AHD (Video High Density/Audio High Density) and RCA's Selectavision.

Phillips' system uses a miniature laser inside the player to scan video sync. and reference signals encoded on a 10 in transport disc. Light bouncing off the disc's protectively coated surface reaches a photo-cell moving with the laser transmitter under servo control from the centre of the disc. Thirty minutes of information can be stored on each side using a constant rotational speed. But with development Phillips claims it could increase this to one hour per side. The main obstacle to the system is the critical conditions under which the disc must be pressed. However, its advantages are considerable. A frame or chapter indexing facility makes it the trick-play fanatic's dream, and, more importantly renders it ideal for educational and data retrieval applications. Another advantage is the disc's ability to withstand misuse. You can put thumbmarks on it, pour beer on it, or even scratch it — up to a point — because the information lies beneath a transparent coating, such misuse never reaches the information. Minor scratches are, quite simply, so massive compared to the data that the photo cell ignores them.

JVC's VHD/AHD system poses a formidable threat to VLP. Thorn-EMI has just announced its backing for this format, which uses a grooveless capacitive disc in a protective sleeve. Thorn has a massive chunk of the rental and retail market in consumer electronics, and its EMI arm will become a ready-made software provider. Thorn-EMI chose VHD/AHD — which offers one hour per side with indexing and trick-play — on the basis of the player's ease of servicing and the disc's ease of pressing. Discs can be manufactured on conventional presses, after mastering on a lathe which, 'cuts' a photo sensitised glass plate. Phillips has meanwhile begun to equip a special VLP pressing plant in Blackburn, Lancashire.

So summarising on what is increasingly appearing to be a massive video game, there are some exciting moves to be made in the future. The stakes are indisputably high; and the outcome will reverberate through most of the electronics industry for many years to come.

Right: The Akai VS9800 VHS deluxe home video system



Left: The Grundig 2x4 Video 2000 with front loading cassette feature

	<b>GRUNDIG VIDEO 2 X 4 V2000</b>	<b>PANASONIC NV 7000 VHS</b>	<b>PHILLIPS VR 2020 V2000</b>	<b>FERGUSON VIDEOSTAR 3V23 and JVC HR7700 FERGUSON and VIDEOSTAR 3V23</b>	<b>AKAI VS 9800 VHS</b>	<b>HITA VT 500 VF</b>
<b>Typical Price:</b>	£690 guide price	£650 approx.		Under £700 (available in Autumn 1980)		£539
<b>Maximum Recording Time:</b>	2 x 4 hours	3 hour	2 x 4 (flip Over)	3 hours	3 hours	3 Hours
<b>Timer:</b>	10 day/ 4 programme	14 day/ 8 programme	16 day/ 5 programme	14 day/ 8 programme	8 day	10 day
<b>Remote Control:</b>	Optional extra	12 mode supplied	Full function Optional Extra	Full function supplied	6 function included	Pause control only. Optional
<b>Still Frame:</b>		Yes		Yes and Frame Advance	Yes	Yes
<b>Variable Speed Playback:</b>		Double and half speed		Normal and double speed with sound	Double or slow motion	Single frame advance
<b>Review Feature:</b>				Yes		
<b>Audio Dub:</b>		Yes		Yes	Yes	Yes
<b>Automatic Tuner:</b>	Yes		Automatic Search Tuner	Yes		
<b>Portable Recorder Available:</b>				3V24	VP7100	
<b>Camera:</b>	FAC 1800	Socket included	V100 or V200	3V20	VC 30	VKC 500
<b>Extra Features:</b>	Dynamic Track Following Automatic Programme finding Dynamic Noise Suppression	Dolby Noise Reduction	'Go To' function Automatic Rewind Dynamic Noise Suppression	Dolby Noise Reduction 1 Hour Battery Back-Up in Power Failure Edit Start Control		Free Cassette

HI ER	JVC HR 3660EK VHS	SONY C7 BETA	SANYO VTC 5500P BETA	SHARP VC 6300H VHS	HITACHI 5500E VHS	mitsubishi HS 300G VHS
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	3 Hours	3½ hours	3¼ hours	3 hours	3 hours	4 hours
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	Playback only. Supplied	12 mode supplied	9 Function Optional Extra	Wired supplied		Wireless or wired (optional)
	Yes	Yes		Yes and Frame Advance	Yes and Frame advance	Yes and single frame advance
	Double and Slow motion	5 alternative speeds		6 speed		half and sevenfold
		Cue and Review				
	Yes	Yes	Yes	Yes	Yes	Yes
		Yes			Automatic Channel Lock (during recording)	
	HR4100	SL 3000P				
	GL4100	HVC 2000P	VCC 545P	xC-35H	VK C500E or VK C750E	
		Picture Search		Automatic programme Locater	Automatic Programme Search Battery back-up for short power failures	Low power consumption

## VIDEO VIEWPOINT: Tina Boylan examines the Video Recorder Marketplace.

The long awaited video disc, although perched firmly on the horizon of home video, will take a considerable time to descend to the plane of the general consumer as a viable mass market product. Even then the existing tape system will hold an unchallengable position in home entertainment, taking over where the cine-camera leaves off. At present manufacturers are improving facilities for home-movie making with high quality cameras, improved edit facilities, portable recorders and better sound reproduction — already available as peripherals to the higher quality machines. Even the newest and most advanced of the recorders, with 'the sky's the limit' facilities, are becoming something of an enigma. It seems that almost every month a new system is launched, which claims new and better features: An eternal game of manufacturers' leapfrog.

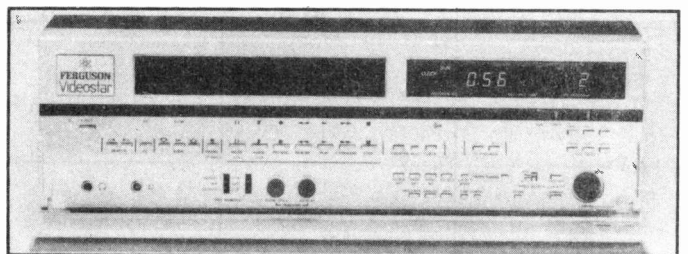
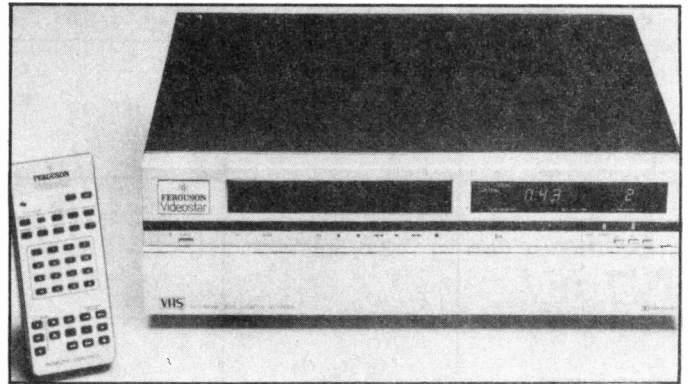
### To Buy or Not to Buy...

However, the resultant cost of research and development, coupled with high manufacturing costs, (precision playing an important part in production) are inevitably relayed to the customer, despite the considerable drop in price of video equipment generally. This can, to a certain degree, leave manufacturers with marketing difficulties. In the final analysis, selling high price luxury items during an economic recession is tough going. Many machines are tentatively priced at 'around £700', which to Joe Public represents a considerable investment with so many other, and more economically justifiable, items monopolising his income. He needs considerable persuasion to embark upon this type of financial undertaking, and even having decided that he wants or needs a video recorder, finding a way around that price tag is going to hinder him further.

With a mere 1% penetration of the TV market in Britain, (225,000 recorders in 20 million TV-owning homes) today's video company can see all too clearly a large market waiting to be tapped, if it can discover how. Recently a number of them have done just that, focusing their attention on an already well established method — TV rentals.

### Easy Access

The TV rental shop came into its own during the 1960's, as the price of traditional black and white television was coming down, and the more advanced colour models were arriving on the market. Its presence heralded the age of



The new Ferguson Videostar 3V23 due for launch in the Autumn

widespread TV ownership, as it enabled the average household to afford the most advanced and reliable sets available, without the subsequent financial responsibility for repairs and servicing.

Since then, chains of rental shops have appeared and prospered considerably, with most high streets in England boasting at least one well known name in television rentals — and it is here that the video industry has found an outlet.

Many of the large manufacturers are either directly affiliated to chain rental stores, (Ferguson to Thorn-EMI, through DER, Radio Rentals, Multi-Broadcast, Rumbelows and Rediffusion) or have made agreements with them — for example JVC has found outlets through Thorn-EMI. Sony too will now have rental access through its agreement with Telefusion, (a wise move) in order to market its innovative new creation, the C7.

### Video For Everyone

These new developments through the rental industry, will not only allow the already interested consumer to obtain a video recorder at a reasonable price, but will also draw the attention of the remainder of the public to their existence. A prominent shop window display of video recorders is now on view to anyone walking down the high street who cares to glance toward the brightly lit interior of the, already familiar, rental shop.

Here, it seems, is the basis for a growth in home video, comparable perhaps to hi-fi during the past decade. Indeed it could well become an integral part of home entertainment, with a range of equipment as varied as can be found in stereo systems today, its impact will certainly effect the leisure industry far into the future.

The Mitsubishi MS 300.

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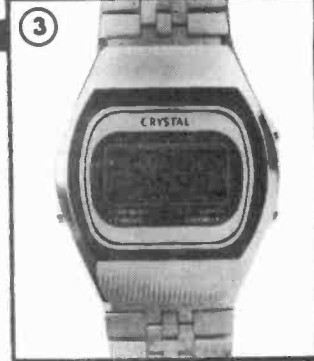
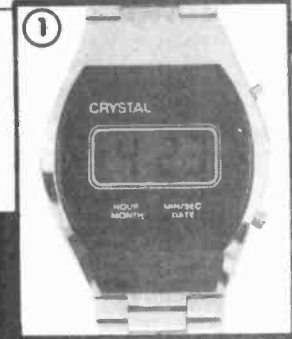
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**QUARTZ LCD ALARM.** 6 digit, hours, mins, secs, day, date, 24-hour alarm with on/off indicator.  
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5

**QUARTZ LCD Alarm/Chronograph.** 22 functions. Hours, mins, secs, day, date, month, 1/10 sec stopwatch, split and lap modes, 12 and 24 hour modes, 24 hour alarm.  
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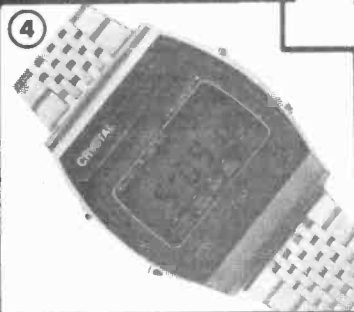
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14

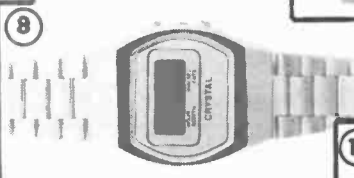
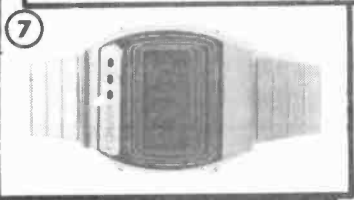
**CREDIT CARD CALCULATOR.** Very slim with standard 4 functions plus memory, percentage and square root. Complete with a mock leather wallet with credit card pocket.  
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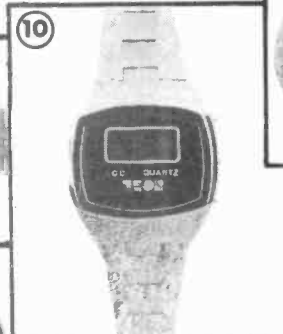
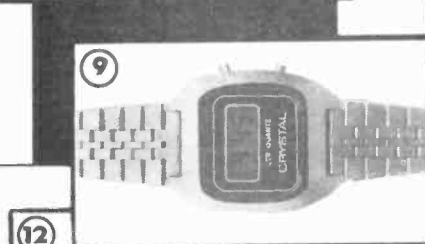
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8 **LADIES QUARTZ LCD.** 5-function as Gents No. 1. Available with black or white face.  
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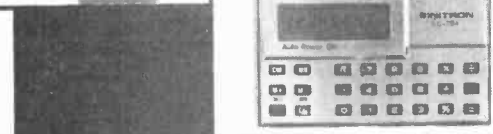
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2N3006	5p	74C20	25p	2N5447	5p	BC171A	5p
1N4305	5p	74C08	25p	2N5449	5p	BF160	5p
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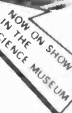
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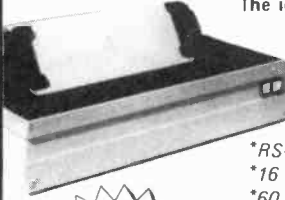
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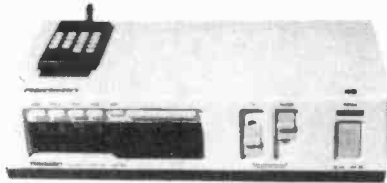
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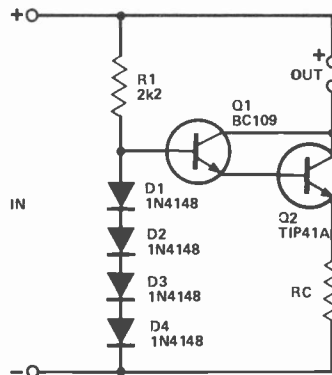
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## Nicad Current Generator

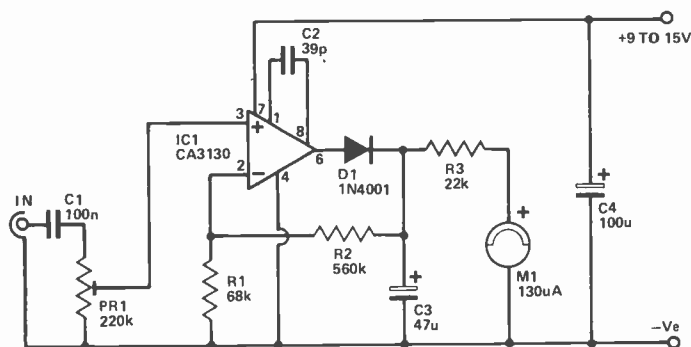
This simple add-on circuit enables a DC bench power supply to be used as a Ni-Cad charger. These cells have a low internal resistance and can be damaged if a charge current significantly higher than the figure recommended by the manufacturer is used. Furthermore, the cell voltage increases as charging progresses, making it necessary to steadily increase the charge voltage as charging progresses, if the charge current is to be maintained.

This unit is a constant current generator circuit which limits the current fed to the Ni-Cad cell(s) to an acceptable level. In effect, the unit automatically adjusts the charge voltage to just the right level to give the desired charge current. The circuit is a standard constant current generator configuration with R1 and D1-4 being used as a sort of low voltage zener stabiliser. About 0V7 is developed across each of the four forward biased silicon diodes, giving a total zener voltage of about 2V8. Q1,2 are used as a Darlington pair and, therefore, have a very high combined gain, so that quite high output currents can be produced by the fairly low drive current available. About 0V65 is dropped across the base-emitter terminals of both Q1 and Q2, giving about 1V5 across emitter resistor RC. The emitter current can be controlled by RC. The collector current of Q1,2 is virtually identical to the emitter current and is actually just fractionally lower as the emitter current is equal to the sum of the base and collector currents. Thus, provided a low impedance load (such as Ni-Cad cells) is present at the output, the current fed to the load can be set by giving RC the appropriate value.



The value of RC is equal to 1,500 divided by the required output current in milliamps and would, for example, be 10 R for rapid charge Ni-Cads requiring a charge current of 150 mA (1,500 divided by 150 = 10 R).

The input voltage should be 3-6 V more than the total voltage of the cells being charged. The cells should be connected in series across the output. Of course, the power supply must be capable of supplying the charge current drawn by the cells plus the additional few milliamps drawn by the current generator circuit itself. For charge currents of more than about 100 mA it will probably be necessary to fit Q2 with a small finned heatsink to prevent it from overheating.



## Peak Reading VU Meter

The type of VU meter normally employed in tape decks and other items of audio equipment is the average reading type. These can give misleading results on signals that have a pulse-like waveform of relatively low average amplitude for the peak

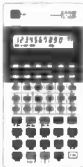
amplitudes involved. This can lead to overloading and consequent distortion on signals of this type eg piano and percussions. One way around this problem is to use a peak reading VU meter. This type of circuit has a fast attack and slow decay time so that it responds properly to brief and intermittent signals. The normal response times for a unit of this type are 2.5 ms attack and 1 S decay. This unit roughly adheres to these figures.

IC1 is an operational amplifier which is used in the non-inverting mode. R1,2 form a negative feedback network which sets the closed loop voltage gain of the circuit at a little under ten. D1 is included at the output so that IC1 can supply an output current, but a current cannot flow into the output of IC1. The feedback is taken from the junction of D1, R2 etc., so that the input voltage appears here amplified by about ten times and the feedback overcomes the non-linearity of D1. C3 is rapidly charged to the peak output voltage as it is fed from the fairly low impedance of IC1 and D1. Its only discharge paths are through the much higher impedances of R3-R2 and R4-M1. This gives the circuit the required fast attack and slow decay times. M1 responds to the voltage across C3, which is, of course, proportional to the peak positive input level (the circuit is a halfwave type and does not respond to negative going inputs). The VU meter movement used in the prototype had a FSD value of 130 uA, but the circuit should work with any type having a sensitivity of between about 50 and 200 uA.

R1 biases the non-inverting input of IC1 to the negative rail and also enables the sensitivity of the circuit to be adjusted to the correct level. At maximum sensitivity, less than 1 V peak is needed for FSD of M1. Current consumption is only about 400 uA.

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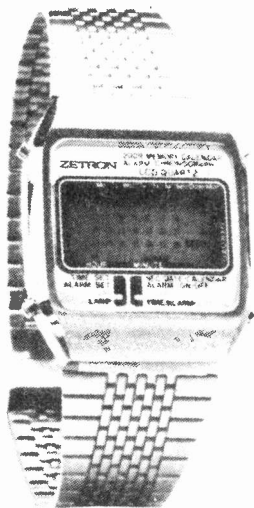
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A 1/106th second chronograph with split and lap mode facilities are built into the watch with a 12-hour capacity.

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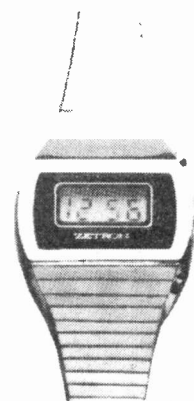
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# 100W POWER AMPLIFIER



Upgrade your hi-fi system with this 100W per Channel stereo power amplifier design from Ambit International, featuring ultra-fast MOSFET output stage.

There is no shortage of audio amplifier designs appearing in the enthusiast press, so to be worthy of close attention, anything new has to justify its existence with a number of innovative features. The amplifier described here is a (nearly) indestructible 100 W RMS per channel unit, employing ultra fast Hitachi MOSFET output transistors, providing excellent amplifier performance. The drive circuitry is considerably less complex than similarly powerful bipolar designs and makes construction far more straightforward.

Like all MOSFETs, the nature of the device construction is such that it is not susceptible to the thermal runaway and secondary breakdown, which is probably the single most pernicious aspect of high powered amplifier designs using conventional bipolar techniques. This means that much of the protection circuitry associated with bipolar amplifiers is unnecessary — and since the current limiting technique in bipolar circuitry involves inserting resistance between the output transistors and the load — the damping factor of the output stage is not compromised.

## Fail-Safe

The major problem area with any DC coupled amplifier is the potential for damage to the loudspeaker by large DC offsets at the speaker terminals. In this design, a separate control circuit has been used to monitor the output DC levels and switch off a fail-safe relay in the event of a potential hazard. The same relay is also driven from a 'thump' prevention circuit that only connects the loudspeakers to the output stage when a suitably stable DC condition has been maintained for a brief time.

Whilst the power supply is active, but the relay is being held open by the protection circuitry, a LED in the front panel will flash intermittently. Yet more LEDs are employed in a switchable 10 W/100 W logarithmic output level bar graph indicator that provides functional (peak) indications.

The MOSFET output stage is a source follower system, requiring only sufficient drive to overcome the gate capacitance effects and thus very little drive power is consumed. So little, in fact, that plastic encapsulated extended TO92 devices are quite sufficient to drive a single output pair.

## Silence Is Golden

The amplifier input stages are designed using low noise high voltage devices from Hitachi. So low noise that this is one of the few amplifiers where it is completely impossible to tell if the mains is switched on. Both AC and DC input coupling are selectable from the front panel.

## Power Supply

A well regulated power supply is an important feature of a high powered PA. The power output of an amplifier is usually limited by the capacity of the power supply (and the load impedance), so the output can be doubled by halving the load resistance, provided the PSU can supply the necessary current.

The PSU of this amplifier uses two entirely independent transformers, rectifiers and reservoir capacitors which all serve to reduce interchannel crosstalk,



especially at low frequencies. It is desirable to achieve as little difference between the output voltage across the reservoir capacitors when the amplifier is operating at 10 W output, as it is when it is putting out full power. The design is specifically for transformers of 5-8% regulation, so that the DC supply voltage only moves between 47-55 V as the power varies. The use of a fully regulated PSU is not required, since factors such as the amplifier voltage gain are independent (or should be) of supply voltage. Separate windings and rectifier/reservoir systems are used to power the DC offset and relay protection circuitry on one unit and the LED bar graph output indicator from the other channel transformer.

## Earth Talk

Perhaps the single most vital aspect of high current amplifier design is the correct layout of the earthing paths of those sections carrying high current. The fact that an earth is not necessarily an earth unless it is 0R impedance has led to the downfall of many PA designs.

Real earth leads contain a finite resistance, so in the example shown the load current ( $I_L$ ) will be far greater than the input bias current — so  $V_1$  will follow the output voltage directly. Since the input current is basically feeding the (+) side of the amplifier — this is positive audio feedback and can very easily lead to complete instability, or at the very least, increased distortion. Thus the policy is to use single point earthing of all such systems wherever possible. The temptation to lump earths together for the sake of convenience must be avoided.

These considerations also apply around the PSU, where ripple current can cause some similarly inconvenient effects.

## Taking Precautions

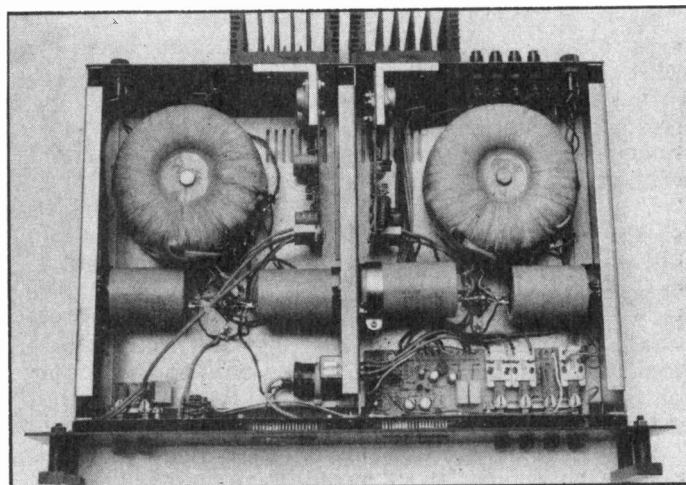
The DC condition, of each channel output is monitored via a 100k resistor feeding the bases of a differential amplifier (Q101, Q201). A 22uF capacitor at this point determines the maximum frequency that will trigger the relay circuit, according to the time constant. Assuming all is well on switch-on, the DC offset circuit does not trigger, but the 100uF capacitor sandwiched between the collector of Q2 and the base of Q103 takes approx. five seconds to charge up, holding the relay open with Q104 still off. As long as the relay is off, the multivibrator formed by Q105 and Q106 can function and so the LED in the collector load of Q105 will flash.

As soon as Q104 turns the relay on and the speakers are connected, the base of Q106 is clamped and the multivibrator stops oscillating with Q105 held permanently on.

## Red Alert

If a DC offset should occur, or (depending on the time constant of the input network) a large low frequency 'thump' be transmitted through the system by a noisy switch connection in the preamp or tuner, either Q101 or Q102 will turn on, instantly charging a 100uF and switching off Q104 again. The LED starts flashing and you know something is wrong somewhere. As soon as the DC offset has been removed, the 100uF discharges and normal service will be resumed with the LED permanently on.

For sheer simplicity, the AEG U257/U267 bargraph drivers are best. They are logarithmic units, which are used in cascaded form to provide a ten LED output (per channel) driven from the loudspeaker terminals. As well,



Take the lid off the 100W PA at your peril - those power supplies mean business.

as providing instantaneous output power indication, the fact that the detector is right at the front of the circuit means that the output bargraph can also indicate the presence of an ultrasonic instability. (ie bargraph reads, with no audible output — assuming you have connected the speakers to the output terminals.) Do not use DIN two pin speaker sockets, as they are not substantial enough for the currents carried in 100 W systems.

A switched resistor network provides attenuation to set the peak reading the bargraph to the desired level (nominally chosen at 10 W and 100 W).

## Construction And Testing

Take careful note of the earth layout in particular. The amplifier modules are mounted via right angle brackets to the output heatsink and care should be taken to use enough heatsink for the sort of use you envisage.

The heatsinks shown are proprietary Redpoint units, just about sufficient for 200 W RMS operation. Since the PSU is capable of driving the amplifier to 250 W in total, you should increase the radiating area of the heatsinks to cope with a heavy duty application such as disco usage, etc. Many commercial amplifier designs of the 'domestic' variety use outrageously inadequate heatsinks, on the basis that even the most dedicated audiophile only ever listens to an average level of 20 W. 100 W crescendos and peaks are then either dealt with by the reserve margin of the heatsink or the fuses blow.

The MOSFET amplifier will get progressively quieter as the drain resistance increases under overheating conditions, so even if you skimp on the heatsinks, the chances are that the worst that can happen will be enforced pianissimo.

If you want to demonstrate the 'screwdriver across the output' trick to your friends unlucky enough to suffer from bipolar amplifier problems, then bypass the relay, since in the authors' experience the first things to get fouled are the relay contacts, which inconveniently weld themselves together at the same time as a large molten pit mark appears on your screwdriver. The switch-on thump is not at all serious even without the relay protection circuit, but there is a very real danger of evaporating the costly voice coil in your loudspeakers if a fault should occur causing the output to slam hard over to one of the rails.

Use large gauge wire (15A will do) for anything like a power amp earth or supply connection and all output leads, etc, and do not forget to fuse the transformer

# On Top Of Old Smokey

As a final precaution, ensure that you have the MOSFETs in the right places. Turn on to check the current consumption. Set for approx 35 mA using the cermet preset. If the current cannot be set sufficiently low, or smoke and other unpleasantness ensues, turn off and check all the connections.

If all is well, fit the loudspeaker, but keep the 8R series resistor and fuse in place as a further precaution. Turn on and listen to the output to make sure that obvious problems like excessive noise and hum are not present. If the input is unterminated, there will be extraneous hum pickup, but shorting the input socket should remove this completely. The only earth connection of the system should be via the PA and the input lead earths.

If all is quiet, but the LED bargraph is lit, then it is possible that there is an HF instability occurring in the PA. Check with an oscilloscope. The points to observe are usually around the output (Zobel) network, where any sustained HF instability will cause the series resistor in the Zobel network to warm up. Persistent HF instability may easily be due to incorrect earthing and a host of interactive problems, but the modular construction of the PCB and connection systems should avoid insurmountable problems.

Unduly distorted sound whilst the DC conditions appear to check out can be due to many problems, but here is a list of the ones the authors have encountered:

Connecting the loudspeakers between the two outputs, not output and ground.

Components around Q1 and Q2 being wrong values.

Forward biasing electrolytic capacitors in the signal path (ie insertion the wrong way round) can lead to both distortion and noise.

On the assumption that your ears are likely to be as good a judge as anything, you can go ahead and connect the loudspeakers directly. Keep the volume setting low if your speakers are not 100 W RMS rated. There is always the chance of high voltage spikes getting through and causing damage. You can artificially suppress the gain by altering the gain setting resistors in the feedback loop, but the only certain way to limit the output power capability is to reduce the power supply voltage.

## HOW IT WORKS

The whole circuit may be likened to a large 'op amp', with the (+) input being the main input, and the (-) input being used for the negative feedback connection — so the input will respond to DC equally as well as to AC and may thus be used for a very large form of servo control if so desired.

The gain of the amplifier is set at 22 according to the ratio of R8/R7 — so that an input of 1V RMS from the preamp will drive the output to 22V RMS, which by Ohm's law gives:  
 $V^2/R = 22^2/8 = 60.5 \text{ W}$  (assuming 8R load).

To achieve 100 W output, you need:  
 $28/22 = 1V28v$  RMS input.

The two stages of differential voltage amplification use 120V transistors for maximum safety, with the collector of the driver stage being fed from a constant current source (Q5). This makes for exceptionally high open loop voltage gain in the overall system, so that very large amounts of negative feedback are applied. Some schools of thought feel that a lot of feedback in PA design is not a "Good Thing", but maybe they had not benefitted from the speed of the H MOSFET. The problem in bipolar designs has usually involved the delay when getting the feedback information round the works, leading to transient intermodulation distortion (TIM). The H MOSFET is sufficiently fast to cope with all this and not produce any TIM.

The 22k (R8) in the negative feedback loop from the output is not compensated in any way due to the ultra-high speed of the MOSFETs and comparison with a bipolar design will usually reveal a substantial phase correction here in the guise of a parallel capacitor.

A high quality cermet preset is used between the gates of the output devices to set the quiescent current at approx. 30 mA by developing a voltage between the two MOSFET gates. Since Q5 is a constant current source, the voltage across the gates is then simply  $I_c \times R_{Vr}$ .

The gates are also provided with zener diode clamp protection to clip the drive voltage to below 14V (the maximum permissible). In normal use, the gate voltage never gets near 14V, so this is primarily a fault protection precaution and not any sort of general overload protection.

A Zobel network at the output is necessary to prevent HF instability, since, although MOSFET PA design is inherently more stable than bipolar design, it is still necessary to cope with problems associated with the high impedance inputs of the FETs and the uncertainties of finite earth path resistances. A choke coil in series with the output provides additional stability with particularly reactive loads — although it is debatable whether or not it is necessary in this design. Output protection is inherent in the H MOSFET, since as the temperature of the transistor rises, so the channel resistance increases, causing the maximum available output current to diminish. Rating this amplifier at 100 W is reasonably conservative, since with a correctly regulated power supply design (5%) as much as 160W RMS can be achieved — and still it is possible to short circuit the output without destroying the MOSFETs!

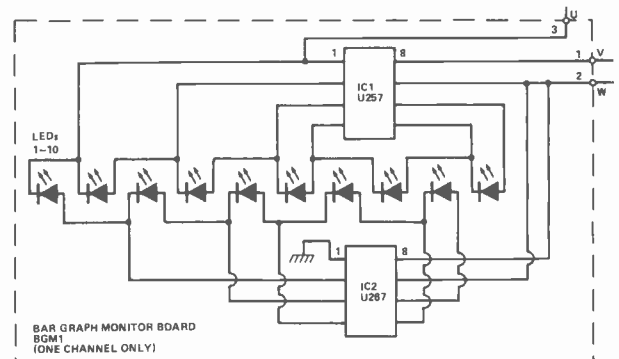
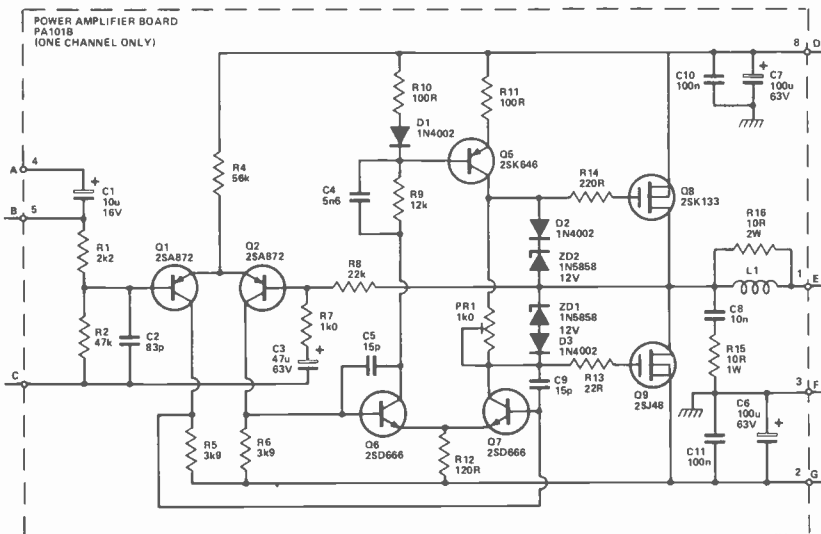


Fig.4. (left) Circuit diagram of the Power Amplifier.

Fig.5. (above) Circuit diagram of the Bargraph Monitor.

# PROJECT: 100W Power Amplifier

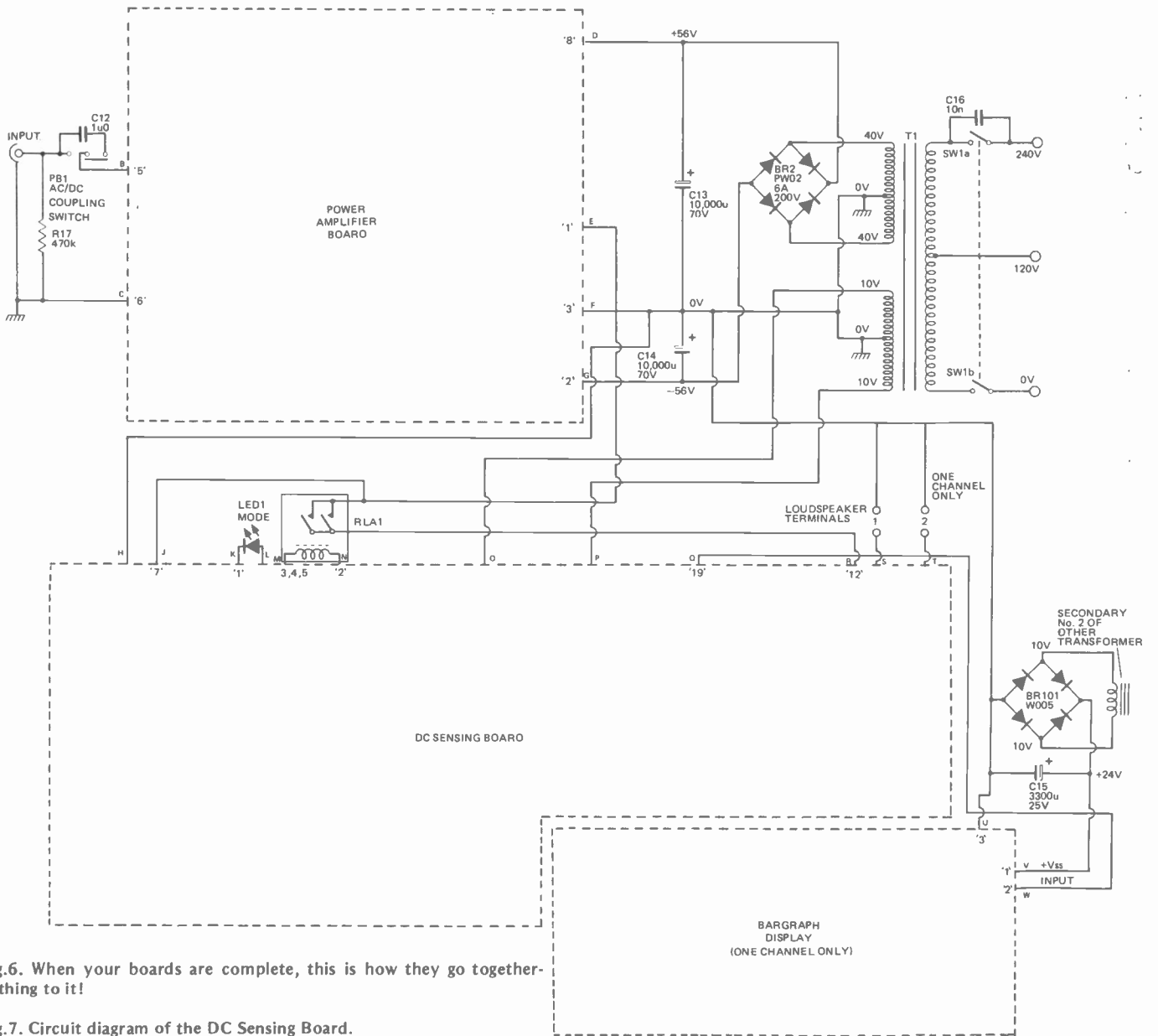
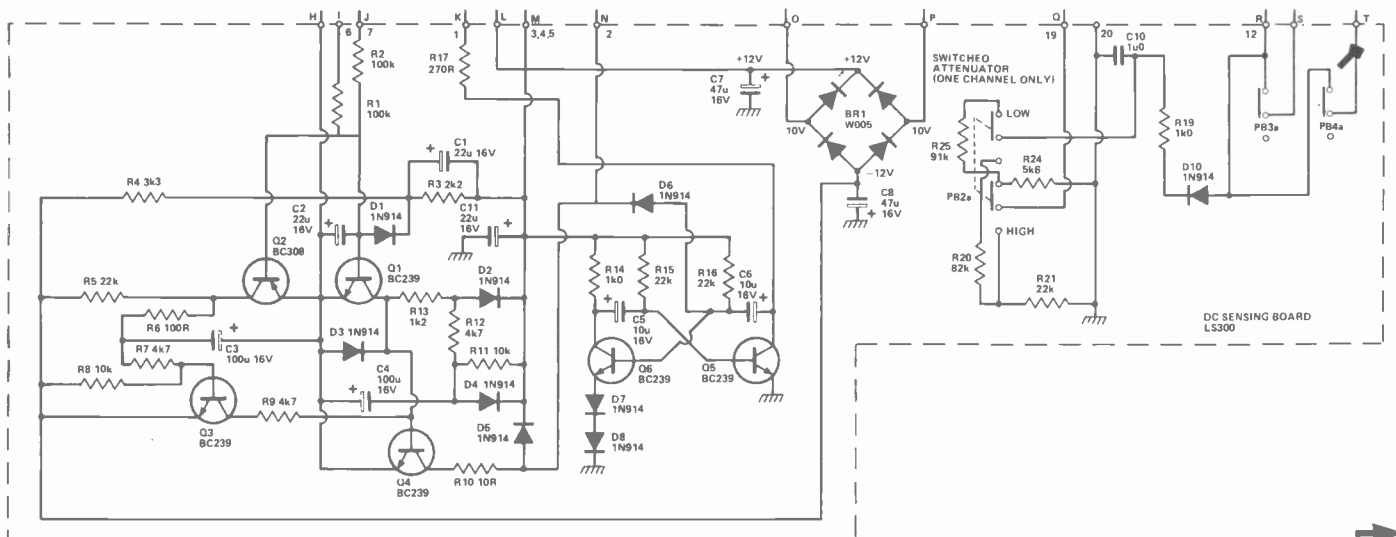


Fig. 6. When your boards are complete, this is how they go together—nothing to it!

Fig. 7. Circuit diagram of the DC Sensing Board.



## PARTS LIST

### POWER AMPLIFIER BOARD (one channel)

Resistors ¼W 5% unless specified

R1	2k2
R2	47k
R4	56k
R5,6	3k9
R7	1k0
R8	22k
R9	12k
R10,11	100R
R12	120R
R13,14	220R
R15	10R 2W
R16	10R 1W

(R3 has been deleted from this design)

### POTENTIOMETER

PR1	1k0 linear preset
-----	-------------------

### CAPACITORS

C1	10u 16V tantalum
C2	33p 160V polystyrene
C3	47u 63V electrolytic
C4	5n6 160V polystyrene
C5,9	15p 160V polystyrene
C6,7	100u 63V electrolytic
C8	10n 100V mylar
C10,11	100n 250V polyester

### SEMICONDUCTORS

Q1,2	2SA872
Q5	2SB646
Q6,7	2SB666
Q8	2SK133
Q9	2SJ48
D1-3	1N4002
ZD1,2	1N5858

(Q3,4 have been deleted from this design)

### MISCELLANEOUS

L1 12 turns 16 swg enamelled copper wire (around R17), PCB, 8 way 0.2" plug connector, 4 x 1 ¼" capacitor clips, 2 x 8 way flying lead sockets and 16 connector pins.

### OFF-BOARD COMPONENTS

#### RESISTORS ¼W 5%

R17	470k
-----	------

#### CAPACITORS

C12	1u0 250V polycarbonate
C13,14	10,000u 70V electrolytic
C15	3300u 25V electrolytic

#### SEMICONDUCTORS

BR2	PW02 (6A 200V)
LED 1	5 mm. red

### DC SENSING BOARD

RESISTORS All ¼W 5%

R1,2	100k
R3	2k2
R4	3k3
R5,15,16	
21,22	22k
R6	100R
R7,20,23	47k
R8,11,27	10k
R9,12	4k7
R10	10R
R13	1k2
R14,19	1k0
R17	270R
R24	5k6
R25	91k

(R18,26,27 are on other channel)

### CAPACITORS

C1,11	33u 16V electrolytic
C2	4u7 16V electrolytic
C3,4	100u 16V electrolytic
C5,6	10u 16V electrolytic
C7,8	47u 16V electrolytic
C9,10	1u0 100V electrolytic

### SEMICONDUCTORS

Q1,3,4,5,6	BC239
Q2	BC308
D1-10	1N914
BR1	W005 1A 50V

### MISCELLANEOUS

PCB, 21 way 0.2" plug strip (multiples of 14 and 7 way).

### BAR GRAPH DISPLAY (one channel only)

#### SEMICONDUCTORS

IC1	U257
IC2	U267
LED 1-6	Flat LED, green
LED 7	Flat LED, yellow
LED 8-10	Flat LED, red

### MISCELLANEOUS

T1	40-0-40, 10-0-10, 250 VA mains transformer
RLA1	12V 4 pole Continental relay, 700R coil
	¼" stereo jacket socket, spring-loaded terminals (4 red, 4 black), 2 x 3A fuses and chassis mounting holders, filtered (or unfiltered) 3A mains socket, stereo phono socket, 2 way 20mm SUF switch (input), mains on/off switch, 4 pole C/O push button switch, 3 x 2 pole C/O push button switches.

primaries. Under no circumstances should you ever rely solely on the fuse in the mains plug.

Check that the mains fuse is in place. Do not connect the circuit boards to their respective PSUs yet. Switch on, and check all the various DC voltages with a meter. And make sure that you have clearly marked the positive and negative connections, as reversing the low impedance power connection to the output modules is one of the most certain ways of destroying the whole lot. The main PSU capacitors should be carefully checked for correct polarity, as 10,000uF on the ceiling makes a very unpleasant mess. Remember to ground the centre point of the PSU's.

## DC Offset Protection

The first part of the circuit to verify is the output pro-

tection unit and switch-on delay PCB. Connect this to the PSU and switch on.

The result should be a flashing LED, which extinguishes after 5 S to the accompaniment of the speaker relay clicking 'in'. You can verify this by placing an ohmmeter across the relay terminals if you like. If not, ground the input to the offset detector (the connection from the amplifier output), since stray pickup could conceivably cause the failsafe to trip.

Failing this, an analysis of the circuit board construction and test voltages is the only solution. Make certain the diodes are in the correct way round, since this is one of the more frequent causes of trouble.

Assuming that a combination of sound construction/ thorough debugging/luck leads to a correctly functioning circuit, check that the application of a DC offset to

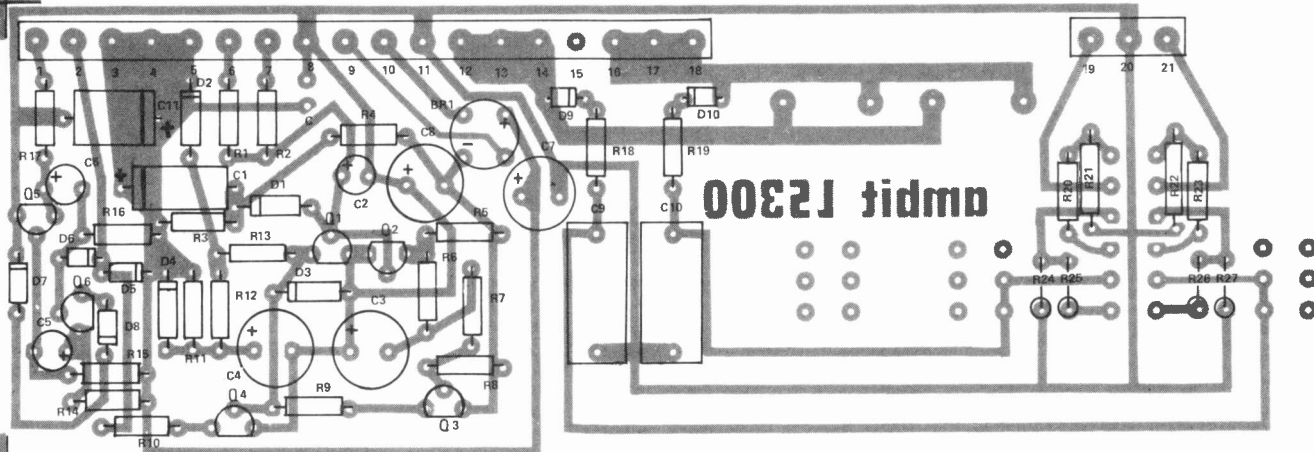


Fig.1. Component overlay of the DC Sensing Board. Note capacitor polarities.

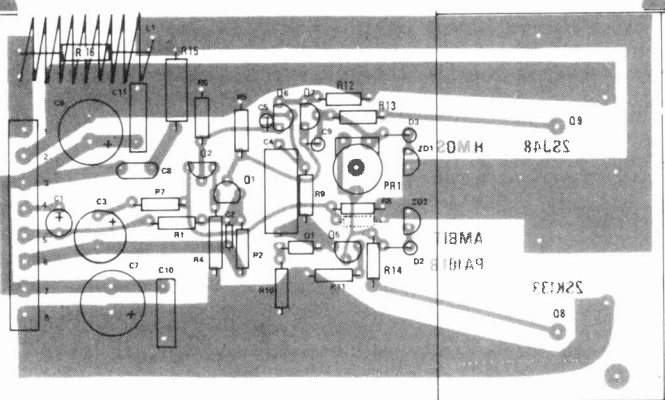


Fig.2. Component overlay of the Power Amplifier Board. Coil L1 is wound round R16.

the input (via the limiting resistor) (from a 1V5 battery for example) causes the relay to drop out and the LED to start flashing again.

Make certain that the loudspeaker connections are wired via the normally open contacts, since the circuit is fail-safe ie if the power to the relay is cut, the speaker path is discontinued.

## Output Bargraph

Connect the power to the output bargraph driver PCB. With no output from the power amplifiers, inject a signal from your finger onto the input of the bargraph board. Depending on your conductivity and the amount of hum about, some or all of the LEDs should light. The input attenuator switch selects a potential divider from the rectified output of each channel, nominally set for FSDs of 10 W and 100 W, but if you are proposing to use the amplifier with speakers rated at less than 100 W (and most of them are) then set the attenuator to read the appropriate FSD. Simply adjust the potentiometer ratios pro-rata. The U257/U267 use logarithmic steps, covering a 26 dB range.

## Home Welding

Now comes the hairy bit. +60 V on the ends of 10,000uF reservoirs is not to be trifled with, so make certain the first connection you make to the amplifier modules is the correct one. Before attempting this, switch off and discharge the main PSUs via a suitable resistor, such as 2k/2 W.

A quick dab with the screwdriver across the terminals of 10,000uFs will lead to a damaged screwdriver and a fresh set of underwear.

Fit a millimeter in series with one of the supply leads (use one in each arm of the supply if you have two meters) and test one module at a time. Set the output quiescent preset to minimum resistance (minimum bias current) and connect the output to the DC offset sensing circuit. A load of 8R/10 W should be connected across the appropriate output terminals. Select the correct output via the panel switch. Do not connect direct to your favourite speakers at this stage. A 3 A fuse in series with the load is not a bad idea during testing. This should be removed once you are satisfied that all is well since the resistance of such fuses is a serious contribution to some of the distortions otherwise avoidable in high power audio amplifiers.

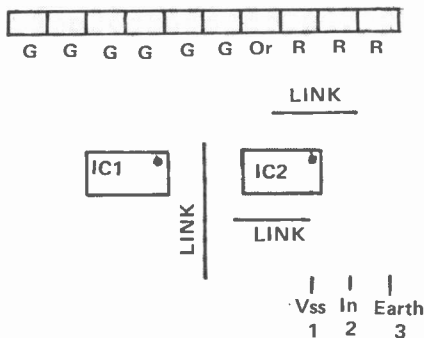


Fig.3. Component overlay of the Bargraph Monitor Board, using only two ICs.

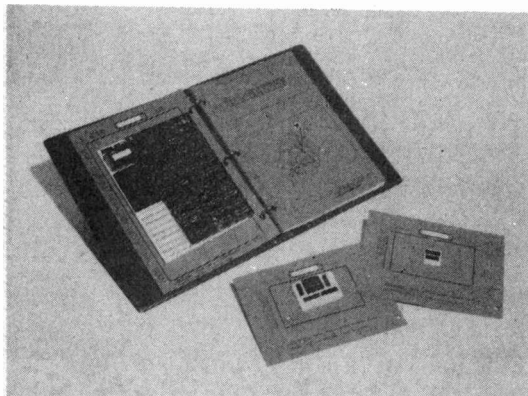
## BUYLINES

A complete kit for the HMOS Power Amplifier is available for £155 + VAT from Ambit International, 200 North Service Road, Brentwood, Essex. The PCBs, metalwork, etc can be bought separately. Contact Ambit for latest prices.

# MICROTAN 65

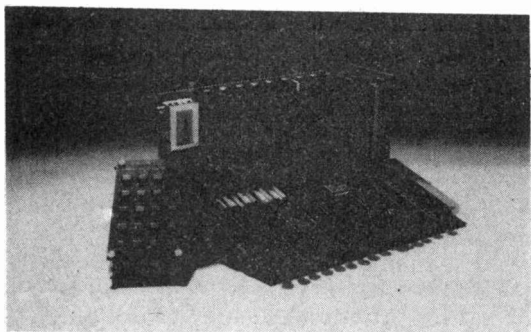
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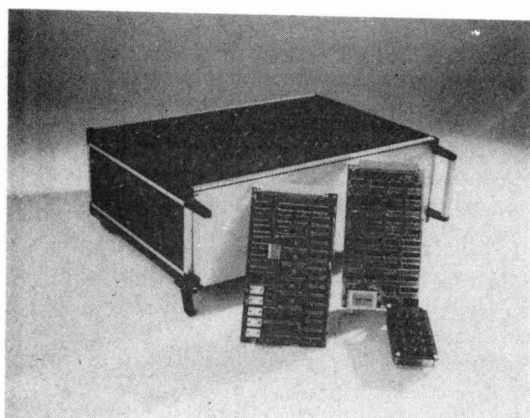


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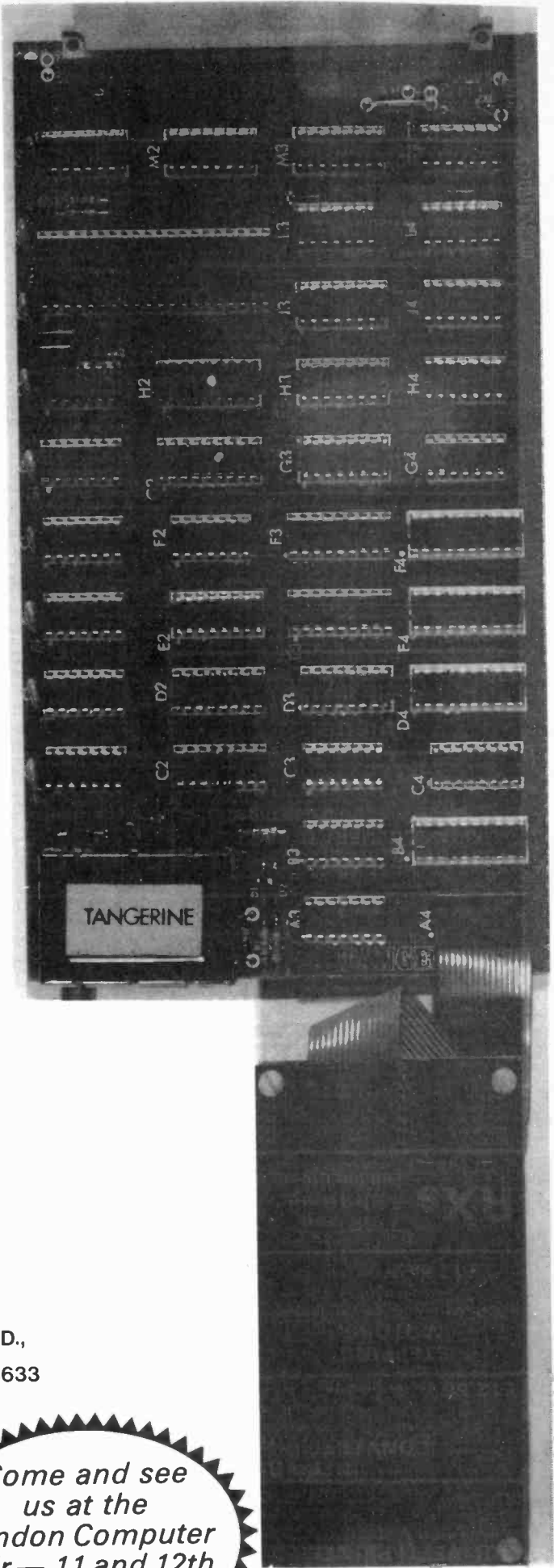
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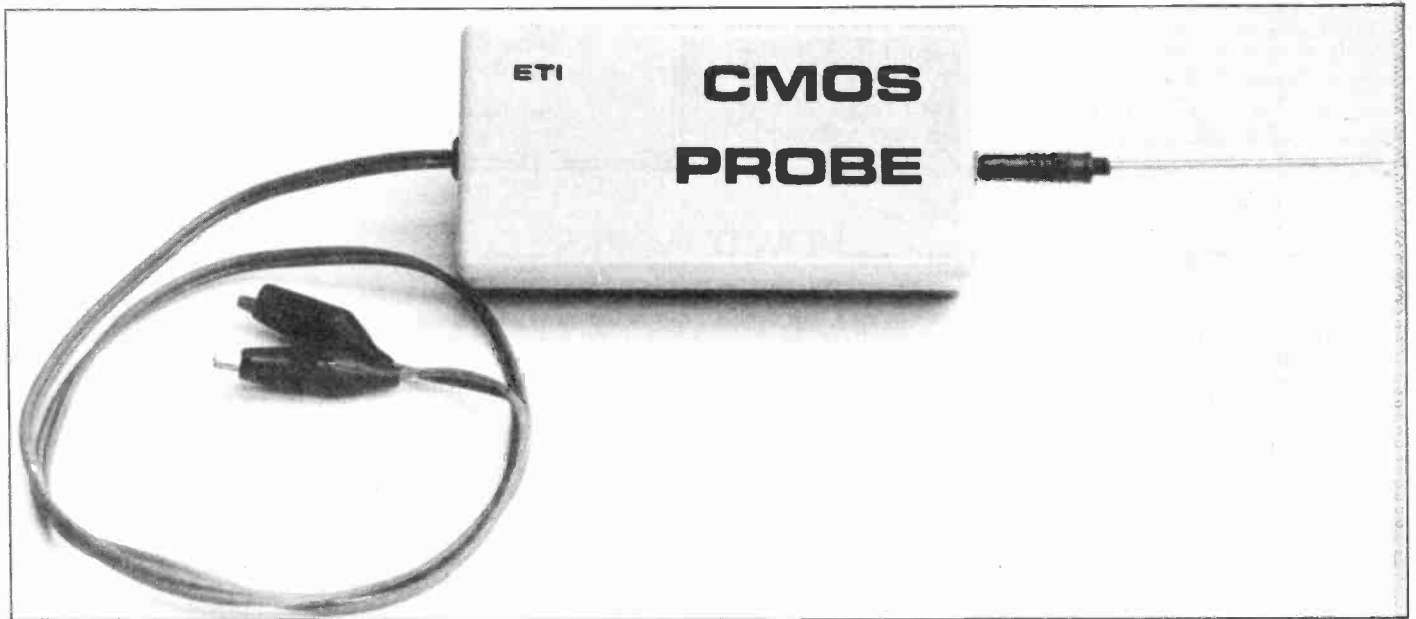






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Check you CMOS voltage levels with this economical piece of test gear.



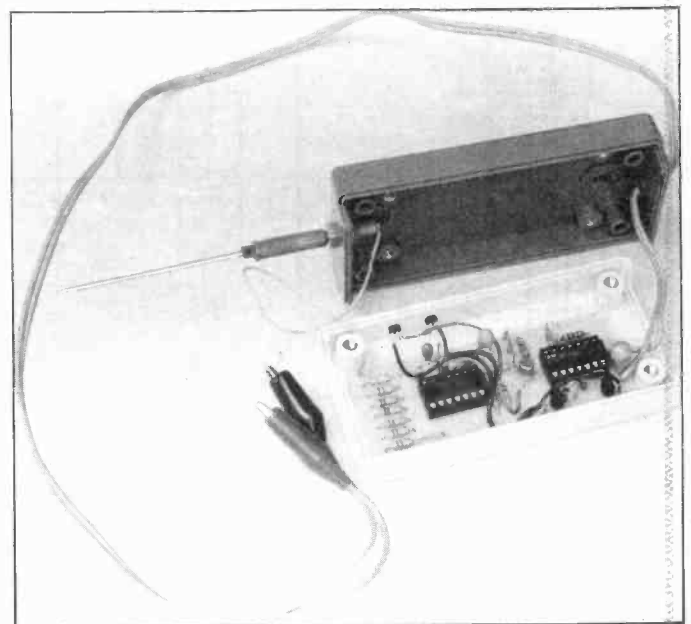
**T**his unit, powered from the equipment under test, enables the voltage levels of CMOS circuitry to be checked to determine if they are within the valid logic range. Two LEDs are used to indicate high and low logic levels, invalid levels and open circuit conditions.

## 1, 0, Or Just Out To Lunch

With no input, the internal current source is held off and neither LED is illuminated. One of the two LEDs will light to indicate a valid input signal. When the input is between thirty and seventy percent (CMOS logic thresholds) of the supply voltage, both LEDs will illuminate. Both LEDs are also on for an oscillating input. Although no provision has been made to detect single pulses, a simple 555 monostable circuit would accomplish this. If triggered from pin 10, IC2, the unit would detect both positive and negative going transitions.

## 2 Chips, 2 LEDs

Use of a quad comparator and a Schmitt input quad NAND package enable sophisticated performance to be obtained from a handful of chips and transistors. Use the transistors specified, as they are chosen for their high minimum current gain. Any type or colour LEDs can be



The inside story - the tester's board exposed.

used. Note that the LED current is set by R14 which can be reduced if you require a brighter display. With the value specified, a current of between 10 mA and 15 mA flows depending on the supply voltage. The use of a 'constant current' driver stage avoids the problem of excessive drive current at high supply voltages.

Although CMOS is characterised to operate at 3 V, it was felt that the extra circuitry required to ensure reliable operation of the unit at this level would have been uneconomical. The prototype gave good results at a supply level of between 4V5 and 18 V.

If you use our PCB design, you can't go wrong. Of course, any method of construction may be employed. Keep connecting leads short, especially around the comparator inputs. We used tantalum capacitors for the higher values. They are small, efficient and worth the extra cost. Use 35 V working types.

We were able to fit our unit in a small verobox by removing one of the internal pillars. They come out quite cleanly if you snip around them with a stout pair of wire cutters. However you build it, the CMOS logic probe will soon become a valuable addition to your range of test gear and help you get your projects up and running in double quick time.

## PARTS LIST

Resistors	
R1,4,6,11	120k
R2,3,5,7,8	100k
R9	470k
R10	1M0
R12	22k
R13,15,16	47k
R14	82R

Capacitors	
C1	10u 35V tantalum
C2	4u7 35V tantalum
C3	10n ceramic
C4	22u 35V tantalum

Semiconductors	
IC1	LM339
IC2	4093B
Q1	BC477
Q2,3	BC184L
D1-D4	1N4148
LED 1,2	any LED

Miscellaneous  
Verocase 202-21027E, PCB.

## HOW IT WORKS

Valid voltage levels for CMOS operation are below 30% and above 70% of the supply voltage. This circuit uses four comparators to determine whether or not an input voltage is within the valid ranges and its polarity. There is also circuitry to detect an open circuit condition.

Gate IC2d is connected as an oscillator running at between 1 kHz and 5 kHz, depending on component tolerances and supply voltage. Its output is capacitively coupled to diode pump D1,2. A voltage is developed across C1 about 3-15 V more positive than the positive supply voltage and this provides the positive supply for the LM339 quad comparator. IC1d is used to compare the voltage at the probe with a bias voltage slightly greater than the positive supply. When the probe is unconnected, IC1d's output is off. When the probe is connected to a voltage within the supply range, IC1d's output (an uncommitted collector) goes low, sink-

ing current through R12 and turning on constant current source Q1. In summary, when the probe is unconnected Q1 is off and neither LED can light.

Comparators IC1a,c are connected as a conventional window comparator whose output is high when the probe input voltage is invalid. This signal, inverted by IC2a, causes IC2b,c to go high turning on Q2,3 and illuminating both LEDs. An oscillating unit will also cause both LEDs to illuminate.

With a valid input voltage, IC2a output will be high and LED 1 or 2 will light to indicate the polarity of the input signal. Comparator IC1b is used to determine input polarity, comparing it with a mid-supply voltage at the junction of R2,3. Note that when the probe is connected to a logic '0', the gate under test sinks about 50 uA max from the auxiliary positive supply and associated bias resistor, R9.

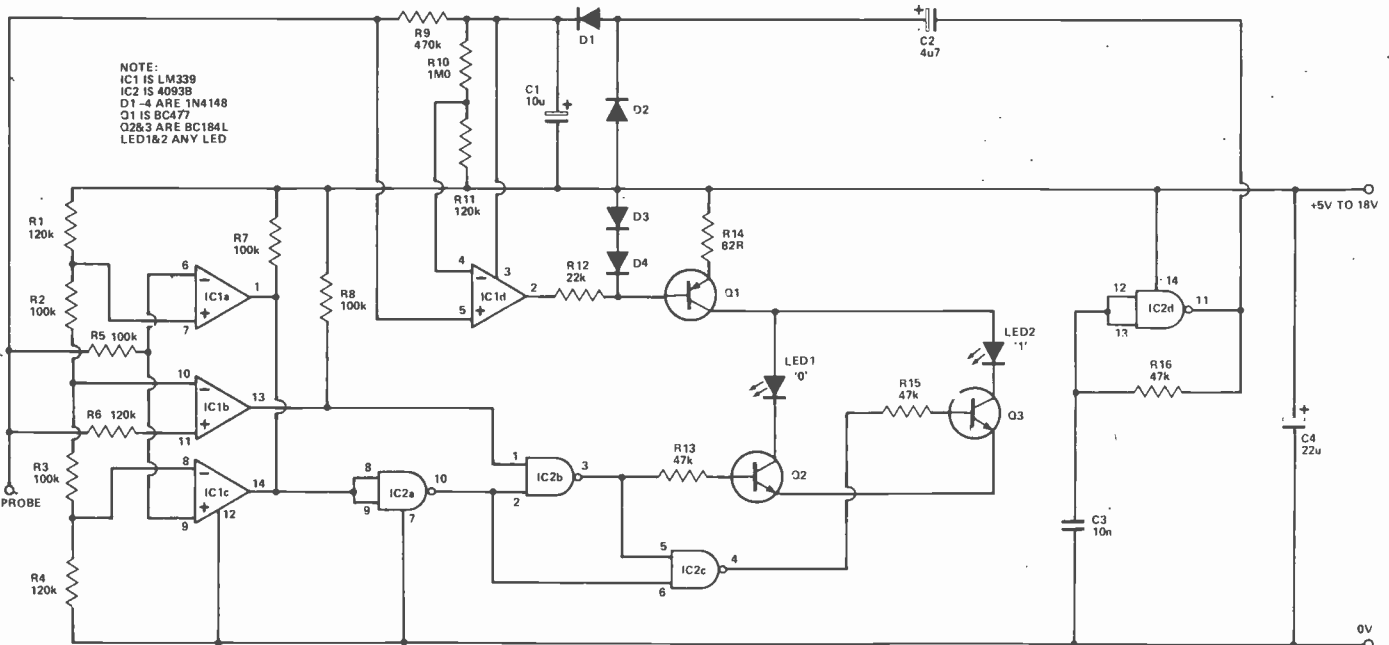


Fig.1. Circuit diagram.

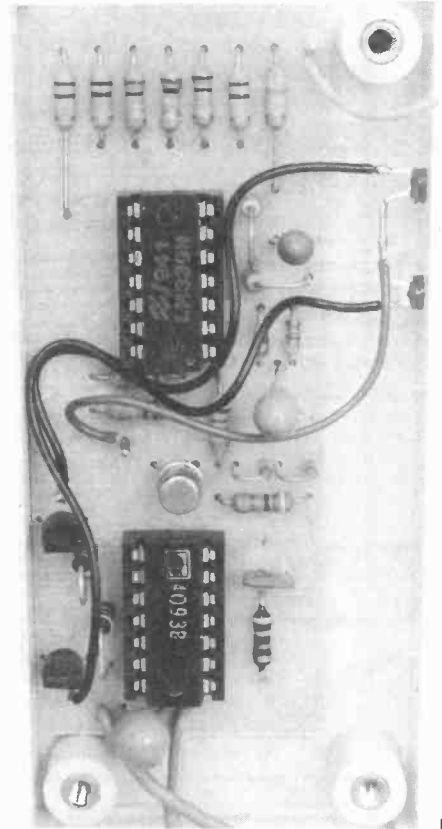
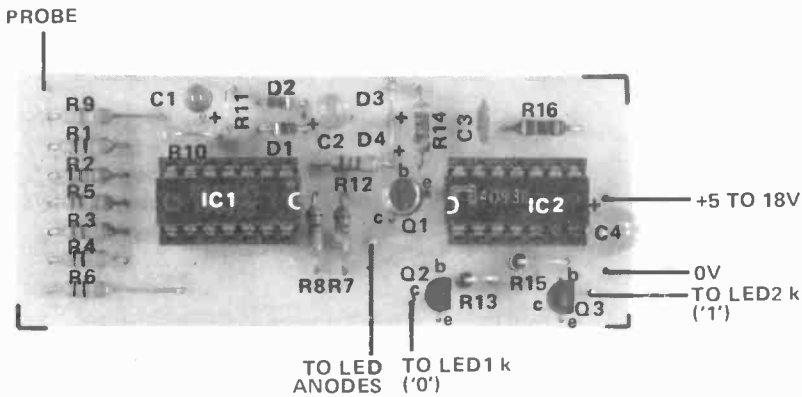


Fig.2. (above) Component overlay. Note the orientation of IC1 and IC2. Board construction is straightforward.

The completed board (right) installed in the case. The two LEDs push-fit into the side of the case.

## BUYLINES

All the components should be readily obtainable. In case of difficulty, try Watford, Marshall's or Technomatic or check with other suppliers advertising in ETI.

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Red	0.125in	0.2in	
Green	TIL209	TIL220	10p
Yellow	TIL211	TIL221	16p
Clips	TIL213	TIL223	16p
	3p	3p	

DISPLAYS

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

### TRANSISTORS

AC127	25p	BC547	8p	TIP30C	70p
AC128	25p	BCY71	18p	TIP2955	65p
AD161	40p	BD131	35p	TIP3055	60p
AD162	40p	BD132	35p	ZTX107	12p
BC107	10p	BD139	35p	ZTX108	12p
BC108	10p	BF140	35p	ZTX109	12p
BC109	10p	BFX29	25p	ZTX300	14p
BC147	9p	BFX84	26p	ZTX500	15p
BC178	16p	BFY50	23p	2N3053	25p
BC182	10p	BFY51	23p	2N3055	55p
BC182L	10p	MJ2955	98p	2N3702	9p
BC184	10p	TIP29C	60p	2N3703	9p
BC184L	10p			2N3819	22p
BC212	10p			2N3905	10p
BC212L	10p	1N914	4p	2N3702	9p
BC214	10p	1N4001	4p	4015	85p
BC214L	10p	1N4006	7p	4017	80p
		1N4148	3p	4018	90p
		1N4002	5p	4020	110p
		1N5401	14p	4022	100p
		BZV88 series	8p each.	4023	25p
				4024	60p
				4071	25p

### LINEAR

741	18p	LM324	52p	MM57160	650p
747	70p	LM339	55p	NE531	140p
748	40p	LM348	100p	NE555	23p
7106	850p	LM377	170p	NE556	60p
CA304E	70p	LM378	230p	NE567	120p
CA3080	75p	LM380	80p	RC4136	100p
CA3130	100p	LM381	140p	SN76477	230p
CA3140	60p	LM382	120p	TBA800	80p
LF347	170p	LM386	90p	TBA810	110p
LF351	45p	LM387	120p	TDA1022	630p
LF353	90p	LM1830	180p	TL081	45p
LF356	95p	LM3900	60p	TL082	85p
LM301A	30p	LM3909	72p	TL084	125p
LM318	85p	LM3911	120p	XR2206	390p
		LM3914	320p	ZN414	80p
		LM3915	320p	ZN425E	475p

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4002	25p	4026	150p	4081	30p
4006	95p	4027	50p	4082	30p
4007	25p	4028	90p	4085	85p
4011	30p	4029	110p	4093	80p
4013	30p	4040	110p	4095	110p
4015	85p	4042	85p	4510	90p
4016	48p	4045	110p	4511	100p
4017	80p	4048	60p	4518	90p
4018	90p	4049	50p	4520	110p
4020	110p	4050	50p	4527	165p
4022	100p	4052	80p	4528	100p
4023	25p	4060	120p	4532	125p
4024	60p	4066	63p	4543	170p
		4068	25p	4583	80p
		4069	25p	4585	115p

### SKTS

8 pin	9p	22 pin	20p
14 pin	11p	24 pin	20p
16 pin	12p	28 pin	26p
18 pin	16p	40 pin	38p
20 pin	18p		

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### SWITCHES

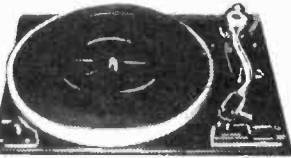
TOGGLE			
Standard	SPST	40p	DPDT 55p
Miniature	SPDT	80p	DPDT 85p
Subminiature	SPST	65p	DPDT 85p
SLIDE	Standard	DPDT 17p	Miniature 16p each
PUSH	Push to make	16p	Push to break 22p

### TTL

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7401	15p	7448	65p	74125	60p
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7406	38p	7474	36p	74141	95p
7408	22p	7475	40p	74145	90p
7410	18p	7476	40p	74150	120p
7413	35p	7483	80p	74154	110p
7414	56p	7485	80p	74157	80p
7420	16p	7486	35p	74164	120p
7427	30p	7490	45p	74165	120p
7430	30p	7492	55p	74174	100p
7432	35p	7493	45p	74175	95p
		7494	70p	74190	100p
		7495	70p	74191	100p
		7496	70p	74192	100p
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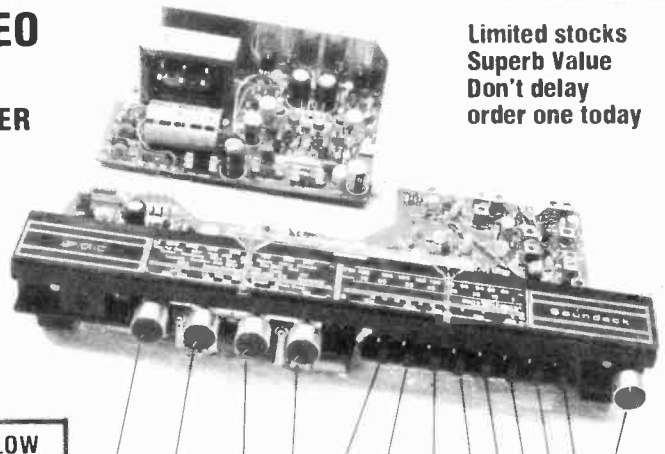
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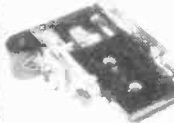
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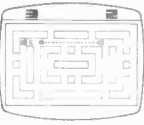


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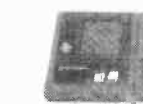
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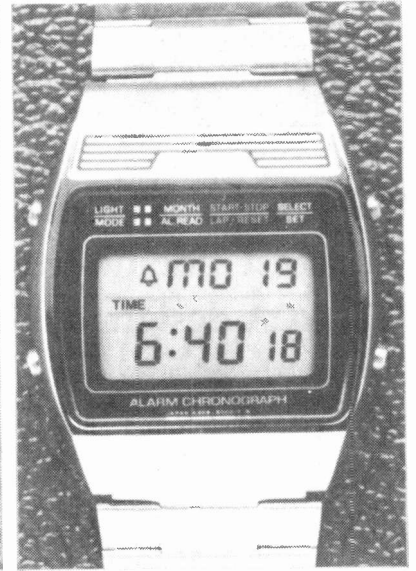
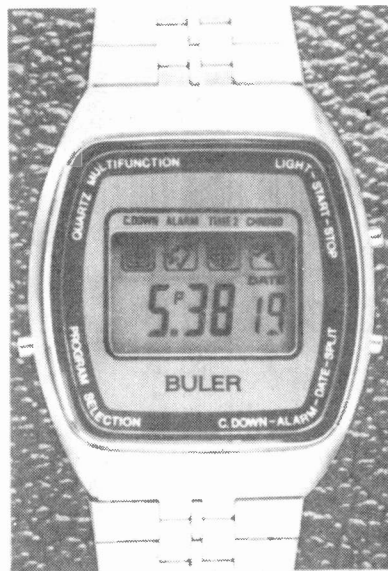
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Time 1 12 / 24 hour AM / PM display	✓
Time 1 24 hour alarm	✓
Time 1 Day of week in English	✓
Time 1 Day of week in French and German as well	✓/✓
Hourly chimes	
Time 2 Hours mins secs day and date	✓/✓/✓/✓
Time 2 Automatic viewing of time day and date	✓
Time 2 12 / 24 hour AM / PM display	✓
Time 2 24 hour alarm	✓
Time 2 Day of week in English French and German	✓/✓/✓
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Time 1 12 / 24 hour AM / PM display	
Time 1 24 hour alarm	✓
Time 1 Day of week in English	
Time 1 Day of week in French and German as well	
Hourly chimes	
Time 2 Hours mins secs day and date	
Time 2 Automatic viewing of time day and date	
Time 2 12 / 24 hour AM / PM display	
Time 2 24 hour alarm	
Time 2 Day of week in English French and German	
Chronograph Measuring up to 12 hours	✓
Chronograph Measuring up to 24 hours	
Chronograph Split lap timing mode	✓
Count down timer up to 100 minutes	✓
Count down timer up to 23 hours 59 mins	
Number of digits	10
Number of symbols	7
Thickness	8mm
Battery life	2 years
Battery availability	Seiko dealer only
Stainless steel construction	✓
Quartz mineral crystal lens	✓
Water resistant to a depth of	Yes, but not specified

To: Metac 24-hour Despatch Centre,  
47 High Street, Daventry, Northants  
Please send me Buler watches at £24.95 plus  
75p&p. I enclose cheque / PO for £

Barclaycard / Access No \_\_\_\_\_

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Please Complete

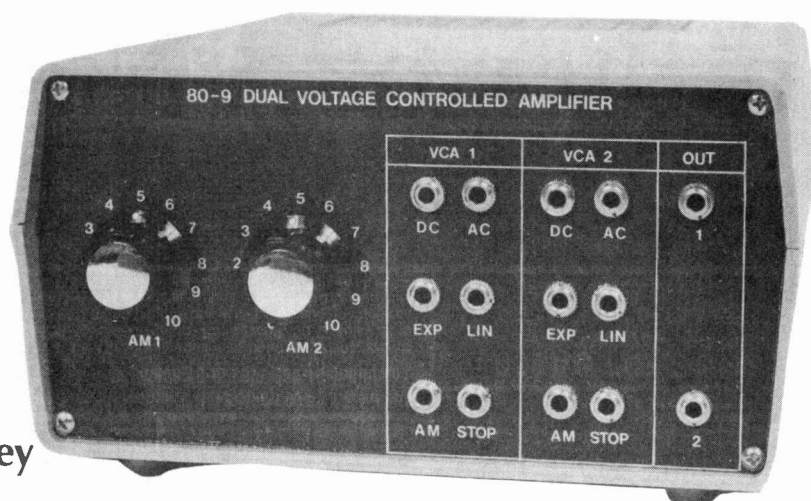
Name \_\_\_\_\_

Address \_\_\_\_\_

ET18

# DUAL VCA

The Project 80 family grows.  
The latest addition - this  
Dual VCA design by R.C. Blakey



A voltage controlled amplifier (VCA) when used in conjunction with an envelope shaper provides dynamic control over the amplitude of signals. Although the advantage of customised ICs for electronic music has been demonstrated in previous modules this dual VCA effectively illustrates their cost-performance benefits. It is a true dual VCA with each half having facilities for exponential or linear control; 0 to 100% linear amplitude modulation (tremelo); an external control of amplitude (expression). Furthermore, one can almost forget about overloading the VCAs and causing distortion, since they will accept  $\pm 10$  V signals and yet their low inherent noise is such that much smaller signal levels are acceptable. Each VCA also has a dynamic control range of some 80 dB using our standard 0 to +10 V control voltages.

## Design Features

The design is based on the CEM 3330 Dual VCA IC produced by Curtis Electromusic Specialties, as used in Module 80-4 VCM.

A VCA is normally employed in conjunction with an ADSR envelope generator to provide the contour of sound dictated by this controller. Ideally the response to the envelope shaper voltage should be exponential since the human ear responds to loudness in a logarithmic manner. This facility is provided with a response of approximately 8 dB/volt. The overall response is such as to avoid problems arising from small levels of control voltage feedthrough from the envelope shaper. A linear control input is also included for other purposes but may be used with an envelope shaper to obtain a different type of response. In this instance, however, small amounts of control voltage feedthrough from the ADSR may be audible, although this can be cancelled out by applying an external positive voltage into the AM input. Increasing this voltage will bury the envelope voltage, that is, the attack and decay voltages will begin and end, respectively, at a voltage equal to the voltage applied to the AM input. The aural effect is more realistic since it effectively shortens the exponential decay time of the envelope — a technique adopted in some commercial synthesisers.

Another use of a VCA is for amplitude modulation (tremelo) and the design allows 0 to 100% amplitude modulation using any of the 0 to +10 V signals from the VCLFO (or VCO). The linear input or the linear AM input may also be used for loudness control, or expression, by using a

foot pedal outputting a control voltage or by taking a control voltage from, say, the keyboard. Another feature incorporated into the linear control input is a 'STOP' facility. In live performance it can be disconcerting when the rest of the group stops sharply at the end of a piece and the synthesiser is still playing as the envelope shaper continues its decay time.

Normally the signal into the VCA will be AC coupled, but if the VCA is being used for electronic control over the amplitude of signals which are to be processed further then a DC input is useful. Signals up to  $\pm 10$  V may be used and either AC or DC coupled. Mixing of signals at the VCA is not included since other ETI 80 modules have ample facilities for mixing prior to the VCA. Likewise the gain is fixed at about 0.6 so as to retain a very high signal to noise ratio for signals which will undergo further treatment and in other circumstances the output can be attenuated at the input of the power amplifier. If necessary the gain may be adjusted by using external control voltages, as described above.

The CEM 3330, from Curtis Electromusic Specialties, contains two voltage controlled amplifiers each of which consists of a variable gain cell and a log converter. The gain cell is the current-in, current-out type with an exponential control scale. The log converter generates the logarithm of the linear control input current while transmitting the exponential control input unchanged to its output, thus providing simultaneous linear and exponential controls.

Only one VCA using pins 1 to 9 of the CEM 3330 will be described since the other VCA using pins 10 to 18 is identical. The exponential control input (pin 6 of IC1) has a scale sensitivity of 18 mV/−6 dB and an increasing positive control voltage decreases gain. To reverse the polarity, so as to accept the 0 to +10 V control voltages used in the ETI 80 modules, IC2b with R12 and R14 provide a unity gain inverting stage and the voltage is attenuated by R15 and R16 to acceptable levels. R13 connected to −15 V produces a nominal 253 mV at pin 6, which sets the minimum level, and a +10 V control voltage applied to R12 will result in about −16.5 mV for maximum gain. Thus the nominal control range at this input is about 90 dB.

The overall gain of the VCA is given by

$$A_v = \frac{R_f}{R_i} \times \frac{I_{CL}}{I_{REF}} e^{-V_{CE}/V_T}$$

where  $R_f$  is the value of the output resistor (R24);  $R_i$  the signal input resistor (R17);  $I_{CL}$  the linear control current developed across

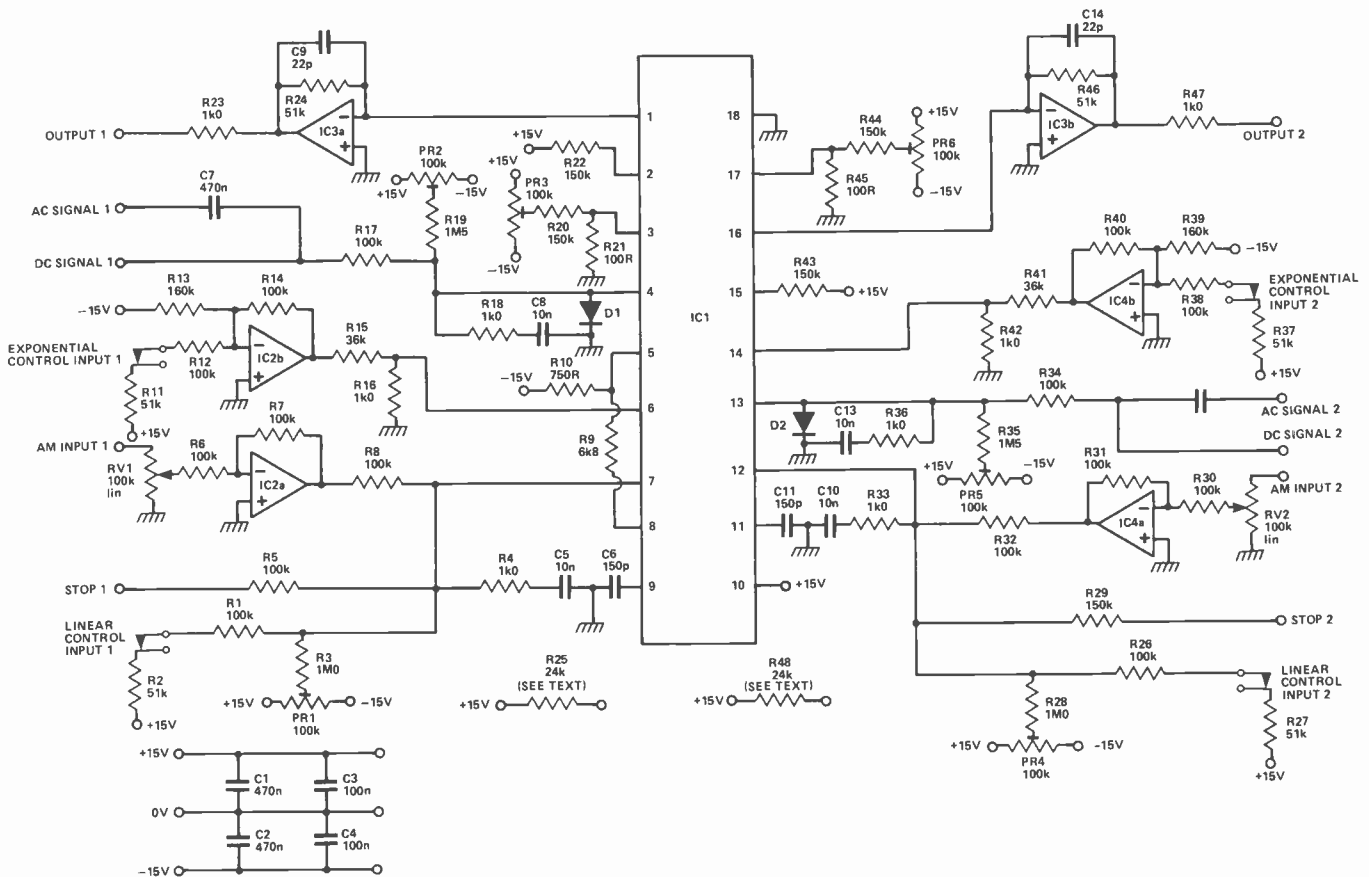


Fig.1. Circuit diagram of the Project 80 Dual VCA.

## HOW IT WORKS

R1;  $I_{REF}$  the current input to pin 2 via R22 which has been set to 100  $\mu$ A for best overall performance; and  $V_{CE}$  the exponential control voltage discussed above. Thus +10 V into pin 7 via R1 (100k) produces maximum gain. By using jack socket inputs to both linear and exponential controls and connecting these to +15 V via R2 and R11 respectively, the VCA is operating at maximum gain. With a signal applied via R17 and no jack plugs inserted into either control socket the signal will pass through at maximum gain (about 0.75), which is a useful facility when setting up or tuning the synthesiser. A 0 to +10 V control voltage applied to either control socket will attenuate the signal over the full control range and with the appropriate control characteristics. These same facilities can be obtained by switches and R25 is included on the PCB for this purpose; it is connected via a switch to both control inputs (R1, R12) so as to allow signals to pass through the VCA at maximum gain. Normally the exponential input is used in conjunction with an ADSR envelope shaper and the linear control input used for amplitude modulation (tremelo). 0 to 100% amplitude modulation is obtained from the linear input using any 0 to +10 V waveform applied via RV1 and the inverting stage built round IC2a. Thus +10 V with RV1 at zero resistance will result in 100% modulation of the control voltage applied to the exponential input. PR1 and R3 are provided to balance the control voltage applied to the linear input, via R1 and R2, with the voltage applied to the AM input. Also connected to the linear input is a 'STOP' facility via R5 which may be activated externally by push button or foot switch connected to -15 V. Since a negative current at this input cuts the VCA completely off the 'STOP' action is functional at all times and allows the synthesiser output to be stopped on demand. Alternatively, a

foot pedal switch containing a 9 V battery (positive to jack socket ground) can be used if R5 and R29 are changed to 91k. Components R4 and C5 are for compensation purposes.

The signal input may be AC coupled via C7 and R17 or DC coupled direct to R17. R18, C8 and C6 are compensation components and D1 prevents latch up. PR2 and R9 allow trimming of control voltage feedthrough. The current output from pin 1 is converted to a voltage using IC3a and R24.

To operate the CEM 3330 from the standard  $\pm 15$  V supply a current limiting resistor must be added between pin 5 and the negative supply, which in the present application may be calculated from the formula  $R_{EE} = (V_{EE} - 7.2)/0.010$ ; which for -15 V supply requires a 750R resistor (R10).

One of the unique features of the CEM 3330 is that the operating point of the amplifiers may be set anywhere from Class A to Class B according to which parameters are most important in a particular application. The quiescent standby current of the signal carrying transistors is varied by placing a resistor between the  $I_{EE}$  pin (pin 5) and the idle current adjust pin (pin 8). For this VCA application the amplifiers are run Class AB with the 6k8 resistor (R9) providing a standby current of about 7  $\mu$ A.

When operating the VCAs less than Class A, internal transistor mismatches will cause the gain during the positive portion of the input signal to differ from that during the negative portion, thus introducing even harmonic distortion — predominantly second. In this design the untrimmed distortion is typically less than 1%, at 1 kHz and 10 dB below clipping, but this can be improved by about a factor of ten if a small voltage is injected into the distortion trim pin (pin 3). R3, R20 and R21 provide an adjustment of  $\pm 10$  mV for this purpose, if required.

By employing jack sockets for the inputs the VCAs are normally open, that is, a signal applied to the input of either will be present at the appropriate output at a level governed by the maximum gain of the VCA. As soon as a jack plug is inserted into either the linear or exponential control input then the VCA is under the control of the external voltage and with 0 V at either input the signal is completely cut off. The normally open VCA is useful while tuning the VCOs and setting up patches. This same facility may also be obtained using switches. The necessary resistors are incorporated into the PCB layout to cope with the different methods of construction.

Other advantages of having a true dual VCA incorporating the controls described above are:

(1) The ability to use the VCAs for auto panning by applying the signals to both (the same or different signals) and controlling pan by, say, a sawtooth wave into the linear control input of one and into the AM control of the other. Many panning variations are possible by using the exponential control, the inverted voltages from the 80-5 processor module, and so on;

(2) Taking the output from one VCA whose signal has been amplitude modulated and applying further modulation in the second VCA.

A truly versatile module.

## Construction

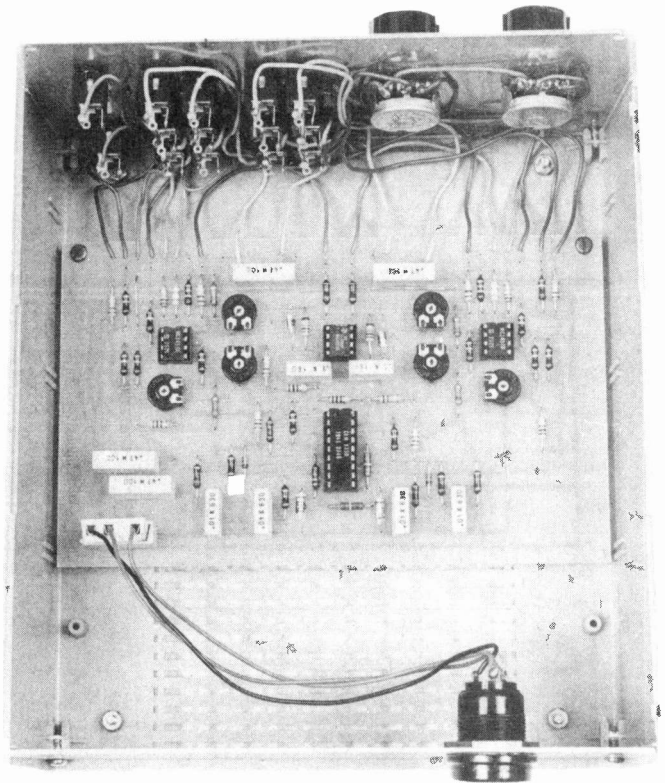
The module is designed for control voltages of 0 to +10 V and so if it is to be used in conjunction with ETI 80-8, whose peak voltage may reach +11 V, then resistors R11 and R37 should be replaced by 39k and R12 and R38 by 110k. This alteration is to prevent excessive output voltages and the substitute resistors are included in the kit of parts. R5 and R29 should also be changed to 91k if a footswitch with a 9 V battery is used to operate the 'STOP' control, as described in the previous section.

R25 and R48 need not be installed if jack sockets are used for the control inputs. With the latter method of construction R1, R12, R26 and R38 are wired to the jack socket connection which makes contact with a jack plug while R2, R11, R27 and R37 go to the respective socket connections which are disabled when a jack plug is inserted. If jack sockets are not used then a three position double pole slide switch may be employed for each VCA. For example, with VCA 1 the switch should be wired to connect R2 to R1 (position '1' to enable the exponential control); connect R11 to R12 (position '2' to enable the linear control); connect R25 to both R1 and R12 (position '3' to by-pass the VCA during tuning, etc.)

## Calibration

Although there are three trimmers on each side the calibration can be carried out quickly with a minimum of equipment. During calibration the VCA must be in the open position, ie no jack plugs inserted into the control inputs (or R24/R48 switched to both control inputs). Set all trimmers to their mid position.

1. To balance the AM input control voltage against the voltage applied to the linear control input via R2 and R27. Turn the AM control, RV1 or RV2, fully clockwise (minimum resistance) and apply a 10 V VCO signal to the DC input. Apply exactly +10V0 to the AM input, using a potentiometer as a voltage divider and either examine the output of the VCA being calibrated with an oscilloscope set to its maximum sensitivity or listen to the output by connecting it to an amplifier. Turn PR1 (PR4) so that the



The Dual VCA board fitted into the Teko Alba A23G case (available from West Hyde Developments).

## PARTS LIST

### RESISTORS ¼W 5% carbon film unless stated

R1,6,7,8,12*,14,17, 26,30,31,32,34,38*, 40	100k
R2,11*,27,37*	51k
R3,28	1M0
R4,16,18,23,33,36, 42,47	1k0
R5,20,29,44	150k
R9	6k8
R10	750R
R13,39	160k
R15,41	36k
R19,35	1M5
R21,45	100R
R22,43	150k (1% metal film)
R24,46	51k (1% metal film)
R25,48	24k
*see text	

### CAPACITORS

C1,2,7,12	470n polyester
C3,4	100n polyester
C5,8,10,13	10n polyester
C6,11	150p polystyrene
C9,14	22p polystyrene

### TRIMMERS

PR1,2,3,4,5,6	100k carbon
---------------	-------------

### POTENTIOMETERS

RV1,2	100k linear
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### SEMICONDUCTORS

IC1	CEM3330
IC2,4	LM1458
IC3	TL072CP
D1,2	1N4148



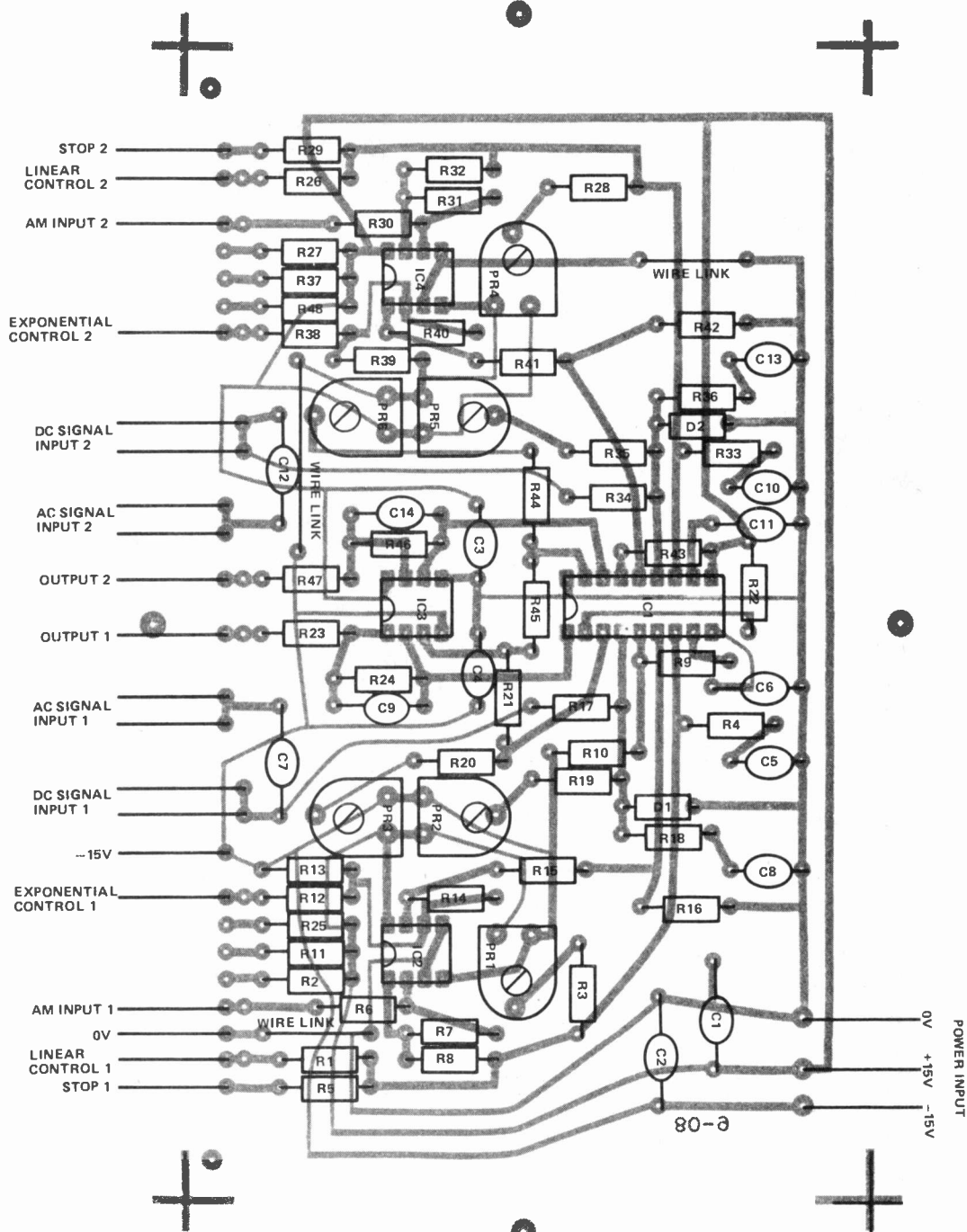


Fig. 2. Component Overlay.

signal is seen (or heard) then reverse direction until the signal is just cut off.

2. Trimming distortion. Connect the output to a voltmeter and adjust PR3 (PR6) for zero output. Next connect a fresh 9 V battery to the DC signal input with the positive terminal to R17(R34) and the negative terminal to a ground point on the module. Measure the voltage at the output as accurately as possible. Reverse the battery leads and measure voltage again. Adjust PR3 (PR6) until the voltage obtained between +V applied and no voltage applied is exactly the same as that obtained with -V and no voltage. This difference must take into account any drift from zero output, with no voltage applied, as PR3 (PR6) is adjusted. The polarity reversal may have to be carried out several times to achieve the calibration step. NOTE: For those that find this step difficult or who are content with up

to about 1% distortion then components PR3, R20 and R21 (PR6, R44 and R45) may be omitted and the PCB connections for R21 and R45 replaced by wire links. In this event only calibration steps 1 and 3 are required.

3. Trimming control voltage feedthrough. With no connections to any VCA inputs adjust PR2 (PR5) to give exactly 0V output.

ETI

BUYLINES

The Dual VCA kit with PCB and all components shown in the circuit diagram, except jack sockets, is available for £14.33, inclusive of postage and VAT, from Digisound Limited, 13 The Brooklands, Wrea Green, Preston, Lancs PR4 2NQ.

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## The Sinclair ZX80.

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\*Use a 600 mA at 9 V DC nominal unregulated mains adaptor. Available from Sinclair if desired (see coupon)

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- Timer under program control.
- PEEK and POKE enable entry of machine code instructions,USR causes jump to a user's machine language sub-routine.
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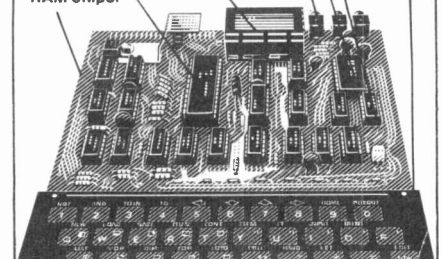
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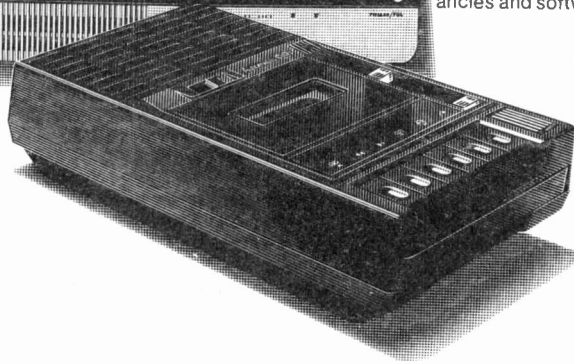
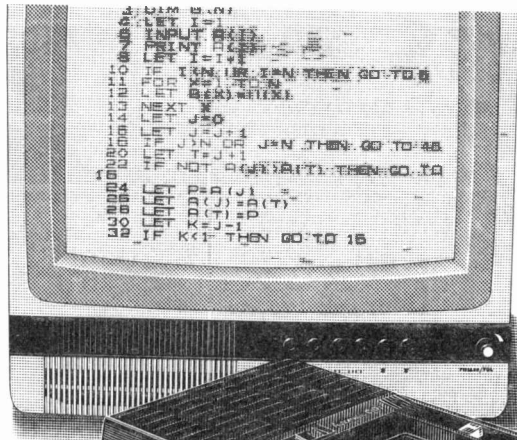
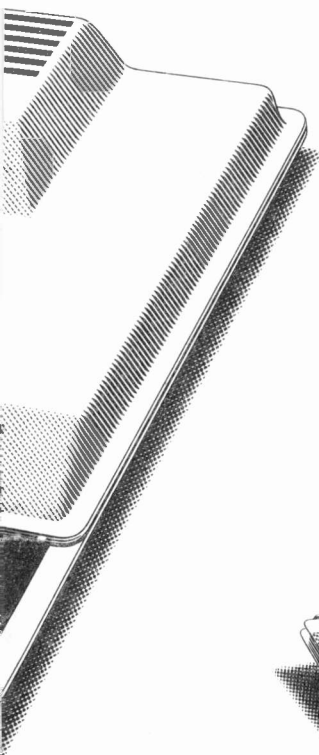
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	Mains Adaptor(s) (600 mA at 9 V DC nominal unregulated).	<b>8.95</b>	
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	RAM Memory chips – standard 1K bytes capacity.	<b>16.00</b>	
	Sinclair ZX80 Manual(s) (manual free with every ZX80 kit or ready-made computer).	<b>5.00</b>	
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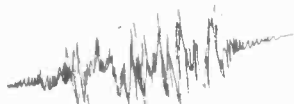
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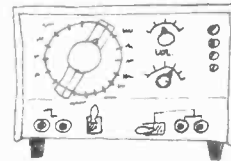
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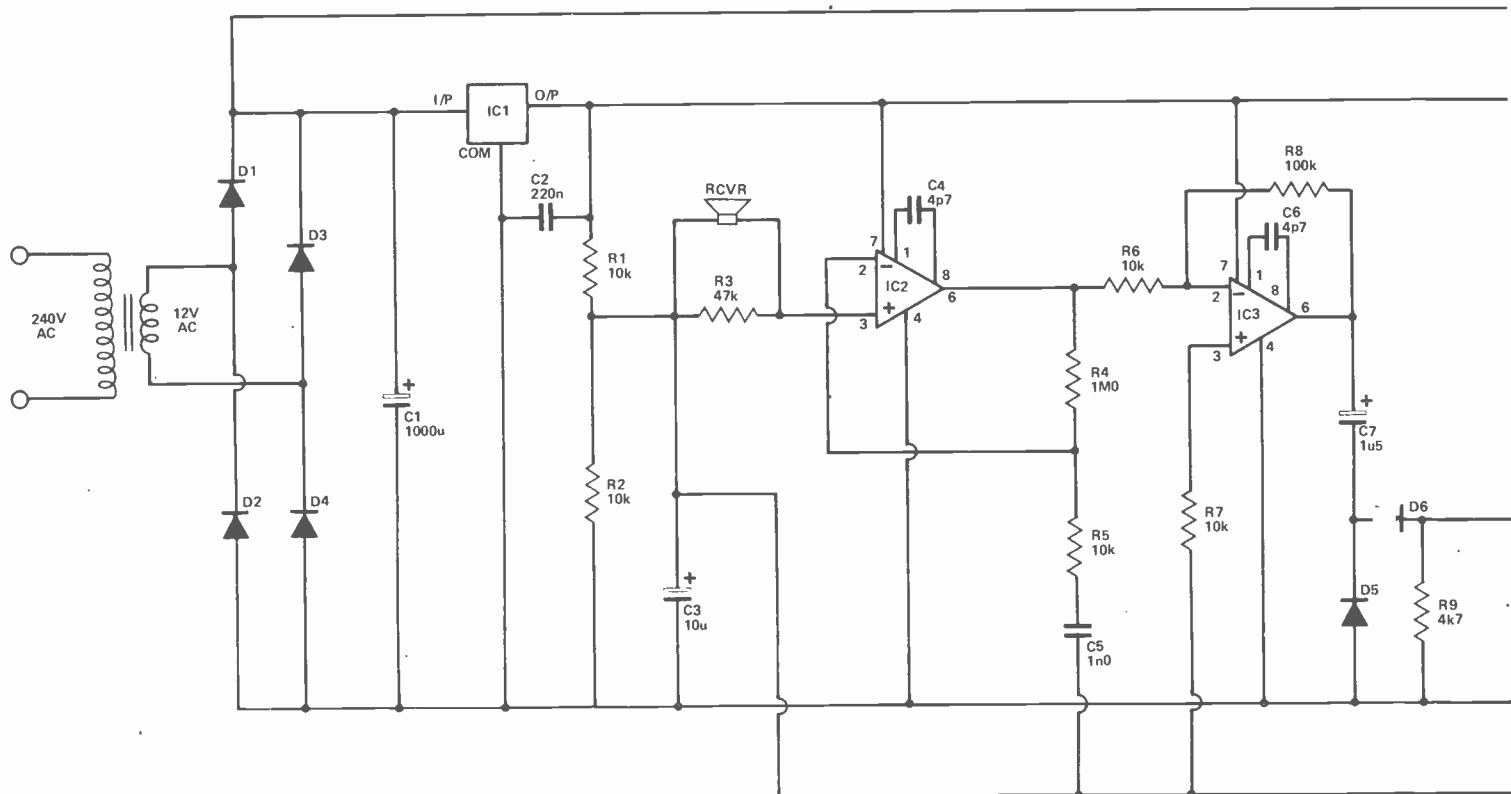
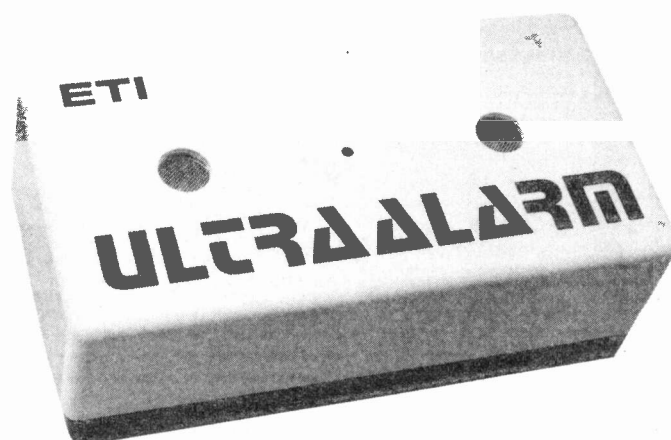
# ULTRASONIC BURGLAR ALARM

Use our Doppler circuit movement detector to catch anything on the move. New design offers high sensitivity.

If you have even a passing interest in electronics, you'll know that there have been more than a few burglar alarm designs published — alarms set off when a switch opens or closes or when an invisible beam is broken or activated by a pressure mat. The permutations are endless. This project offers a novel movement detector based on the Doppler shift principle.

## Super Shift

The unit consists of an ultrasonic transmitter radiating at about 40 kHz. Energy reflected from a moving target is shifted in frequency slightly. When mixed with the original signal, a heterodyne or 'beat' note is generated. This is detected by



HOW IT WORKS

An ultrasonic drive signal is generated by IC6, a 555 configured as an astable oscillator. The circuit differs from the conventional design, as it has the timing resistor returned to the output and the internal discharge transistor (pin 7) is unused. This arrangement was chosen as it enables a 50% duty cycle to be obtained providing a better drive signal to the transmitter transducer. If close tolerance components are used then RV2 should tune the circuit between approximately 30 and 50 kHz, enabling the transmitter to be set up for most efficient operation. The power supply to IC6 is decoupled by C15 directly at the chip.

The reflected ultrasonic waves are picked up by the receiver transducer. Signals from this are coupled directly to the non-inverting input of op-amp IC2. The 'Q' of the transducer is lowered by the shunt resistance of R3, facilitating 'setting-up' the unit. IC2 is a non-inverting amplifier with a gain of 100 at 40 kHz. Gain versus frequency is tailored for best response by C4 and C5. IC3, directly coupled via R6, operates as an inverting amplifier with a gain of 10. Compensation is provided by C6. The low frequency signals resulting from Doppler shifts are demodulated from the 40 kHz signal by the network around C9. They are then amplified by IC4. The gain of this stage is made variable by adjustment of RV1, enabling overall sensitivity of the unit to be controlled.

The AC output from IC4 is integrated by C12 and the associated network. When the voltage across C12 exceeds the upper threshold of the IC5 input, transistor Q1 will be driven on and the load energised. One section of IC5 is connected directly to IC4's output and drives the LED which indicates the major excursions of IC4's output. This is of considerable use when 'setting-up' the unit. Components R15 and C13 provide a delay following switch-on before the alarm becomes active.

The values of C12, R13 and C13, R15 may be changed to suit your particular requirements. For some applications, IC5 and its associated components may not be required. In such a case, they may be omitted and an output taken directly from IC4.

The power supply for the unit is utterly conventional and needs no description here. Current consumption will depend on the load employed. The circuit draws only about 10 mA when unloaded.

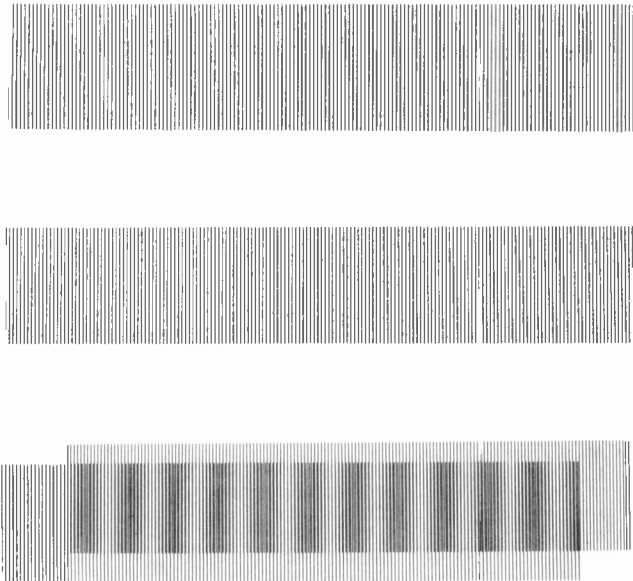
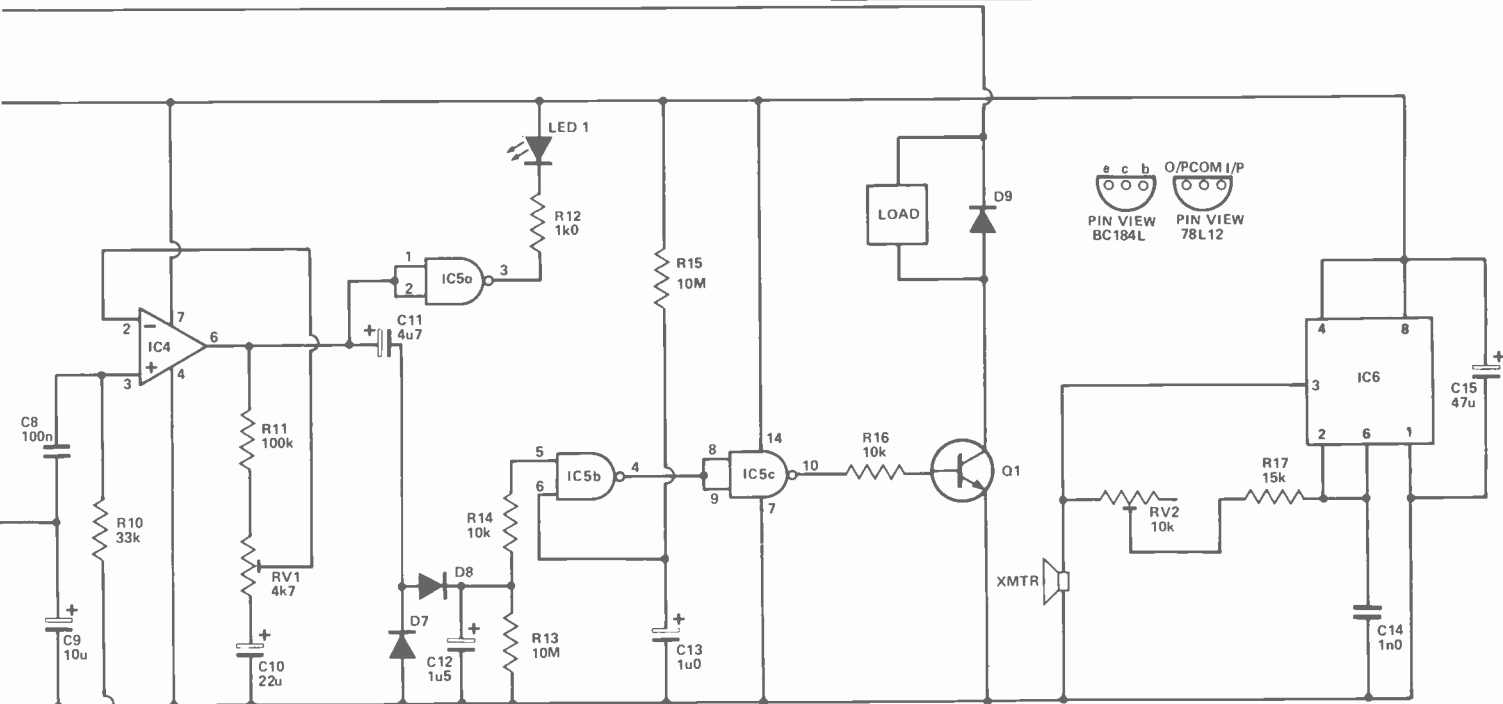
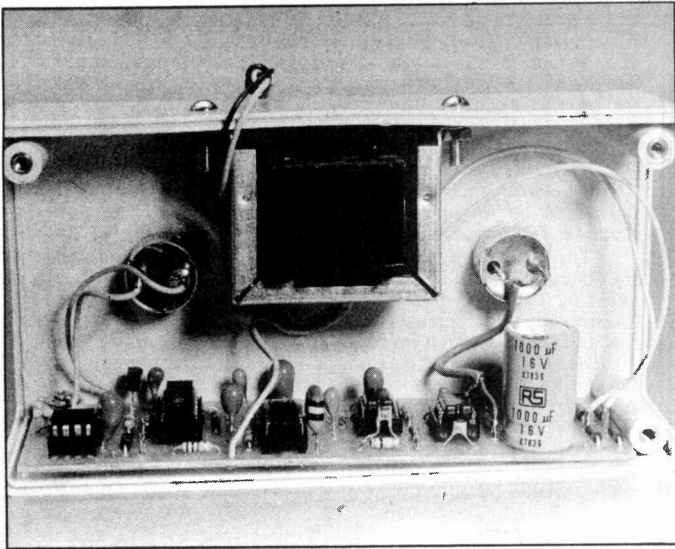


Fig.1. (above) When the received signal is mixed with the original signal, the slight difference in frequency produces a heterodyne or beat note.

Fig.2. (below) Circuit diagram.



- NOTES :
- IC1 IS 78L12
  - IC2,3 ARE LM301
  - IC4 IS 741
  - IC5 IS 4093B
  - IC6 IS 555
  - D1,2,3,4,9 ARE 1N4001
  - D5,6,7,8, ARE 1N4148
  - Q1 IS BC184L
  - LED 1 IS ANY LED
  - XMTR RCVR ARE 40kHz TRANSDUCER PAIR



A behind-the-scenes view of the ETI Ultrasonic Burglar Alarm. The two transducers can be held in place by a couple of spots of that well known contact adhesive. Note the use of the screened cable to connect the receiver transducer to the PCB. The single board contains power supply components together with transmitter and detector circuits, making the unit self-contained no-add-on-supplies or peripheral 'black boxes'. Note the use of IC sockets on the PCB. It's worth the expense. The board, transformer and transducers all fit neatly into a standard verocase (see Buylines).

demodulating the ultrasonic carrier. The frequency of the heterodyne depends on the speed of the moving target and its direction. Consequently the unit is most sensitive to objects moving directly towards or away from the sensors. A person walking directly towards the unit will normally produce heterodynes in the 0 to 30 Hz range. Higher frequencies are generated by the faster moving limbs, swinging arms and legs, for example.

A drawback with systems of this type is that they are sensitive to any movement, including swinging doors, fluttering curtains and even convection air currents from heating or air conditioning systems. However, by careful positioning of the unit, these problems can be largely overcome.

## Construction

Although any method of construction can be used, our PCB provides a convenient and practical solution. Use of a PCB helps to prevent possible problems with instability as the ultrasonic amplifier has considerable gain. Only one wire link is needed and this should be soldered into place first, followed by the IC sockets (use them! It doesn't cost much and it can save lots of time afterwards), resistors, capacitors and semiconductors. Watch out for the polarity of the capacitors and semiconductors.

Current consumption of the unit is low; most of the current used will be that required by the load and a suitable transformer rating can be calculated from this. Flying leads connect the transducers to the board. Use shielded cable for the receiver connection; it doesn't matter for the transmitter. Note that a wire lead is required to return the load to the unregulated supply. The specified driver transistor will sink in excess of 100 mA.

When connecting the transducers, take care not to over-heat them. A quick soldered joint should not cause any problems. Although the transducers are sensitive to mechanical

## PARTS LIST

### RESISTORS

R1,2,5,6,7,14,16	10k
R3	47k
R4	1M0
R8,11	100k
R9	4k7
R10	33k
R12	1k0
R13,15	10M
R17	15k

### POTENTIOMETERS

RV1	4k7 miniature horizontal preset
RV2	10k miniature horizontal preset

### CAPACITORS

C1	1000u electrolytic
C2	220n polycarbonate
C3,9	10u tantalum
C4,6	4p7 ceramic
C5	1n0 ceramic
C7,12	1u5 tantalum
C8	100n polyester
C10	22u tantalum
C11	4u7 tantalum
C13	1u0 tantalum
C14	1n0 polystyrene
C15	47u tantalum

### SEMICONDUCTORS

IC1	78L12
IC2,3	LM301
IC4	741
IC5	4093B
IC6	555
D1,2,3,4,9	1N4001
D5,6,7,8	1N4148
Q1	BC184L
LED 1	any LED

### MISCELLANEOUS

Ultrasonic transmitter-receiver pair, 12 V transformer, case.

vibration, no special mounting precautions will normally be needed. We fixed ours to the case with a few dabs of contact adhesive and that worked fine.

## Setting Up

If you have an oscilloscope, then setting up will be very easy. Even without one, it will not be too difficult; in fact a small screwdriver is all you need. With power applied, adjust RV2 for maximum indication of signal from pin 6, IC3. If you don't have a 'scope then connect a voltmeter across C9 and adjust for a maximum here. You will probably find two positions for RV2 which produce a high reading. Use either. This operation tunes the transmitter to about 40 kHz; the operating frequency of the transducers. The required sensitivity may now be set by adjustment of RV1. Too much sensitivity will lead to the unit being triggered by fluctuating air currents, low flying bats, etc and LED 1 has been included to indicate large signals at IC4's output. You will soon find the best operating position for your unit. Avoid placing the unit near fires, radiators, etc and keep the area near the sensors clear as this could otherwise severely restrict sensitivity. Overall range will depend on the target and the working environment. Hard, reflective surfaces are best.



# PROJECT: Ultrasonic Burglar Alarm

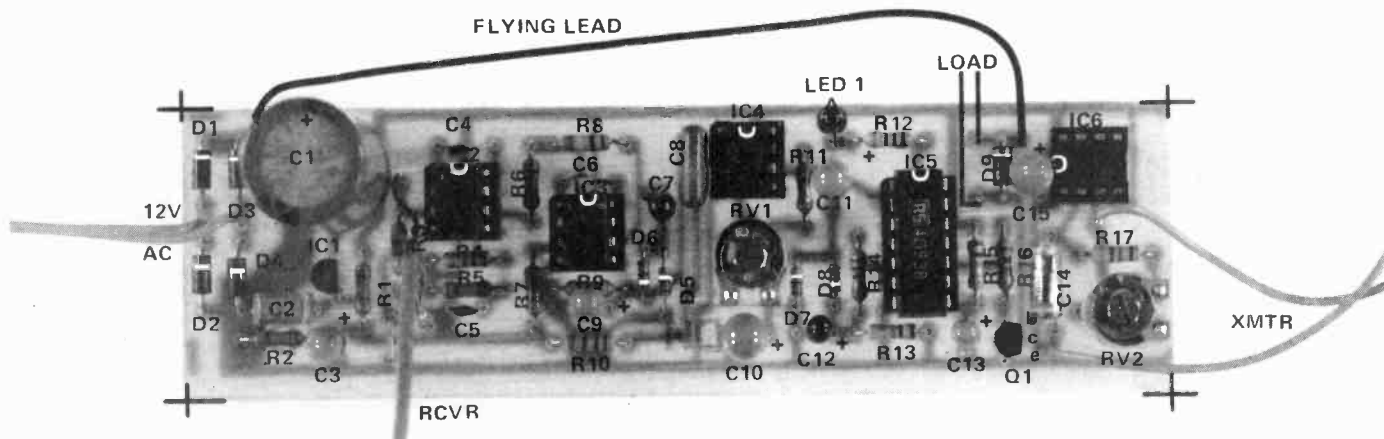


Fig.3. Component overlay.

Soft furnishings absorb the energising beam and fluttering curtains or swaying houseplants can generate considerable 'noise'. When first operating the unit, you may find it useful to connect an audio amplifier to the output of IC4 to monitor the 'noise'. A person's approach will be signalled by a rhythmic whooshing sound. We have not researched whether the unit is less sensitive to the gentler (and softer) sex. Why not build one and find out.

## BUYLINES

We built our ultra-alarm in a verocase no. 202-21030K. Suitable ultrasonic transducers can be obtained from Dataplus Developments, 81 Cholmeley Road, Reading, Berks.

ETI

## 3½ DIGIT LCD MULTI-METER KIT

# NEW

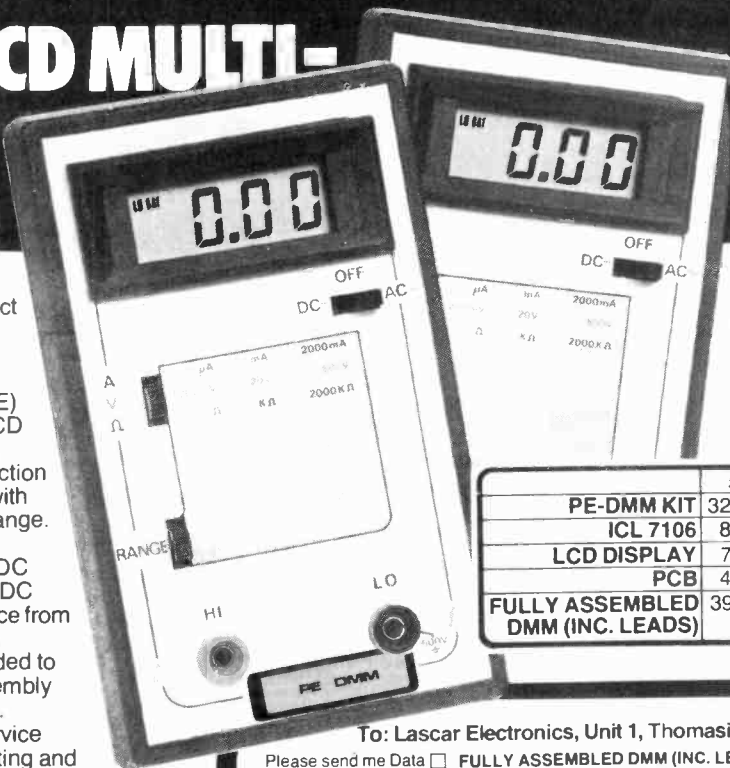
Build the Practical Electronics handheld DMM. This superb product offers professional precision with extended battery life. Five function operation (AC and DC VOLTS, AC and DC CURRENT, RESISTANCE) with ability to check diodes. 0.5" LCD display with 'Battery Low' warning. Auto-polarity, Auto-zero. Full protection against transients and overloads with ability to withstand mains on any range. 0.5% basic DC accuracy and 15 different ranges. It measures AC/DC voltages from 0.1mV to 500V. AC/DC current from 0.1µA to 2A. Resistance from 0.1Ω to 2MΩ. 200 hour battery life.

The Kit contains all parts needed to construct the multimeter plus assembly instructions, battery and test leads.

We also offer a calibration service (£5.00 + VAT) and a trouble-shooting and calibration service (£7.50 + VAT). Various other component parts are also available as listed.

The multimeter is also available fully assembled and calibrated at a cost of £39.70 + P&P + VAT.

Lascar Electronics Ltd., Unit 1, Thomasin Road, Basildon, Essex. Telephone No: Basildon (0268) 727383.



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PCB	4.95	0.50	0.82	6.27
FULLY ASSEMBLED DMM (INC. LEADS)	39.70	1.25	6.14	47.09

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NEW

## CT4000 CLOCK/APPLIANCE TIMER KIT

The CT4000 has been designed to preset the state (on or off) of four outputs at four times per day for up to 7 days in advance, enabling the unit to control tape recorders, appliances, central heating, lights, etc. The times are set on a 0.1" high red LED display by means of a keyboard and the output states are displayed on four LEDs. Each output can switch up to 20mA at 9V. For mains loads use our Solid State Relay Kit (MK2). The kit includes a PCB, keyswitches, IC, 4 digit LED display, transformer, plus all other components and a screen printed and drilled box which can also accommodate up to 4 Solid State Relay Kits.

Size: 10x12x4.5cms  
Colour: Black

ONLY  
**£25.25**



## D.V.M. THERMOMETER KIT

Based on the ICL 7106 This kit contains a PCB, resistors, presets, capacitors, diodes, IC and 0.5" liquid crystal display. Components are also included to enable the basic DVM kit to be modified to a Digital Thermometer using a single diode as the sensor. Requires a 3mA 9V supply (PP3 battery). **£20.75**

## MINI KITS

These kits form useful subsystems which may be incorporated into larger designs or used alone. Kits include PCB, short instructions and all components.

**MK1 TEMPERATURE CONTROLLER / THERMOSTAT**  
Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater  
**500W £3.20 1KW £3.50**

**MK2 SOLID STATE RELAY**  
Ideal for switching motors, lights, heaters, etc. from logic. Opto-isolated with zero voltage switching. Supplied without triac. Select the required triac from our range. **£2.60**

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Displays an analogue voltage on a linear 10 element LED display as a bar or single dot. Ideal for thermometers, level indicators, etc. May be stacked to obtain 20 to 100 element displays. Requires 5-20V supply. **£4.75**

**MK4 PROPORTIONAL TEMPERATURE CONTROLLER**  
Based on the TDA1024 Zero voltage switch, this kit may be wired to form a 'burst fire' power controller or a proportional temperature controller enabling the temperature of an enclosure to be maintained to within 0.5°C  
**1.5KW £5.25 3KW £5.55**

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**TD300K TOUCHDIMMER.** Single touchplate with alternate action. Brief touch switches lamp on and off, longer touch dims or brightens lamps. Neon lamp helps find the switch in the dark. **£6.50**

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**TSD300K TOUCHSWITCH & DIMMER**  
Single touchplate, small knob controls brightness. **£5.50**

**TSA300K TIME DELAY TOUCHSWITCH**  
Turns off after preset delay (2 secs. to 3½ mins.). **£4.30**

**LD300K Conventional Lightdimmer £2.90**

## INTEGRATED CIRCUITS

555 Timer	21p
741 Op. Amp	19p
AY-5-1224 Clock	£2.60
AY-5-1230 / 2 Clock / Timer	£4.50
AY-3-1270 Thermometer	£6.20
ICL7106 DVM (LCD drive)	£7.00
LM337 Dual 2W Amp	£1.45
LM379S Dual 6W Amp	£3.50
LM380 2W Audio Amp	80p
LM382 Dual / low noise Preamp	£1.00
LM386 250mW low voltage Amp	75p
LM1830 Fluid Level Detector	£1.50
LM2907 1V Converter (8 pin)	£1.40
LM2917 1V Converter (14 pin)	£1.60
LM3909 LED Flasher / Oscillator	55p
LM3911 Thermometer	£1.20
LM3914 Dot / Bar Driver	£2.10
MM74C911 4 digit display controller	£6.50
MM74C915 7 segment-BCD converter	98p
MM74C926 4 digit counter with 7 seg. o/p	£4.50
S566B Touchdimmer	£2.50
S9263 Touchswitch 16-way	£4.85

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TDA2020 20W Audio Amp	6A with trigger 80p
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# CAPACITANCE METER

Take the huff out of measuring  $\mu\text{F}$ s with this cheap and handy piece of test gear.

If you are the kind of constructor who keeps a 'junk box' . . . and in this impoverished age who can afford not to . . . you are bound to have come across the problem of unmarked components. Resistors can be checked quite easily on most multimeters but capacitors pose more of a problem. The 'ballistic' method usually results in the mysterious components becoming ballistic missiles — straight in the bin!

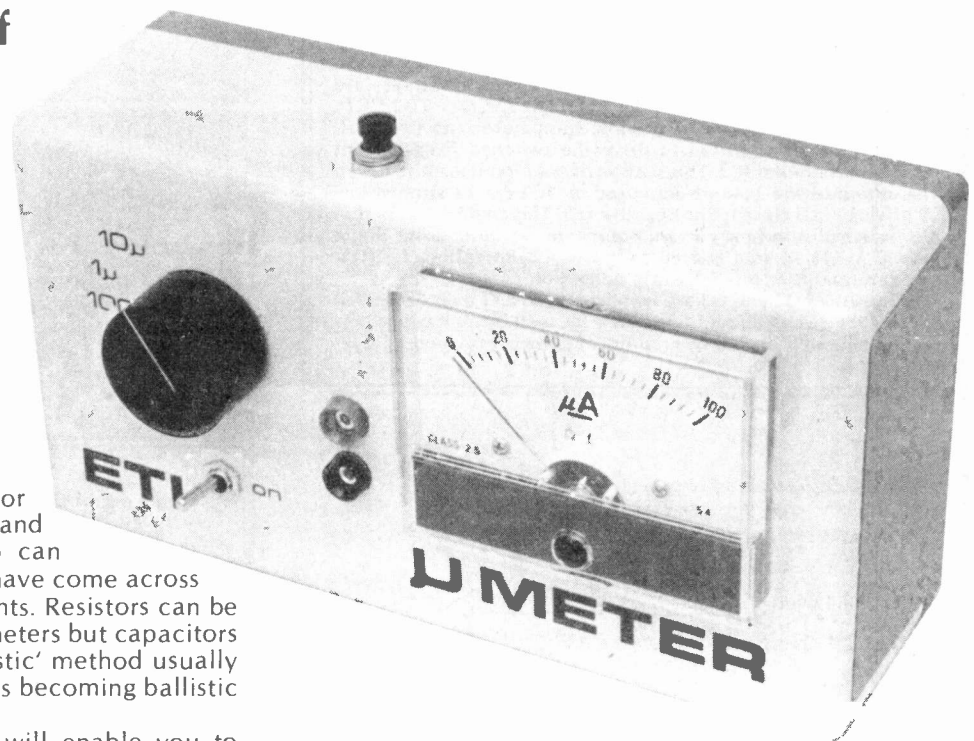
This useful piece of test gear will enable you to measure values of capacitance from  $10\text{pF}$  to  $10\mu\text{F}$  in five decade ranges. A simple modification would enable an ordinary voltmeter to be used as indicator, though our prototype used a  $100\mu\text{A}$  movement mounted in the case. Power for the unit is provided by two nine volt batteries which results in a voltage of up to  $18\text{V}$  across the capacitor under test. This should be borne in mind when testing low voltage electrolytics or tantalum capacitors which may be damaged by this voltage.

## Simple PCB

Use of a quad op-amp package keeps the component count to a minimum and simplifies the PCB design. IC2 is a BIFET device and contains MOSFET transistors, though these are adequately protected and no special handling precautions are required.

## Cap Testing

In use the unknown capacitor is connected and PB1 is depressed. If you use 1% resistors for R5-9 then quite accurate readings can be obtained. Even with low tolerance resistors, the unit will find application in matching components for filter design, etc. Note that the meter



will hold a steady reading for quite a few seconds before a slow drift may become evident. Current consumption of the unit is quite high (about  $10\text{mA}$ ) owing to the currents required for the zener diode voltage references.

## Construction

Any method of construction may be employed but we think PCBs are best. A fair number of interconnections will be required whatever method is chosen and the circuit will tolerate quite sloppy wiring layout. If you use 1% resistors, you may want to use a large meter scale to take advantage of the extra accuracy obtained. Using the prototype, which features a miniature meter movement, we were able to correctly identify values of capacitance as low as  $12\text{pF}$ . If desired, the power switching may be incorporated in the range switch though this necessitates a 3 pole 6 position switch.

As mentioned above, an ordinary voltmeter may be used with the unit. One with a  $3\text{V}$  FSD scaled 0-10 is required. As R23 and RV1 are not required, the full scale must be adjusted by trimming the current determining resistor R22. A value of about  $5\text{k}\Omega$  should be right. Once you have built this unit, you'll wonder how you ever managed without it!

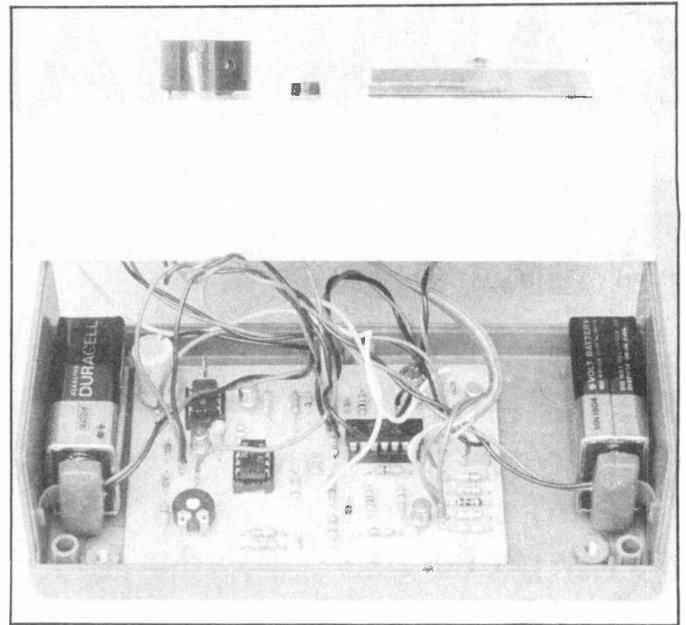


## HOW IT WORKS

A glance at the block diagram will help you to understand operation of this unit. When the 'test' button is depressed (PB1 on the circuit diagram), the capacitor under test is charged to the positive supply and C2 is discharged. Upon releasing the pushbutton, Cx will discharge at a preselected rate (SW1 range switch determines this). Rate of change of voltage across Cx for a given constant discharge current is directly proportional to its capacitance. A measurement of this is obtained by timing the period during which the Cx voltage is between two reference voltage levels. For this period, a fixed current source is switched on by the output of the window comparator. Capacitor C2 thus develops a charge whose voltage is proportional to the value of the capacitor under test. As the unit produces a linear output, values may be read directly from a conventional meter scale.

The circuit blocks can be readily identified in the circuit diagram. IC1a, ZD1 and Q2 form the current sink. Values from 1  $\mu$ A to 10 mA are obtained in decade steps by adjustment of SW1 range switch. The capacitor voltage is buffered by IC1b whose output drives the window comparator. Reference voltages are provided by the potential divider connected across ZD2. IC1c and IC1d together form the window comparator and their outputs are 'OR'ed and used to drive the switched fixed current source built around IC2. This section of the circuit is quite novel. The output of the 3140 op-amp used for IC2 can be strobed low by driving pin 8 close to the negative rail. This enables a very simple switched constant current source to be built using diode gating. A 741 op-amp is used to buffer C2. Potentiometer RV2 sets zero and RV1 sets full scale deflection.

Transistors Q1 and Q3 are switched on when PB1 is depressed to reset the circuit and initiate a new measurement. Reverse bias on Q3 is limited by D3. Overall decoupling is provided by C1.



Taking the lid off the Micrometer. We used two of those batteries that last longer than all the others.

## BUYLINES

Nothing out of the ordinary here. All the components should be readily available from the larger mail order companies.

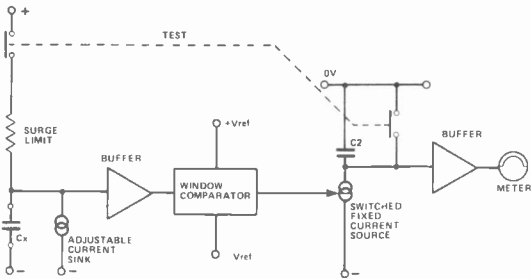
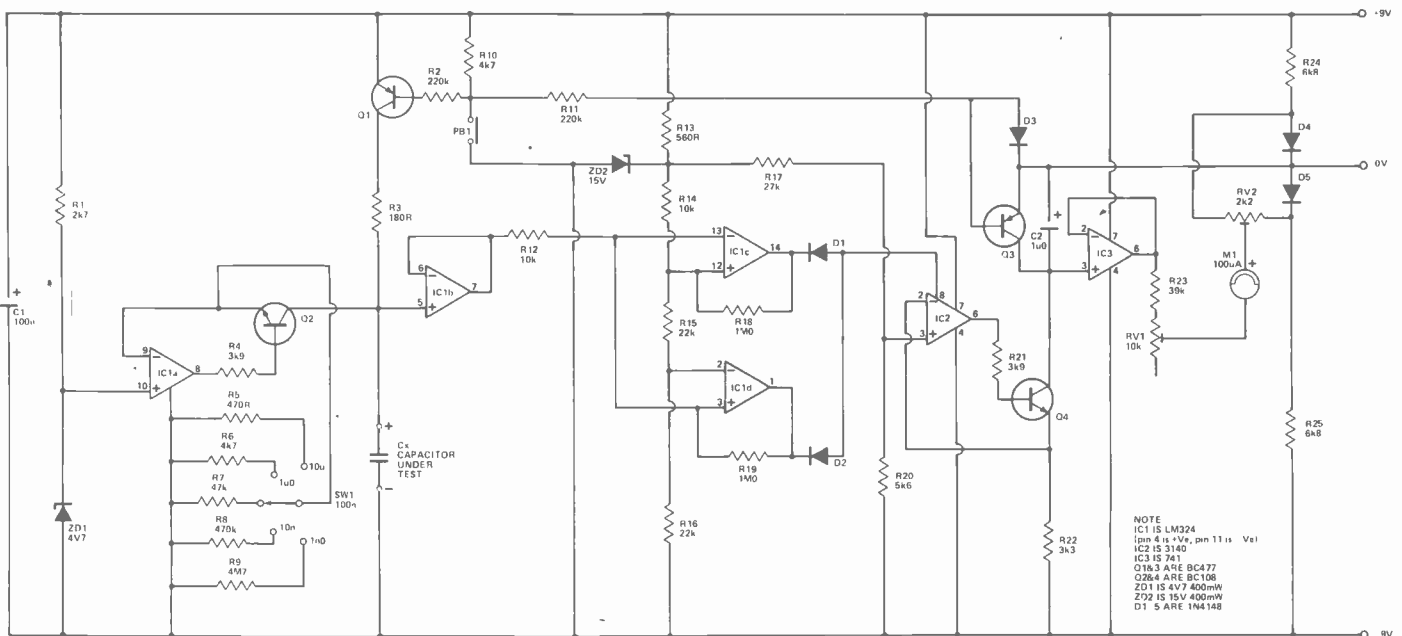


Fig.1. (left) Block diagram of the capacitance meter.

Fig.2. (below) Circuit diagram.



## PARTS LIST

Resistors All 1/4W 5% unless specified

R1	2k7
R2,11	220k
R3	180R
R4,21	3k9
R5,10	470R
R6	4k7
R7	47k
R8	470k
R9	4M7
R12,14	10k
R13	560R
R15,16	22k
R17	27k
R18,19	1M0
R20	5k6
R22	3k3
R23	39k
R24,25	6k8

R5-9 should be 1% types for best accuracy.  
Potentiometers  
RV1 10k preset  
RV2 2k2 preset

Capacitors  
C1 100u electrolytic  
C2 1u0 tantalum

Semiconductors  
IC1 LM324  
IC2 3140  
IC3 741  
Q1,3 BC477  
Q2,4 BC108  
ZD1 4V7 400mW zener diode  
ZD2 15V 400mW zener diode  
D1-5 1N4148

Miscellaneous  
Single pole 5-way switch, push button switch,  
100 uA meter, PCB, Case, etc.

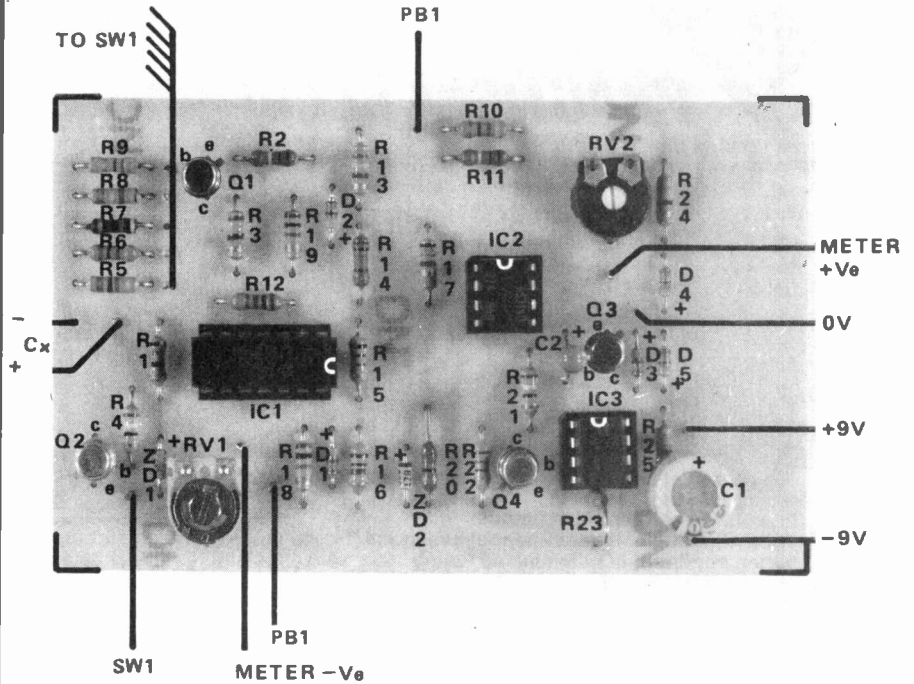


Fig.3. Component overlay. Note the orientation of the ICs. Insert them the wrong way at your peril.

ETI

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Panel Meters, Bridge Rectifiers, Power Supply Units  
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### Minimum & Sub Miniature

Volts	Milli-amps	Ref. No.	Price £	P&P
3-0.3	200	238	2.55	.65
0.6-0.6	1A 1A	212	2.95	.70
9-0.9	100	13	2.25	.65
0.9-0.9	330 330	235	2.10	.65
0.8-9, 0.8-9	500 500	207	2.70	.70
0.8-9, 0.8-9	1A 1A	208	3.80	.70
0-15, 0-15	200 200	236	2.10	.65
0-20, 0-20	300 300	214	2.70	.85
20-12-0-12-20	700(DC)	221	3.45	.85
0-15-20, 0-15-20	1A 1A	206	4.55	1.00
0-15-27, 0-15-27	500 500	203	4.00	.85
0-15-27, 0-15-27	1A 1A	204	6.05	1.00

### 12 AND/OR 24 VOLT

Volts	Amps	Ref. No.	Price £	P&P
12v	24V			
0.5	0.25	111	2.25	.70
1.0	0.5	213	2.70	.85
2	1	71	3.20	.85
4	2	18	4.00	.85
6	3	70	5.55	.90
8	4	108	7.40	1.15
10	5	72	8.20	1.15
12	6	116	8.80	1.15
16	8	17	10.80	1.25
20	10	115	13.80	1.45
30	15	187	16.80	1.45
60	30	226	33.30	1.75

### 30 VOLT (Pri 220-240V)

Amps	Ref. No.	Price £	P&P
0.5	112	2.80	.85
1.0	79	3.55	.85
2.0	3	5.55	1.00
3.0	20	6.25	1.15
4.0	21	6.55	1.15
5.0	51	9.55	1.15
6.0	117	11.05	1.15
8.0	88	14.30	1.45
10.0	89	16.55	1.45

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### 50 VOLT (Pri: 220-240V)

Amps	Ref. No.	Price £	P&P
0.5	102	3.55	.85
1.0	103	4.55	1.00
2.0	104	7.25	1.15
3.0	105	8.55	1.15
4.0	106	10.80	1.25
6.0	107	15.05	1.45
8.0	118	20.15	1.65
10.0	119	24.05	2.15

### 60 VOLT (Pri: 220-240)

Amps	Ref. No.	Price £	P&P
0.5	126	3.80	.85
1.0	124	5.55	1.00
2.0	127	7.50	1.15
3.0	125	11.05	1.25
4.0	123	12.30	1.45
5.0	40	14.10	1.55
6.0	120	17.55	1.55

### AUTO TRANSFORMERS

VA (Watts)	Ref. No.	Price £	P&P
20	113	2.60	.85
75	64	4.05	.85
150	4	5.55	1.00

### Input/Output Tapped

VA (Watts)	Ref. No.	Price £	P&P
300	53	10.05	1.15
500	67	10.80	1.45
1000	84	18.55	1.55

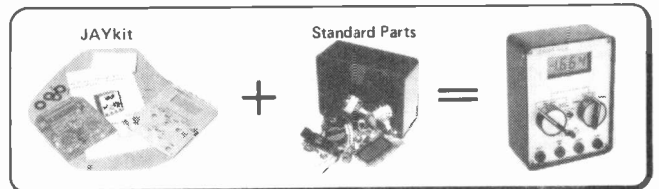
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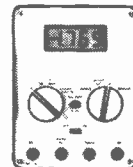
VA (Watts)	Ref. No.	Price £	P&P
60	149	6.55	1.00
100	150	7.55	1.25
200	151	11.05	1.25
250	152	13.25	1.45
350	153	16.25	1.55
1000	156	37.05	3.15

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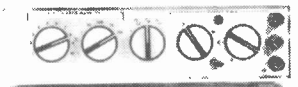
### DM-2



DIGITAL MULTIMETER

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- ★ AC Volts ..... 1V to 500V
- ★ DC Current ..... 0.1mA to 0.2A
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- ★ Auto Polarity & Zero
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- ★ Designed around Intersil 7106 IC
- ★ Total cost around £30 (incl. case)

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- ★ 1Hz to 100kHz
- ★ DC coupled
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- ★ Designed around Intersil 8038 IC
- ★ Total cost around £30 (incl. case)

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- \* INCORPORATES SUPPRESSION CIRCUITS



The pack contains all the electronic components to build the radio, you supply only the wire and solder as featured in the Practical Electronics March issue.

The P.E. Traveller features pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone-control, the other for manual tuning, each set on wood simulated fascia.

The P.E. Traveller has a 6 watts output, negative ground and incorporates an integrated circuit output stage, a Mullard IF module LP1181 ceramic filter type, pre-aligned and assembled and a Bird pre-aligned push button tuning unit.

The P.E. Traveller fits easily in or under dashboards. Complete with instructions.

**£10.50** p&p £1.75

**CONSTRUCTORS PACK 7A** Suitable stainless steel fully retractable locking aerial and speaker (approx 6" x 4") is available as a kit complete.

**£1.95** Per Pack, p & p £1.00. Pack 7A may only be purchased at the same time as Pack 7.

**NOTE:** Constructor's pack 7A sold complete with radio kit **£15.20** including p&p.

**A FEATURED PROJECT IN PRACTICAL ELECTRONICS**



323 EDGWARE ROAD, LONDON W2. For Personal Shoppers Only. 21 E HIGH STREET, ACTON W3 6NG. Mail Order Only. No Callers.

Mon-Sat 9.30am-5.30pm  
Closed Thursday

### NEW 12+12 AMPLIFIER KIT



An opportunity to build your own 12 watts per channel stereo amplifier with up-to-the-minute features. To complete you just supply screws, connecting wire and solder. Features include din input sockets for ceramic cartridge, microphone, tape or tuner. Outputs—tape, speakers and headphones. By the press of a button it transforms into a 24 watt mono disco amplifier with twin deck mixing. The kit incorporates a Mullard LP1183 pre-amp module, plus 2 power amplifier assembly kits. Also featured 4 slider level controls, rotary bass and treble controls and 6 push button switches. Silver finish fascia panel with matching knobs. Easy to assemble teak simulate cabinet and ready made metal work. For further information instructions are available price 50p. Free with kit.

**£13.95**

NOTE: for use with 4 to 8 ohms speakers. p&p £2.55

### 50 WATT MONO DISCO AMP £30.60



Size approx 13 1/2" x 5 1/4" x 6 1/4"  
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.

### NOW AVAILABLE

### 30 + 30 WATT STEREO AMPLIFIER

Viscount IV unit in teak simulate cabinet. Silver finish rotary controls and pushbuttons with matching fascia. Red mains indicator and stereo jack socket. Functions switch for mc magnetic and crystal pickups, tape tuner and auxiliary. Rear panel features fuse holder, DIN speaker and input socket 30 + 30 watts RMS 60 + 60 watts peak for use with 4 to 8 ohm speakers. Size 14 1/2" x 3" x 10" approx.

**£32.90**

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### Mullard AUDIO MODULES IN BARGAIN PACKS

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Brushed aluminium fascia and rotary controls. Size approx. 14" x 4" x 10 1/4"  
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 load level control (PFL) lets YOU hear next disc before fading it in. VU meter monitors output level. Output 100 watts RMS 200 watts peak.

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Belt drive chassis turntable unit semi-automatic, cueing device. p&p £3.00  
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**BSR** Manual single play record deck with auto return and cueing lever. Tined with stereo ceramic cartridge 2 speeds with 45 r.p.m spindle adaptor ideally suited for home or disco use.  
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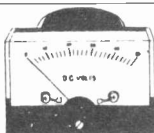
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Official orders welcomed, Gvt./Educational Dept., etc.

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Dims:- 50 x 45 x 33mm. Require 38mm dia. cut out  
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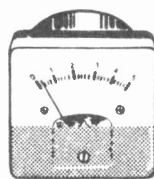
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T24	0 - 1 MA	
T25	0 - 5 MA	
T26	0 - 10 MA	
T27	0 - 50 MA	
T28	0 - 100 MA	
T29	0 - 500 MA	
T30	0 - 1 AMP	
T31	0 - 2 AMP	
T32	0 - 25 Volts	
T33	0 - 50v AC	
T34	0 - 300v AC	
T35	"VU"	
T36	"VU"	
T40	50 - 0 50 UA	
T41	100 - 0 100 UA	
T42	500 - 0 500 UA	
T43	0 - 30v DC	

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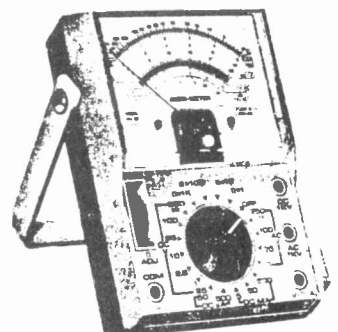
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This board is designed solely for the use of discrete components and is particularly useful for basic educational purposes. (No. of contacts: 208)

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 Dims:- 130 x 88 x 37mm

£9.25 + 15% VAT  
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ETIPRINTS are a fast new aid for producing high quality printed circuit boards. Each ETIPRINTS sheet contains a set of etch resistant rub down transfers of the printed circuit board designs for several of our projects.

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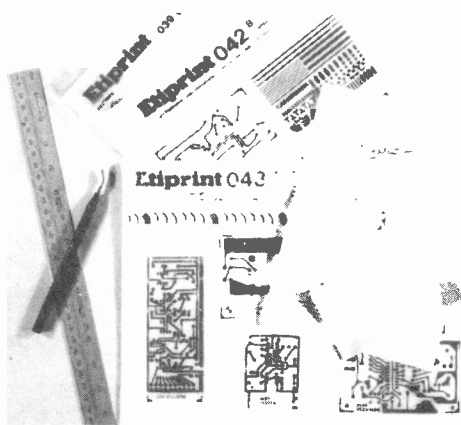
## PARTS LIST

Shown below is the listing for the last year's ETIPRINTS.

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<b>038</b>	Buffer Moving Coil Preamp Process Controller	Jan 80	<b>040B</b>	ETI 80 — PSU Tuning Fork Filter Coin Toss	Feb 80	<b>042B</b>	Touch Dimmer, Battery Charger RC Guardian (Top,Bottom)1&2	Apr 80
<b>039A</b>	Hum Filter Logic Probe	Dec 79	<b>041A</b>	ETI Audiophile ETI VCA Signal Trace ETI HC Electromyogram	Mar 80	<b>043</b>	IR60 preamp, Receiver, PSU, Servo Tester, VU — PPM	May 80
<b>039B</b>	Long Period Timer Rain Alarm Touch Switch Flash Trigger Pseudo Random Noise Gen	Dec 79	<b>041B</b>	VCM Heater Controller	Mar 80	<b>044A</b>	IR60 Function Board (Top & underside) Control Circuit, Line Transmitter, Tape Response Meter Ohmmeter	June 80
<b>039C</b>	Function Generator	Dec 79	<b>042A</b>	300W Amp Module	Apr 80	<b>044B</b>	FM receiver PSU & Monitor Amp Drum Synth (function board)	June 80
<b>040A</b>	ETI 80 — VCO and VCLFO	Feb 80	<b>033</b>	Fuel Level Monitor, Alarm, Screen Controller Dynamic Noise Reducer	Sep 79			

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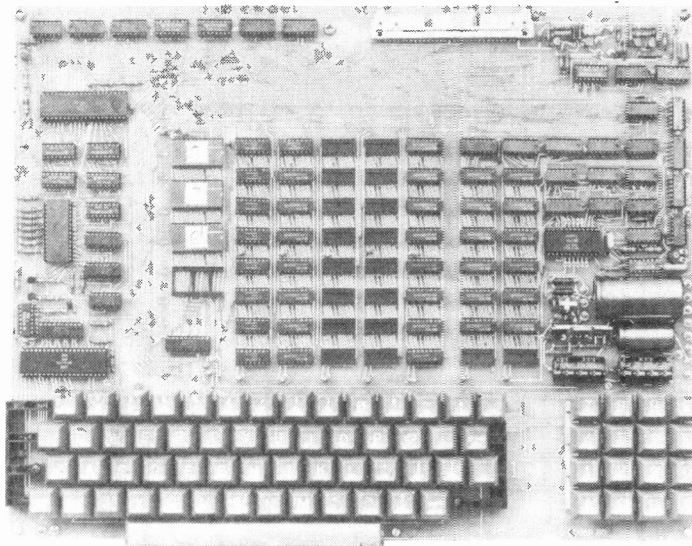
**£225 + VAT**

# POWERTRAN

## PSI Comp 80. Z80 Based powerful scientific computer Design as published in Wireless World

The kit for this outstandingly practical design by John Adams published in a series of articles in Wireless World really is complete!

Included in the PSI COMP 80 scientific computer kit is a professionally finished cabinet, fibre-glass double sided, plated-through-hole printed circuit board. 2 keyboards PCB mounted for ease of construction, IC sockets, high reliability metal oxide resistors, power supply using custom designed toroidal transformer. 2K Basic and 1K monitor in EPROMS and, of course, wire, nuts, bolts, etc.



### KIT ALSO AVAILABLE AS SEPARATE PACKS

For those customers who wish to spread their purchase or build a personalized system the kit is available as separate packs eg. PCB (16" x 12.5") £43.20. Pair of keyboards £34.00. Firmware in EPROMS £30.00. Toroidal transformer and power supply components £17.00. Cabinet (very rugged, made from steel, really heat/robustly finished) £26.50. P.S. Will greatly enhance any other single board computer including OMS SUPERBOARD for which it can be readily modified. Other packs listed in our FREE CATALOGUE.

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New Factory on same Industrial Estate  
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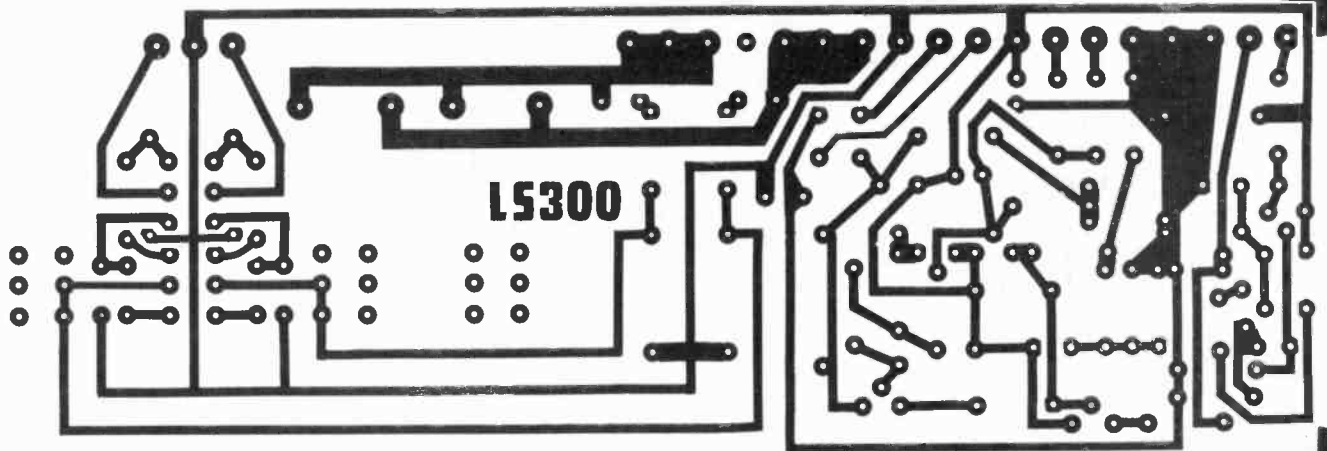
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# POWERTRAN ELECTRONICS

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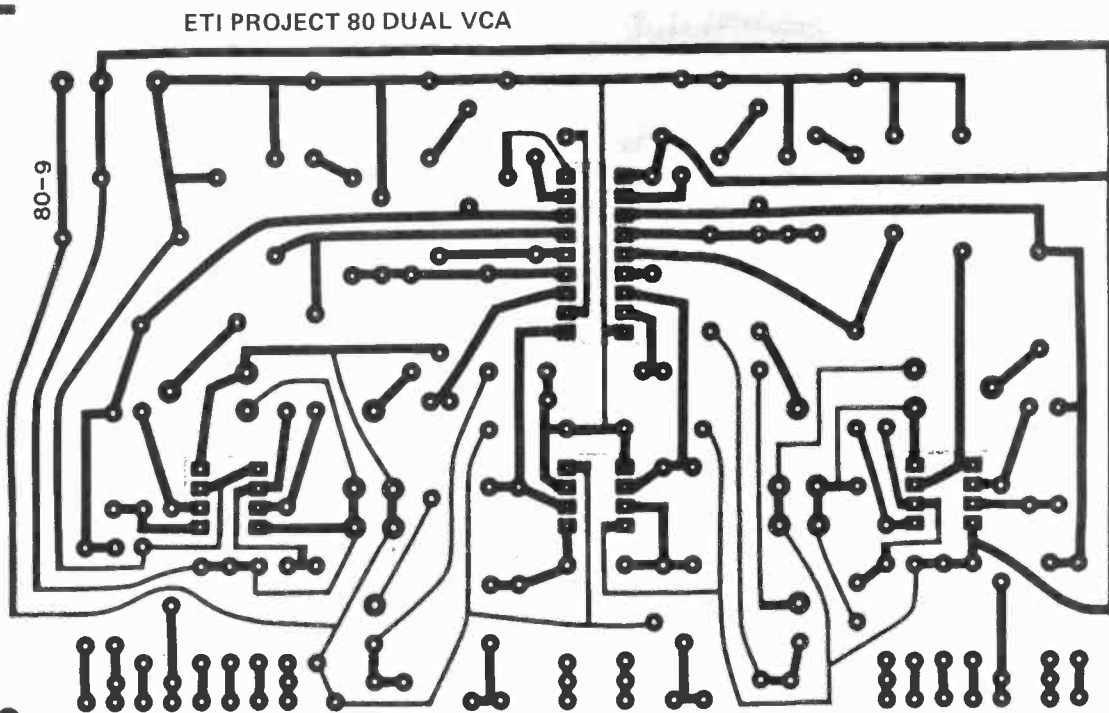
ANDOVER  
(0264) 64455

# PCB FOIL PATTERNS



ETI 100W PA

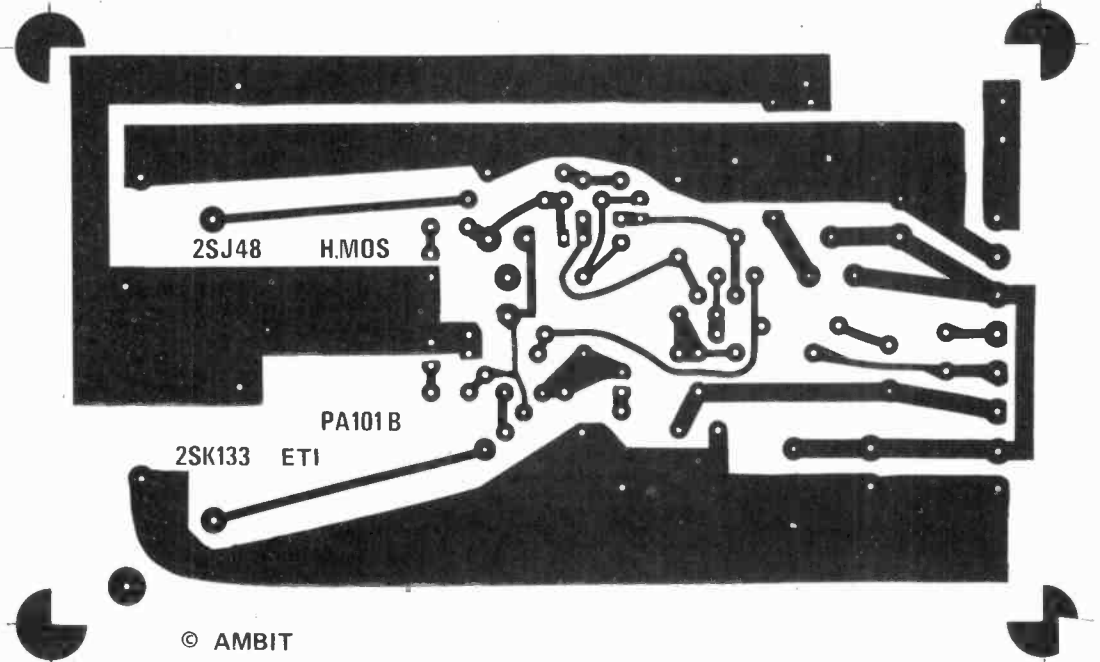
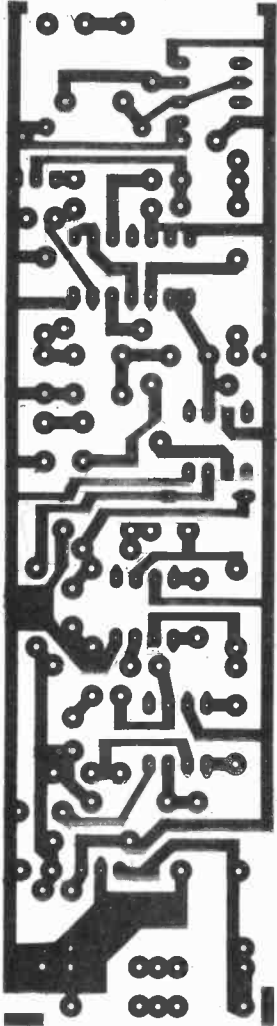
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ETI PROJECT 80 DUAL VCA

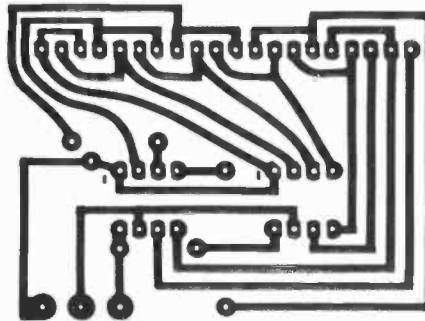
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ETI alarm

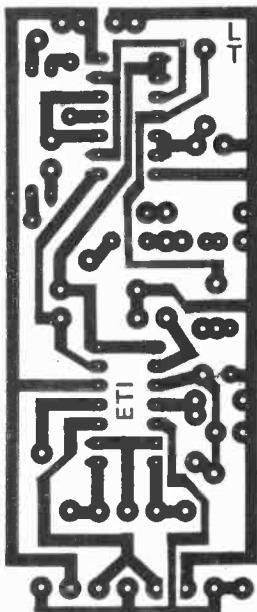


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The Ambit Power Amplifier board (above) and Bar Graph Monitor board (below).

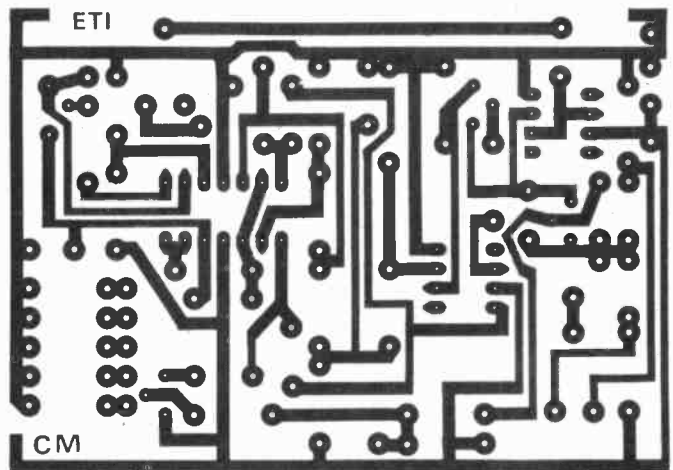
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Foil Patterns for the Capacitance Meter (right) and the CMOS Logic Tester (left).



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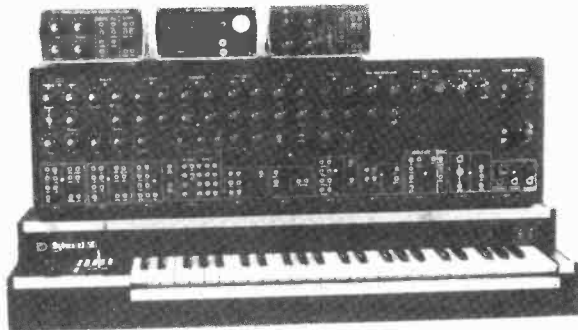
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See review in Hobby Electronics November	
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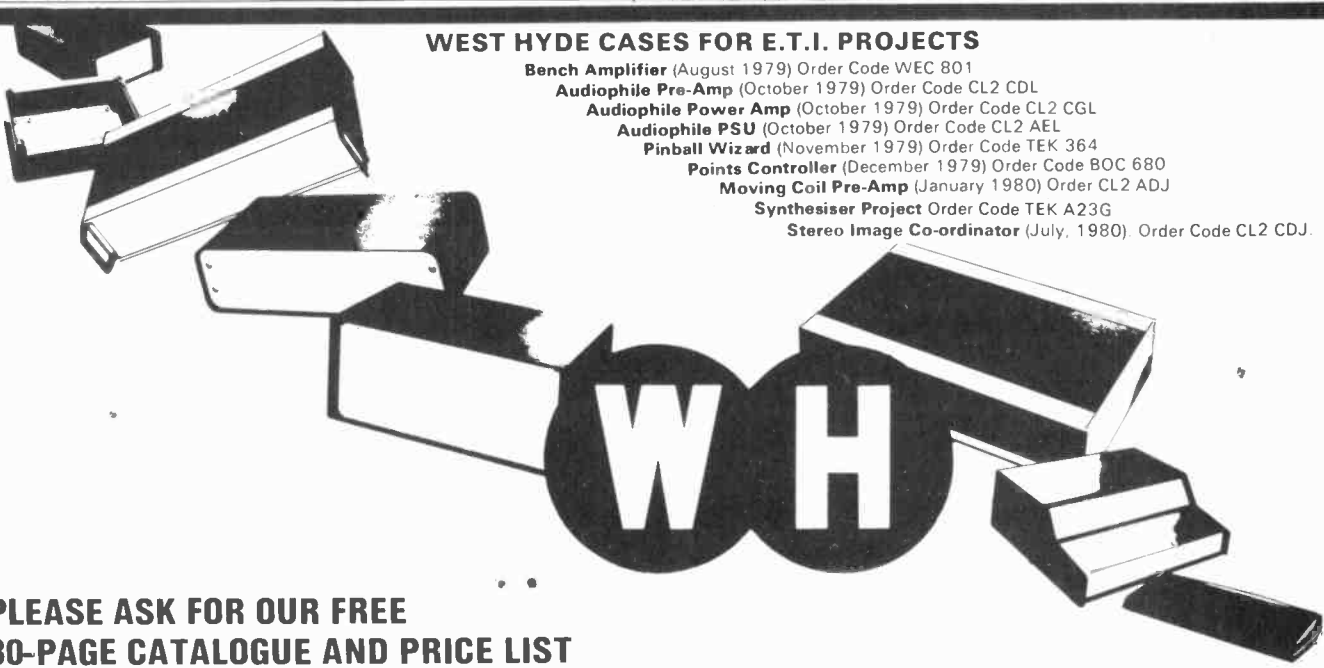
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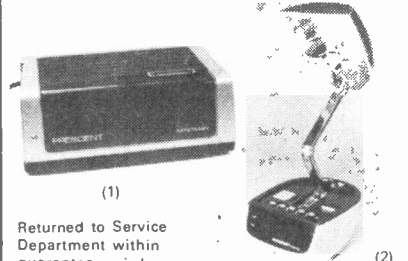
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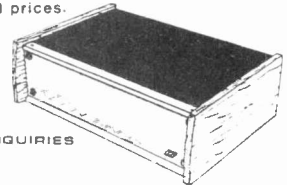
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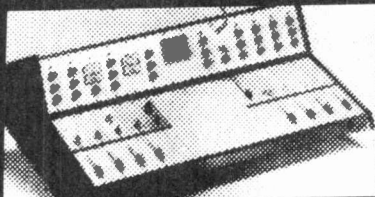


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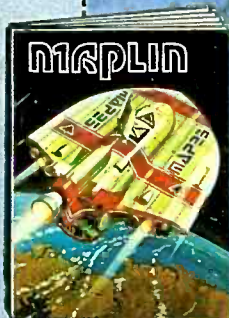


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