

# electronics today

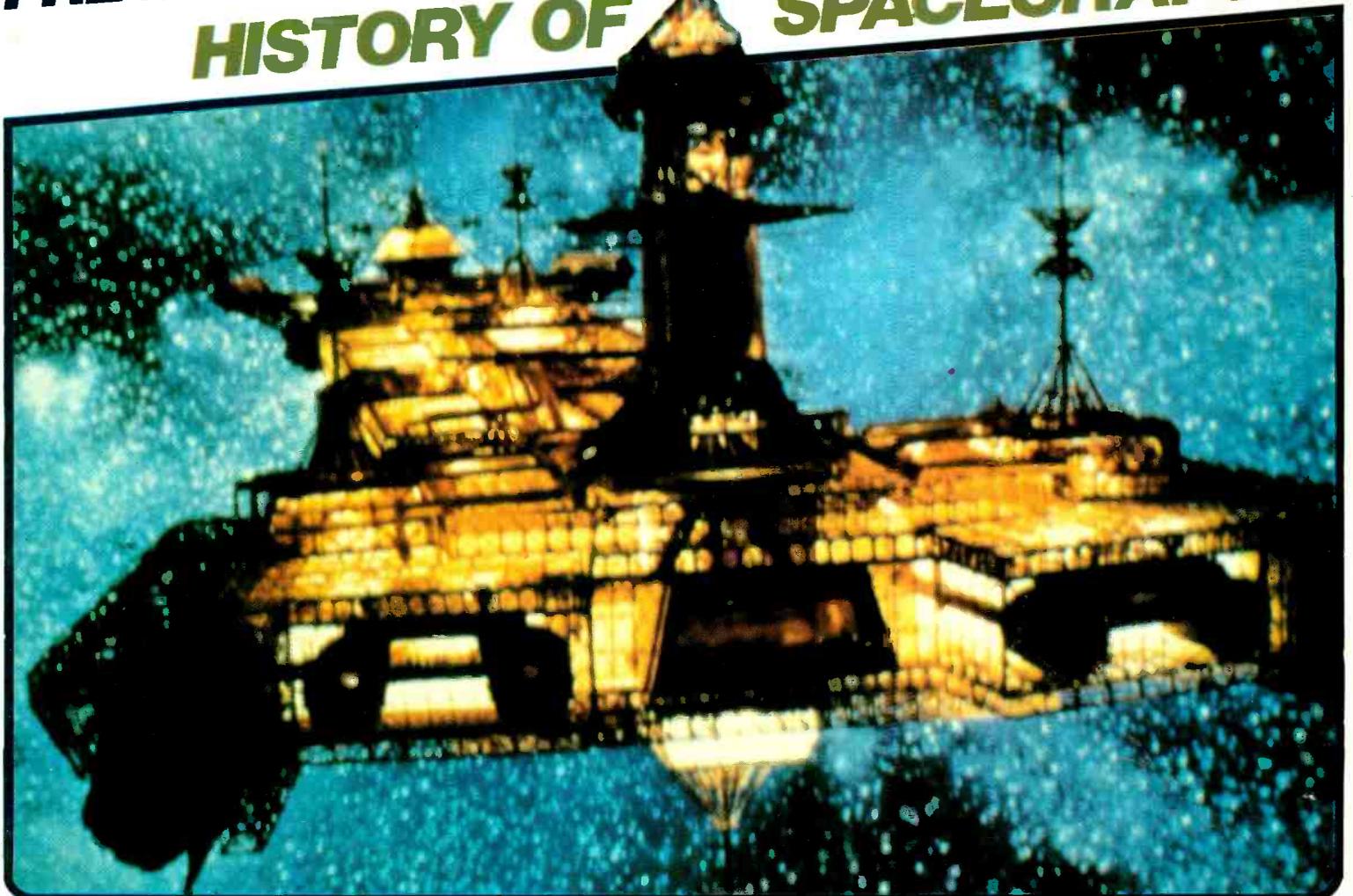
INTERNATIONAL

JULY 1980 60p



**STEREO IMAGE CO-ORDINATOR**  
Move Your Sound Around

**DESIGNING ACTIVE FILTERS**  
**LOUDSPEAKER PROTECTION UNIT**  
**FREQUENCY METER**  
**HISTORY OF**  
**TIME CONSTANTS?**  
**SPACECRAFT**



... 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)

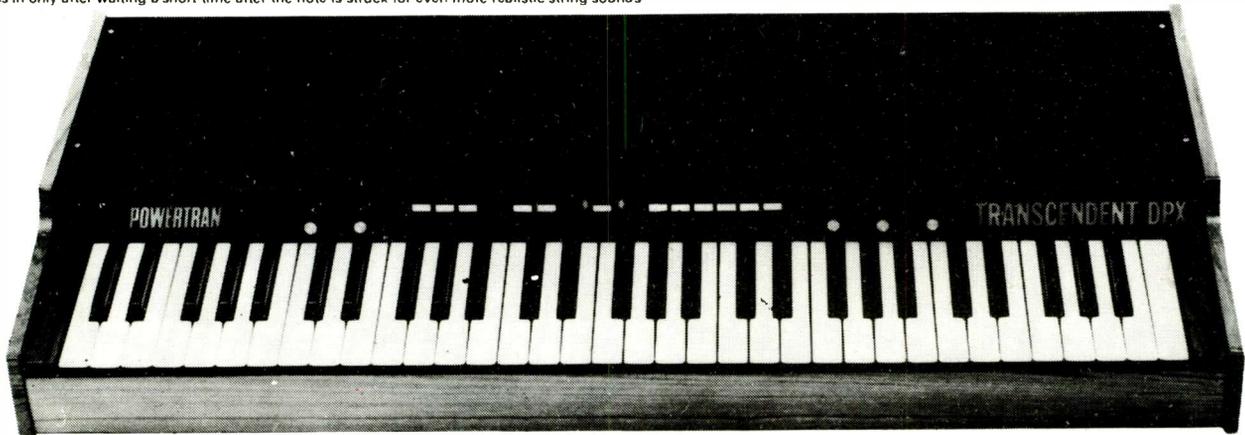
**INCREASED CAPACITY AT OUR BIG NEW FACTORY  
MEANS MANY PRICES DOWN! ALL OTHERS FROZEN!**

**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 9**



# electronics today

JULY 1980 VOL 9 NO 7 **INTERNATIONAL**

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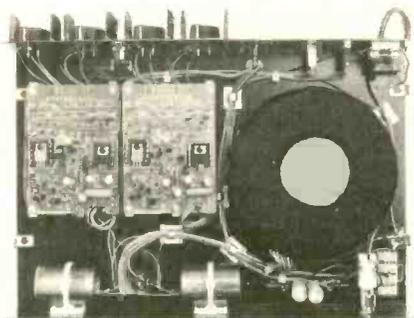
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**POLYESTER CAPACITORS:** Axial lead type.  
 400V: 1nF 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n 9p; 18n 10p; 22n, 33n 11p; 47n, 68n 14p; 100n 17p; 150n, 220n 24p; 330n, 470n 41p; 680n 48p; 1µF 64p; 2µ 282p.  
 160V: 10nF, 12n, 39n, 100n, 150n, 220n 11p; 330n, 470n 19p; 680n, 1µF 22p; 2.2µ F32p; 4.7µ F36p.  
 1000V: 10n, 15n, 20p, 22n 22p; 47n 26p; 100n 38p; 470n 53p; 1µF 175p.

**POLYESTER RADIAL LEAD CAPACITORS: 250V:**  
 10n, 15n, 22n, 27n 5p; 33n, 47n, 68n, 100n 7p; 150n 10p; 220n, 330n 13p, 470n 17p; 680n 19p; 1µ 22p; 1.5µ 30p; 2µ 34p.

**FEEDTHROUGH CAPACITORS:**  
 1000pF/350V 8p

**ELECTRONIC CAPACITORS:** (Values are in µF) 500V: 10 50p; 47 78p; 250V: 100 85p; 83V: 0.47, 1.0, 1.5, 2.2, 3.3, 4.7, 6.8, 8p; 10, 15, 22, 11p; 32, 47, 50, 12p; 63, 100, 27p; 50V: 50, 100, 220, 25p; 470, 32p; 1000, 60p; 40V: 2.33, 8p; 10, 12p; 2200, 3300, 85p; 4700, 98p; 35V: 10, 33, 7p; 330, 470, 32p; 1000, 50p; 25V: 10, 22, 47, 80, 100, 8p; 160, 220, 250, 15p; 470, 25p; 640, 1000, 35p; 1500, 50p; 2200, 45p; 3300, 77p; 4700, 85p; 15V: 10, 47, 7p; 100, 125, 8p; 220, 330, 14p; 470, 20p; 1000, 1500, 30p; 2200, 36p; 10V: 100, 7p; 640, 12p; 1000, 16p.

**TANTALUM BEAD CAPACITORS**  
 35V: 0.1µF 0.22, 0.33, 0.47, 0.68, 1.0µF, 2.2µF, 3.3, 4.7, 25V: 10, 20V: 1.0µF, 2.2µF, 3.3, 4.7, 10, 15p; 16V: 22p, 28p, 47, 100, 50p; 220, 80p; 10V: 15, 22p, 33, 24p; 100, 35p; 6V: 47p, 68, 100, 28p; 3V: 10p.

**MYLAR FILM CAPACITORS**  
 100V: 0.001, 0.002, 0.005, 0.01µF 7p  
 0.015, 0.02, 0.04, 0.05, 0.056µF 8p  
 0.1µF, 0.2, 0.22, 0.5, 0.47µF 12p

**CERAMIC CAPACITORS 50V**  
 Range: 0.5pF to 0.003pF 4p  
 0.015µF 0.022µF, 0.100µF 5p  
 0.047µF, 0.1µF, 0.2µF, 7p

**SILVER MIC (Values in pF) 3.3, 4.7, 6.8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 220, 11p each**  
 250, 270, 300, 330, 360, 390, 470, 600, 800, 820, 16p each  
 1000, 1200, 1800, 2000, 26p each

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

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

**COMPASS TRIMMERS**  
 4.0pF, 10-80pF, 25-190pF 30p  
 100-500pF 45p, 400-1250pF 58p

**GAS & SMOKE DETECTORS**  
 TGS 812 & 813 41Sp; Socket 25p

**JACKSONS VARIABLE CAPACITORS**  
 DILICON 100/300pF 205p  
 500pF 250p  
 6.1 Ball Drive  
 4511/OAF 145p  
 Dial Drive 4103  
 1.6/36.1 775p  
 Drum 54mm 55p  
 D-1.365pF 325p  
 0.02 365pF 395p

**RF CHOKES**  
 1.5µH 4.7, 10, 22, 33, 47, 100, 200, 470, 1500, 1mH, 2.5, 5, 10, 60p each  
 43mH 100

**VEROBOARD** 0.1 0.15 0.1 (copper clad) (plain)  
 58p 51p 42p  
 2 1/2 x 5 1/2 58p 62p  
 3 1/2 x 5 1/2 68p 82p  
 3 1/2 x 3 1/2 58p 68p 85p  
 2 1/2 x 1 1/2 204p  
 3 1/2 x 1 1/2 264p 229p  
 4 1/2 x 1 1/2 345p

**FERRIC CHLORIDE** 1lb bag Anhydrous 125p + 35p P&P  
 Spare spool (wire) 80p Combs 7p each

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

**COPPER CLAD BOARDS**  
 Fibre Single Double SRBP  
 Glass sided sided 9.5" x 8.5"  
 6" x 6" 90p 110p 95p  
 6" x 12" 150p 195p

**DIL PLUGS (Headers)**  
 14 pin 35p; 16 pin 40p; 24 pin 85p; 40 pin 375p

**DIL SOCKETS (TEXAS) Low Wire**  
 8pin 10p 25p  
 14pin 12p 25p  
 16pin 13p 40p  
 18pin 16p 52p  
 20pin 22p 65p  
 22pin 25p 70p  
 24pin 36p 78p  
 28pin 39p 85p  
 36pin 105p  
 40pin 109p

**EDGE CONNECTORS:**  
 (Double type)  
 8BA1008 108  
 8BA1009 108  
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 8BA1099 108  
 8BA1100 108

**POTENTIOMETERS:** Rotary, Carbon, Track 0.25W Log & 0.5W Lin. 470Ω, 680Ω, 1KΩ & 2KΩ (Linear only) Single Gang 29p  
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 Wire Wound Single Turn 1 Watt 200 105p

**SLIDER POTENTIOMETERS**  
 0.25W Log & Linear values 60mm  
 5KΩ-500KΩ dual gang 60p  
 10KΩ 500KΩ single gang 80p  
 Self Stick Graduated Bezels 30p

**PRESET POTENTIOMETERS**  
 0.1W 50Ω-5MΩ Miniature Vertical & Horizontal  
 0.25W 100Ω-3-3MΩ vert. larger 10p  
 0.25W 200Ω-4-7MΩ Vert. 10p  
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 1/4W 2.20-4.7M E24 2p 1p  
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 1.3-0.5W 50Ω-1M E24 8p 6p  
 100+ price applies to Resistors of each type not mixed values

**COMPUTER ICs**  
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 2102-2 250  
 2112-2 299  
 2112 299  
 2708 595  
 2708 595  
 2708 595  
 4047 850  
 4047 850  
 6503 850  
 6504 850  
 6505 850  
 6520 525  
 6532 1050  
 6551 1150  
 6800 800  
 6810 360  
 6821 500  
 6850 485  
 6852 485  
 6853 485  
 6854 485  
 8085A 1220  
 81S95 130  
 81S96 130  
 81S97 140  
 8251 70  
 8054 125  
 8726A 235  
 8728A 280  
 8795N 160  
 8797N 150  
 AY-3-1015 550p  
 AY-5-1013 395  
 AY-5-2376 920  
 CP1610 920  
 DM8123 200  
 MC1488 85  
 MC1489 90  
 MC1441 1020  
 MC1442 1520  
 MK4027-2 470  
 CA3048 214  
 MC3049 132  
 CA3075 213  
 MC3080E 65  
 MC3081 95  
 MC3085 95  
 CA3089E 215  
 CA3090 135  
 CA3123E 150  
 CA3130 90  
 NE515 80  
 CA3140 48  
 NE543K 180  
 IC17106 795  
 IC17107 975  
 CL8038CC 340  
 NE566 55  
 ICM7205 1150  
 ICM7215 1050  
 ICM7216A 1950  
 ICM7216B 1950  
 ICM7216C 1950  
 ICM7217A 790  
 ICM7224 785  
 ICM7227A 885  
 LD130 452  
 LF353 97  
 LM10 395  
 LM301AP 23  
 LM308T 36  
 LM311 150  
 LM315 195  
 LM324A 45  
 LM339 40  
 LM349 90  
 LM379 125  
 LM380 135  
 LM381N 145  
 LM382 125  
 LM387 150  
 LM1458 40  
 M252AA 625  
 AY-5810 735  
 CA1011 110  
 CA3012 150  
 CA3014 157  
 CA3018 68  
 CA3019 70  
 CA3020 186  
 CA3023 181  
 CA3028A 80

**BRIDGE RECTIFIERS**  
 MC1441 1020  
 MC1442 1520  
 MK4027-2 470  
 CA3048 214  
 MC3049 132  
 CA3075 213  
 MC3080E 65  
 MC3081 95  
 MC3085 95  
 CA3089E 215  
 CA3090 135  
 CA3123E 150  
 CA3130 90  
 NE515 80  
 CA3140 48  
 NE543K 180  
 IC17106 795  
 IC17107 975  
 CL8038CC 340  
 NE566 55  
 ICM7205 1150  
 ICM7215 1050  
 ICM7216A 1950  
 ICM7216B 1950  
 ICM7216C 1950  
 ICM7217A 790  
 ICM7224 785  
 ICM7227A 885  
 LD130 452  
 LF353 97  
 LM10 395  
 LM301AP 23  
 LM308T 36  
 LM311 150  
 LM315 195  
 LM324A 45  
 LM339 40  
 LM349 90  
 LM379 125  
 LM380 135  
 LM381N 145  
 LM382 125  
 LM387 150  
 LM1458 40  
 M252AA 625  
 AY-5810 735  
 CA1011 110  
 CA3012 150  
 CA3014 157  
 CA3018 68  
 CA3019 70  
 CA3020 186  
 CA3023 181  
 CA3028A 80

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 Range 2V7 to 39V 400mW  
 8p each  
 Range 3V3 to 33V 1.3W  
 15p each

**LINER ICs**  
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 709 14 pin 38  
 710 16 pin 67  
 733 97  
 747 8 pin 17  
 748 8 pin 36  
 753 8 pin 150  
 810 159  
 LM315 195  
 LM324A 45  
 LM339 40  
 LM349 90  
 LM379 125  
 LM380 135  
 LM381N 145  
 LM382 125  
 LM387 150  
 LM1458 40  
 M252AA 625  
 AY-5810 735  
 CA1011 110  
 CA3012 150  
 CA3014 157  
 CA3018 68  
 CA3019 70  
 CA3020 186  
 CA3023 181  
 CA3028A 80

**NOISE**  
 Z5J 180

**SCRs Thyristors**  
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 IA/100V 42  
 IA/200V 47  
 IA/400V 55  
 5A/600V 39  
 5A/800V 43  
 5A/1000V 48  
 5A/1200V 52  
 12A/100V 42  
 12A/200V 47  
 12A/300V 52  
 12A/400V 55  
 12A/500V 59  
 12A/600V 63  
 12A/800V 68  
 12A/1000V 72  
 12A/1200V 76  
 12A/1500V 80  
 12A/2000V 84  
 12A/2500V 88  
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 12A/6000V 116  
 12A/6500V 120  
 12A/7000V 124  
 12A/7500V 128  
 12A/8000V 132  
 12A/8500V 136  
 12A/9000V 140  
 12A/9500V 144  
 12A/10000V 148  
 12A/10500V 152  
 12A/11000V 156  
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 12A/29000V 300  
 12A/29500V 304  
 12A/30000V 308  
 12A/30500V 312  
 12A/31000V 316  
 12A/31500V 320  
 12A/32000V 324  
 12A/32500V 328  
 12A/33000V 332  
 12A/33500V 336  
 12A/34000V 340  
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 12A/37500V 368  
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 12A/89000V 780  
 12A/89500V 784  
 12A/90000V 788  
 12A/90500V 792  
 12A/91000V 796  
 12A/

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ASTEC RF Modulators <b>250</b> Special Widebandwidth for Computers <b>470</b> Sound Modulator <b>250</b>	<b>DIL SWITCHES</b> 4-way SPST <b>110</b> 6-way SPST <b>120</b> 8-way SPST <b>145</b> <b>RELAYS</b> RLE SPCO <b>175</b> RL6B DPCO <b>215</b>	<b>ALUM. BOXES WITH LID</b> 3x2x1" <b>55</b> 2 1/2x5 1/2x1 1/2" <b>75</b> 4x4x1 1/2" <b>75</b> 4x2 1/2x1 1/2" <b>70</b> 4x5 1/2x1 1/2" <b>90</b> 4x2 1/2x2" <b>80</b> 5x4x2" <b>107</b> 6x4x2" <b>110</b> 7x5x2 1/2" <b>145</b> 8x6x3" <b>185</b> 10x7x3" <b>240</b> 10x4 1/2x3" <b>228</b> 12x5x3" <b>230</b> 12x8x3" <b>275</b>	<b>PANEL METERS</b> FSD 60x46x35mm <b>15p</b> 0-500µA <b>0.100µA</b> 0-500µA <b>0.500µA</b> 0-1mA <b>0.1mA</b> 0-50mA <b>0.50mA</b> 0-100mA <b>0.100mA</b> 0-500mA <b>0.1A</b> 0-1A <b>0.25V</b> 0-50V AC <b>0.300V AC</b> 0-300V AC <b>S</b> 'VU' <b>445p each</b> 4 1/2x3 1/2x1 1/2" <b>0.50µA</b> 0-100µA <b>0.500µA</b> 0-500µA <b>595p each</b>

<b>CRYSTALS</b> 100KHz <b>323</b> 455KHz <b>383</b> 1MHz <b>323</b> 1.008M <b>395</b> 1.28MHz <b>392</b> 1.6MHz <b>323</b> 1.8MHz <b>323</b> 1.8432MHz <b>362</b> 2.4576MHz <b>362</b> 3.2768M <b>323</b> 3.57954M <b>195</b> 4.000MHz <b>290</b> 4.032MHz <b>323</b> 4.433619M <b>135</b> 5.0MHz <b>355</b> 5.185M <b>323</b> 5.24288M <b>323</b> 6.0MHz <b>323</b> 6.5536M <b>200</b> 7.80M <b>323</b> 8.0MHz <b>392</b> 8.08333M <b>362</b> 8.967237M <b>362</b> 9.375M <b>323</b> 10.0MHz <b>323</b> 10.7MHz <b>323</b> 12MHz <b>392</b> 14.31818M <b>362</b> 18MHz <b>323</b> 18.432M <b>323</b> 20.0MHz <b>323</b> 27.648M <b>323</b> 38.6667M <b>350</b> 48.0MHz <b>323</b> 100.00MHz <b>323</b>	<b>TRANSFORMERS (Mains Prim. 220-240V)</b> 6-0.6V 9-0.9V, 12-0.12V 100mA <b>95p</b> 3VA: 0-6V 0-6V (PCB mounting) <b>150p</b> 8VA: 6V-5A 6V-5A 9V-4A 12V-3A <b>215p</b> 12V-3A 15V-25A 15V-25A <b>215p</b> 12V: 4.5V-1.3A 4.5V-1.3A 6V-1.2A 6V-1.2A 12V-5A 12V-5A 15V-4A 15V-4A 20V-3A <b>235p</b> (30p p&p) 24VA: 6V-1.5A 6C-1.5A 9V-1.3A 9V-1.3A 12V-1A 12V-1A 15V-8A 15V-8A 20V-6A 20V-6A <b>320p</b> (55p p&p) 50VA: 6V-4A 6V-4A 9V-2.5A 9V-2.5A 12V-2A 12V-2A 15V-1.5A 15V-1.5A 20V-1.2A 20V-1.2A 25V-1A 25V-1A 30V-8A 30V-8A <b>385p</b> (60p p&p) 100VA: 12V-4A 12V-4A 15V-3A 15V-3A 20V-2.5A 20V-2.5A 30V-1.5A 30V-1.5A 40V-1.25A 40V-1.25A 50V-1A 50V-1A <b>695p</b> (74p p&p). (NB p&p charge to be added above our normal postal charge.)	<b>ALUM. BOXES WITH LID</b> 3x2x1" <b>55</b> 2 1/2x5 1/2x1 1/2" <b>75</b> 4x4x1 1/2" <b>75</b> 4x2 1/2x1 1/2" <b>70</b> 4x5 1/2x1 1/2" <b>90</b> 4x2 1/2x2" <b>80</b> 5x4x2" <b>107</b> 6x4x2" <b>110</b> 7x5x2 1/2" <b>145</b> 8x6x3" <b>185</b> 10x7x3" <b>240</b> 10x4 1/2x3" <b>228</b> 12x5x3" <b>230</b> 12x8x3" <b>275</b>	<b>PANEL METERS</b> FSD 60x46x35mm <b>15p</b> 0-500µA <b>0.100µA</b> 0-500µA <b>0.500µA</b> 0-1mA <b>0.1mA</b> 0-50mA <b>0.50mA</b> 0-100mA <b>0.100mA</b> 0-500mA <b>0.1A</b> 0-1A <b>0.25V</b> 0-50V AC <b>0.300V AC</b> 0-300V AC <b>S</b> 'VU' <b>445p each</b> 4 1/2x3 1/2x1 1/2" <b>0.50µA</b> 0-100µA <b>0.500µA</b> 0-500µA <b>595p each</b>
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<b>VOLTAGE REGULATORS</b> 1A TO3 +ve -ve <b>220p</b> 5V 7805 <b>175p</b> 7912 <b>220p</b> 12V 7812 <b>175p</b> 7912 <b>220p</b> 15V 7815 <b>175p</b> 18V 7818 <b>175p</b> 1A TO220 Plastic Casing 5V 7805 <b>60p</b> 7905 <b>65p</b> 12V 7812 <b>60p</b> 7912 <b>65p</b> 15V 7815 <b>60p</b> 7915 <b>65p</b> 18V 7818 <b>60p</b> 7918 <b>65p</b> 24V 7824 <b>60p</b> 100mA TO92 Plastic Casing 5V 78L05 <b>30p</b> 79L05 <b>65p</b> 6V 78L62 <b>30p</b> 8V 78L82 <b>30p</b> 12V 78L12 <b>30p</b> 79L12 <b>65p</b> 15V 78L15 <b>30p</b> 79L15 <b>65p</b>	<b>OPTO</b> LEOs with Clips TIL209 Red <b>13</b> TIL211 Grn. <b>17</b> TIL212 Yel. <b>18</b> TIL220 2" Red <b>14</b> 2" Green, Yellow or Amber <b>18</b> Square LEDs, Red Green, Yellow <b>36</b> LD271 Infra Red <b>40</b> SFH205 Detector <b>60</b> TIL32 Infra Red <b>58</b> TIL78 Detector <b>70</b> BARGRAPH Red 10 segments <b>225</b> LS400 <b>255</b> OCP71 <b>120</b> ORP12 <b>63</b> ORP61 <b>45</b> 2N5777 <b>45</b>	<b>ISOLATORS</b> IL74 <b>48</b> TIL111/2 <b>85</b> TIL114 <b>95</b> TIL117 <b>110</b> LCD 3 1/2 Digit <b>875</b> LCD 4 Digit <b>975</b>
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**ETI Projects: Parts available for: Digital Test Meter, DM900, 60W Amplifier System. Send SAE plus 5p for list.**

LS202 <b>345</b> LS352 <b>185</b> 4011 <b>24</b> 4050 <b>48</b> 4162 <b>125</b> 4520 <b>115</b>	LS221 <b>120</b> LS353 <b>185</b> 4012 <b>24</b> 4051 <b>80</b> 4163 <b>125</b> 4521 <b>250</b>	LS240 <b>225</b> LS355 <b>65</b> 4013 <b>45</b> 4052 <b>80</b> 4174 <b>130</b> 4522 <b>150</b>	LS241 <b>225</b> LS366 <b>65</b> 4014 <b>85</b> 4053 <b>80</b> 4175 <b>120</b> 4526 <b>150</b>	LS242 <b>232</b> LS367 <b>65</b> 4015 <b>85</b> 4054 <b>130</b> 4194 <b>125</b> 4527 <b>160</b>	LS243 <b>232</b> LS368 <b>65</b> 4016 <b>42</b> 4055 <b>135</b> 4408 <b>790</b> 4528 <b>120</b>	LS244 <b>225</b> LS373 <b>180</b> 4017 <b>82</b> 4056 <b>135</b> 4409 <b>790</b> 4529 <b>175</b>	LS245 <b>270</b> LS374 <b>180</b> 4018 <b>28</b> 4057 <b>2650</b> 4410 <b>790</b> 4530 <b>89</b>	LS247 <b>135</b> LS375 <b>150</b> 4019 <b>48</b> 4059 <b>575</b> 4411 <b>1020</b> 4531 <b>165</b>	LS248 <b>135</b> LS377 <b>199</b> 4020 <b>99</b> 4080 <b>130</b> 4412F <b>1520</b> 4532 <b>140</b>	LS249 <b>135</b> LS378 <b>185</b> 4021 <b>105</b> 4061 <b>1225</b> 4412V <b>1520</b> 4534 <b>575</b>	LS251 <b>130</b> LS379 <b>215</b> 4022 <b>95</b> 4062 <b>995</b> 4415F <b>850</b> 4536 <b>395</b>	LS253 <b>130</b> LS384 <b>50</b> 4023 <b>25</b> 4063 <b>120</b> 4415V <b>850</b> 4538 <b>160</b>	LS257 <b>115</b> LS385 <b>420</b> 4024 <b>75</b> 4066 <b>58</b> 4419 <b>320</b> 4539 <b>135</b>	LS258 <b>120</b> LS386 <b>85</b> 4025 <b>25</b> 4067 <b>430</b> 4422 <b>570</b> 4541 <b>150</b>	LS259 <b>160</b> LS390 <b>140</b> 4026 <b>180</b> 4088 <b>26</b> 4432 <b>1050</b> 4543 <b>175</b>	LS261 <b>450</b> LS393 <b>140</b> 4027 <b>48</b> 4069 <b>26</b> 4435 <b>1050</b> 4549 <b>295</b>	LS266 <b>75</b> LS395 <b>210</b> 4028 <b>82</b> 4070 <b>30</b> 4440 <b>999</b> 4553 <b>440</b>	LS273 <b>180</b> LS396 <b>199</b> 4029 <b>105</b> 4071 <b>25</b> 4450 <b>350</b> 4554 <b>175</b>	LS275 <b>320</b> LS398 <b>275</b> 4030 <b>60</b> 4072 <b>25</b> 4451 <b>350</b> 4555 <b>85</b>	LS279 <b>88</b> LS399 <b>230</b> 4031 <b>225</b> 4073 <b>25</b> 4452 <b>450</b> 4556 <b>75</b>	LS280 <b>250</b> LS445 <b>140</b> 4032 <b>125</b> 4075 <b>25</b> 4490F <b>750</b> 4557 <b>425</b>	LS283 <b>190</b> LS447 <b>195</b> 4033 <b>175</b> 4076 <b>99</b> 4490V <b>750</b> 4558 <b>130</b>	LS290 <b>130</b> LS490 <b>150</b> 4034 <b>210</b> 4077 <b>48</b> 4501 <b>28</b> 4559 <b>290</b>	LS293 <b>130</b> LS668 <b>105</b> 4035 <b>125</b> 4078 <b>30</b> 4502 <b>125</b> 4560 <b>235</b>	LS295 <b>215</b> LS669 <b>105</b> 4036 <b>365</b> 4081 <b>88</b> 4503 <b>75</b> 4561 <b>95</b>	LS298 <b>215</b> LS670 <b>270</b> 4037 <b>115</b> 4082 <b>28</b> 4506 <b>75</b> 4562 <b>595</b>	LS299 <b>420</b> LS673 <b>750</b> 4038 <b>118</b> 4085 <b>90</b> 4507 <b>60</b> 4566 <b>190</b>	LS300 <b>175</b> LS674 <b>850</b> 4039 <b>360</b> 4086 <b>90</b> 4508 <b>325</b> 4568 <b>299</b>	LS302 <b>175</b> 4040 <b>105</b> 4089 <b>150</b> 4510 <b>99</b> 4569 <b>250</b>	LS320 <b>270</b> 4041 <b>80</b> 4093 <b>89</b> 4511 <b>150</b> 4572 <b>48</b>	LS323 <b>450</b> 4000 <b>18</b> 4042 <b>80</b> 4094 <b>240</b> 4512 <b>98</b> 4580 <b>595</b>	LS324 <b>200</b> 4001 <b>18</b> 4043 <b>95</b> 4095 <b>105</b> 4513 <b>225</b> 4581 <b>350</b>	LS325 <b>320</b> 4002 <b>24</b> 4044 <b>95</b> 4096 <b>105</b> 4514 <b>265</b> 4582 <b>150</b>	LS326 <b>300</b> 4003 <b>24</b> 4045 <b>175</b> 4097 <b>350</b> 4515 <b>298</b> 4583 <b>125</b>	LS327 <b>315</b> 4007 <b>22</b> 4046 <b>130</b> 4098 <b>115</b> 4516 <b>120</b> 4584 <b>64</b>	LS346 <b>185</b> 4008 <b>82</b> 4047 <b>98</b> 4099 <b>190</b> 4517 <b>450</b> 4585 <b>140</b>	LS347 <b>150</b> 4009 <b>40</b> 4048 <b>65</b> 4160 <b>125</b> 4518 <b>105</b> 40106 <b>95</b>	LS348 <b>190</b> 4010 <b>48</b> 4049 <b>45</b> 4161 <b>125</b> 4519 <b>70</b>
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ETI JULY 1980

# QUESTION?

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2. Do you understand the application of IC's, Transistors, Diodes, etc?
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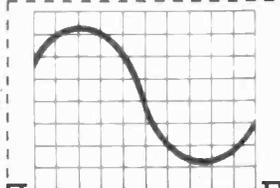
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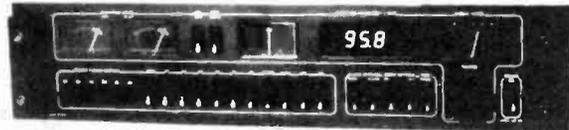
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Mark III A series 'Reference series' tuner modules .....£171.35 inc.  
Mark III B series 'Hyperfi' modules, with switched IF BW, pilot cancel decoder .....£198.95 inc.

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.

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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	IDA1220	1.61	KB4413	2.24
TBA120S	1.15	TDA1083	2.21	KB4417	2.53
KB4406	0.80	TDA1062	2.24	MC3357P	3.16

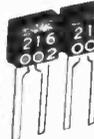


SL1610	1.84	SL1626	2.80
SL1611	1.84	SL1630	1.86
SL1612	1.84	SL1640	2.17
SL1613	2.17	SL1641	2.17
SL1620	2.50	SL6600	4.31
SL1623	2.80	SL6640	3.16
SL1624	3.77	SL6690	3.68
SL1625	2.50	MC1496	1.44

### VARICAP DIODES.....

A section from our PL:

BA102	0.35	16:1 ratio AM tuning	
BB204	0.41	KV1215 9v triple	2.93
BB105	0.41	KV1211 9v dual	2.01
BB109	0.31	KV1225 25v triple	3.16
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).  
2SK133 120v N-ch 100W MOSFET £6.33 2SJ48 Pch complement £6.33  
2SK135 160v N-ch 100W MOSFET £7.29 2SJ50 Pch complement £7.39  
PA101B Kit for 100W MOSFET PA less Heatsink £16.10. (£23 inc heatsink/bkt)

### ULTRA LOW NOISE PU PREAMPLIFIER

The HA12017 is the last word in PU preamps, and general low noise audio design. It is an SIL IC, with 86dB S/N in RIAA configuration, 10v RMS output capability, 0.002% typ THD at 10v RMS output (imagine the overload margin !!). It comfortably supercedes discrete circuit designs in terms of price/performance, and takes the art beyond the TDA1042's capabilities. (Replaces HA1457) £1.80 each - or an RIAA applications PCB with two ICs for £5.75. Complete with Rs&Cs £9.95.

### Radio Control ICs

We have various RC ICs, including NE544 NE5044, and two new ones from OKI

KB4445 - 4 channel dig.prop. FM TX IC, 30mW out (amplifiable) -£2.30 inc  
KB4446 - 4/5 ch. dig. prop FM RX IC. Suits KB4445 or RCME syst. £2.65.  
KB4445/6 pair: £4.75. New 8 page data sheet 35p + SAE. More RC ICs in list

### CMOS, LPSNTTL, TTL, MPU:

Most CMOS is available in low volume - also LPSN. Standard linears and TTL OK.

Things like ICM7216B, ICL8038, 8080A, 6800P, 2708, NE555, NE556, etc

### Coming Soon.....

Contain yourselves, RF fans! Not yet ready for a full launch until autumn, but previewed here:

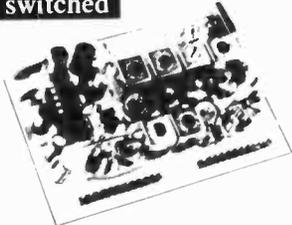
### SSB transceiver system : 10kHz to 1000MHz !!

A modular VLF to UHF SSB TX/RX system at last. With the correct first mixer, the basic PCB covers 10kHz to 1000MHz - using LO fed from ext. source (Our 2 IC Mullard synth for instance) and RF PA for TX OP 0.2uV basic sensitivity in HF. Typ cost for HF synth SSB RX will be less than £200. Add an RF PA for full TRX for another £50. See one in our foyer, and marvel.

## Radio/Audio/Communications Modules

### LW-MW-SW-SW DC tuned and switched

91072- All switching of bands by a single pin to gnd. Varicap tuned, with LO output for synth. MW/LW version or MW/LW plus 1 or 2 SW bands MW/LW: £15.58 +1SW £16.73



### VHF Tunerheads

Europe's largest stock range for broadcast and communications. Probably also the world's - details in the catalogues and PL. Specials are also supplied in the region 30-220MHz.

### Pilot Cancel PLL Stereo decoders

Again, Europe's widest range of stereo decoders including pilot cancel PLL types. The pic shows the 944378 - pilot cancel including post decoder 26/38kHz filtering and muting preamp output

944378-2 £26.45



### Switched bandwidth FM IF strips

Broadcast FM IF strips for all occasions, including the new 911225 - with diode switched narrow filter option, ultra linear phase ceramic filters, 84dB S/N, and 0.04% THD (40kHz deviation). Plus usual things like AGC, AFC, dev. mute, level meter drive. £23.95 (supplied in screen can with 0.1 edge connection system) Also the 7230 hyperfi series - as the 911225, but with slope controlled AFC that operates in conjunction with signal level - and an extra IF amp stage for DXing.

### Various digital frequency displays

The World's largest range of receiver DFM's is now joined by the DFM7 (shown) - and L shaped version of the DFM3 with remote display mount connector possibility. 1kHz SW resolution with 455kHz or 10.7MHz offsets, 100Hz res up to 3.9999MHz, and VHF to 299.99 MHz in 10kHz steps : £41.75



## Components

### Crystal Filters

Most popular types are available ex-stock, and in quantity.

10.7MHz	25kHz Channel spacing 8pole	£16.67
	12½kHz	£17.82
	2.4kHz SSB	£19.78
	M. nolithic dual roofing filter	£2.30
34.5MHz	1.µB loss, 80dB stopband HF first filter in synth. RX	£36.80
RC XTALS	FM pairs (no spilt)	£3.74
	AM pairs	£3.57
USB/LSB	Xtals for 10.7SSB filter	£2.88 ea



### Piezo Sounders

The most efficient warning sounders yet

The latest thing in electro-acoustic efficiency, 1mA of drive from CMOS will give an SPL of 83dB - 10v RMS drive from CMOS uses 3mA for 100dB SPL at 4.8kHz (88dB at 1.65kHz) The data sheets shows various drive circuits, and give full specifications with regard to broadband responses and power consumption etc. 1 off 44p inc. 100 off 28.75p (25p ex vat)



### Keyboard switches and caps

From the world's most widely used switch manufacturers - ALPS - come the biggest and best range of keyswitches, and data entry keyboard switches. The SCM81101 is shown here, with the KT5 2-part cap (with clear top, to enable easy fitting of your chosen legend. Other types are available with built in LED, 90° mounting etc. SCM81101 : 17p, KT5 : 16p - or 29p/pair



### LCD CLOCKS

Clocks use 1.5v at 15uA only.

### LCD DVM

DVM 9v/1mA

CM161:	7mm LCD 12/24hr, alarms etc	£11.44 each
CM172:	13mm, 12hr, alarms, timer etc	£14.32 each
CM174:	13mm, 12hr, min/sec stopwatch	£14.32 ea
DVM 176:	ICM7106 based LCD 3½digit	£22.36 each



## WHAT'S NEW at AMBIT

NEW PRICELIST/SHORTFORM: 28 pages, FOC with A5 SAE pse

Bigger print than our recent one page list - and vastly extended

If you still need convincing to invest £1.60 in the cats, be mean and get this first.

POWER MOSFET APPLICATIONS HANDBOOK by HITACHI :

£1.50 each - or free with pairs of HMOS and the PA101B

Everything you should know about HMOSFET devices theory and applications.

Please send an SAE with all enquiries. Phone orders by ACCESS but minimum £5. Callers welcome

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Parts 1-3 AMBIT catalogues 60p ea, or £1.60 the lot.

200 North Service Road, Brentwood, Essex

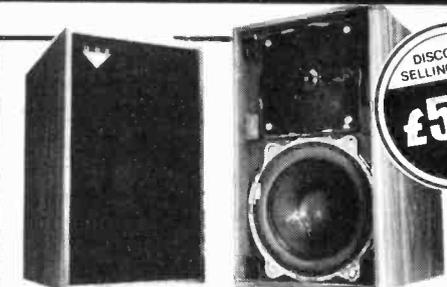
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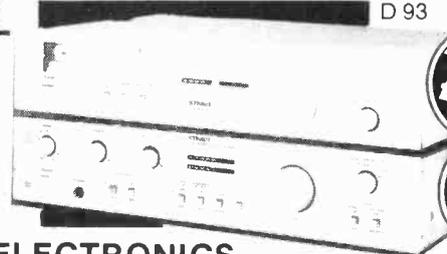


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This new range of Electronics from Videotone redefines the words quality and value for money to a new high.

30 watt amp MC input SA4130	£75.00
Stereo Tuner ST4120	£68.00
Cassette full features SC3200	£98.00
50 Watt amplifier WA7700	£77.00
20 Watt amplifier LA2020	£58.00

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UK's No. 1 Cartridge

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777EX	£35
777E	£25

**MOVING MAGNET**

555SX	£7.28
555E	£14.22
666E	£32.48



**HEAD AMP**

H300	£51.75
T100	£24.75

**HEADSHELLS**

S100	£6
S101	£7
S200	£4



### MICROPHONES

MU 105-22	£29.30
MU 105-12	£22.25
MU 25 C	£17.39

### TURNTABLES

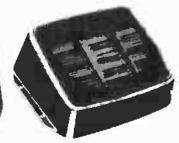
Sansui SR222 Mk2	£69.00
JVC LA 11	£64.00
JVC SLQ 3	£140.00

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### IN CAR ELECTRONICS

FM AM Receiver with fully integral auto reverse cassette	£48
10 Watt Cassette player	£20
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Small Wedge	£2.95
Door Mount	£9.95
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ETI/7/80

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# DIGEST

## Continental Time

An attractive new instrument from CSC offers time and frequency measuring capabilities plus signal conditioning facilities.

The model 5001 has two DC-coupled BNC inputs, both of 1M plus 20 pF input impedance with a sensitivity of 20 mV RMS. Each has three position attenuator (x1, x10 and x100), a positive/negative going slope selector and a variable trigger-level control. Maximum frequency at the A input is specified as 10 MHz and at the B input as 2 MHz. Readings can be held on the display for a variable period.

The frequency counter, with a maximum input frequency of 10

MHz, has a selectable resolution of 100 Hz, 10 Hz, 1 Hz or 0.1 Hz.

The period measurement mode, with a range of 400 nS to 10 S and a maximum input frequency of 5 MHz, can resolve to 100 nS, 10 nS, 1 nS or 100 pS depending on the range chosen.

Time intervals from 200 nS between a rising edge at the A input and the next rising edge at B can be measured, with resolution down to 100 pS.

The ratio of cycles appearing at the A input per cycle at B can also be displayed. The unit will count the number of rising edges arriving at A before the reset button is pushed, in the count mode.

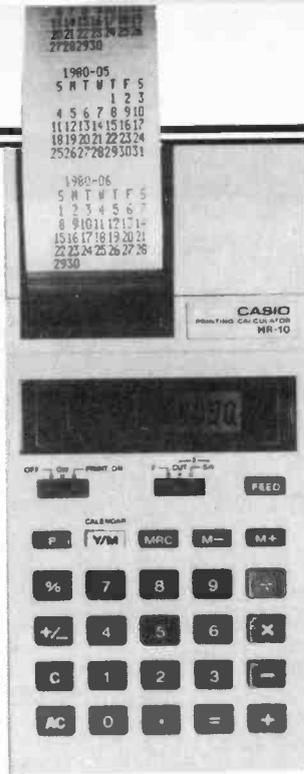
Power consumption is 10 W. The model 5001 Universal Counter-Timer is available at £185 plus VAT from Continental Specialties Corporation, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.



## Look Out Busby

Phillips' M100 Direct Speech System is part of a new range of intercom equipment being launched for the 1980's. Fully compatible with the existing M100 system, its built-in microprocessor enable instant 'hands free' voice links between two and many thousand stations and extra stations are simply plugged into the eight pair parallel cable and reprogrammed within seconds. The keyboard layout includes an improved volume control and privacy button as well as standard optional functions such as automatic call-

back, triplex conversations, group call and links with the DP600 digital paging system through a coupler. There is also facility for twelve programmable direct call buttons for frequently called stations. The M100 system therefore dispenses with the need for a large central exchange and the expense of wiring every station to it. It is available from Pye Business Communications, Cromwell Road, Cambridge CB1 3HE. The BBC has already shown interest in this system by placing a £75,000 order with Pye to instal internal communications in the Beeb's News Department at Television Centre, this covers seven floors and initially 140 stations will be installed. It will replace part of the existing custom-built system.



## Calculate-A-Calendar

The casio HR10 is a slightly out of the ordinary printing calculator, in that apart from all the usual functions and a 10 digit display, it has the capacity to print calendars to order. Simply key in any year and month between January 1901 and December 1099 and it will print out a full conventional calendar. Press add or subtract and it will print the month following or preceding it. The unit can be used either with four AA batteries, rechargeable battery pack or mains adapter. The HR-10 is 3 1/2" wide by 6 3/4" deep and 1 3/4" high. Recommended price is £35.95 including VAT. So, if you want to find out which day of the week your Granny was born on...

## Battery Farming

1980 may well herald a new era for the motor vehicle, this is due to the Chancellor of the Exchequer abolishing Excise Duty from electric vehicles. The interest recently shown in this form of transport is being further strengthened by the forthcoming Drive Electric '80 exhibition to be

held at the Wembley Conference Centre in London during October this year. It will be an international show case of electrically powered vehicles. In Great Britain over a thousand new electric road vehicles are made each year and only here do electrically powered vehicles run as many as 300 million miles each year. The intention of the conference and exhibition is to prove the reliability and performance of the electric vehicle and to extend its acceptability as a means of transport.



## Pinball Prices Slashed

Remember the ETI Pinball Wizard project, featured in the November 1979 issue? It has proved to be so popular (hundreds have been built) that the supplier has made a further bulk purchase of the chips.

ETI readers can now buy the PCB and chip for a mere £9.95 all inclusive only if you send off the attached form.

To: Pinball Offer, NIC,  
61 Broad Lane, London N15 4DJ  
Please send me  
Pinball Wizard PCB/Chip sets at  
£9.95 per set. I enclose cheque/  
PO payable to NIC for  
NAME .....  
ADDRESS .....

# CHROMATHEQUE 5000



Panel size 19.0" x 3.5". Depth 7.3"

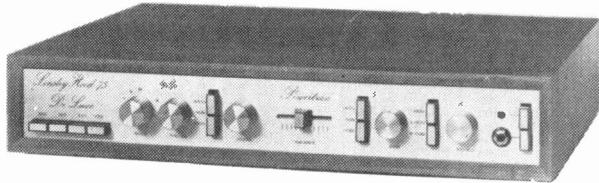
This versatile system featured as a constructional article in *ELECTRONICS TODAY INTERNATIONAL* has 5 frequency channels with individual level controls on each channel. Control of the lights is comprehensive to say the least. You can run the unit as a straightforward sound-to-light or have it strobe 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  
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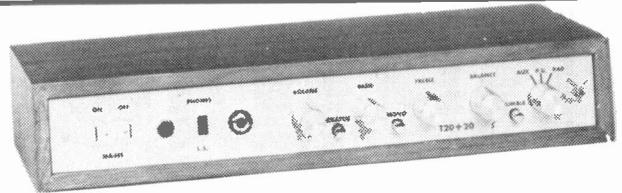
### DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £99.30 + VAT

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)**

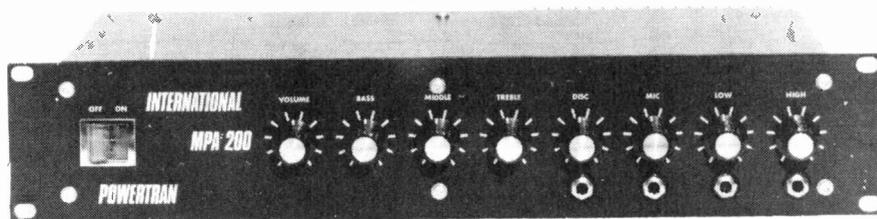
De Luxe version (dual delay line system) also available for **£59.80 + VAT**



# 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 wide 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"

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ONLY  
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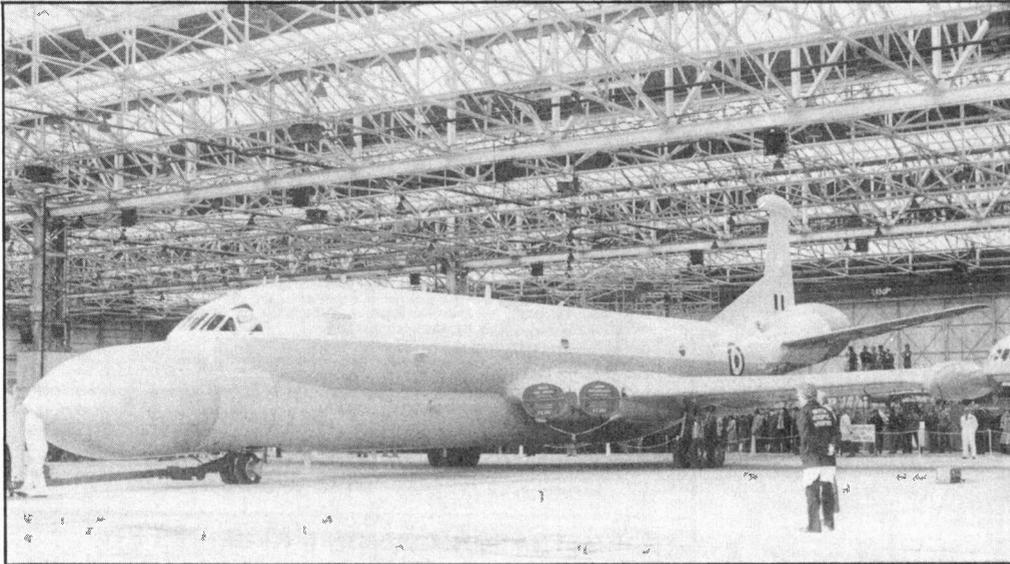
**EXPORT ORDERS:** No VAT. Postage charged at actual cost plus £1 handling and documentation.

**U.K. ORDERS:** Subject to 15% surcharge for VAT. No charge is made for carriage or at current rate if changed.

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

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TIP37A 115p BC159 11p BF53 30p TIP37B 115p BC169C 12p BU104 225p TIP41 130p BC177/8 12p BU105 190p TIP42 130p BC217 15p BU108 250p TIP43 130p BC182/3 10p BU109 225p TIP44 130p BC184 11p BU205 200p TIP45 130p BC187 30p BU206 200p TIP46 130p BC212/3 11p BU406 145p TIP47 130p BC214 12p E300 50p TIS43 34p BC217 15p E308 50p TIS93 30p BC327 16p E310 50p 2TX108 12p BC337 16p MJ2501 225p 2TX300 13p BC461 36p MJ2955 90p 2TX500 15p BC477/8 30p MJ3001 225p 2TX502 18p BC516/7 50p MJE3055 100p 2TX504 30p BC517 18p MJE3055 100p 2N696 35p BC518 18p MJE3055 100p 2N697 25p BC519 18p MJE3055 100p 2N698 45p BC520 18p MJE3055 100p 2N706A 25p BC521 18p MJE3055 100p 2N918 45p BC522 18p MJE3055 100p 2N930 18p BC523 18p MJE3055 100p 2N1131/2 20p BC524 18p MJE3055 100p 2N1131 25p BC525 18p MJE3055 100p 2N1132 25p BC526 18p MJE3055 100p 2N1133 25p BC527 18p MJE3055 100p 2N1134 25p BC528 18p MJE3055 100p 2N1135 25p BC529 18p MJE3055 100p 2N1136 25p BC530 18p MJE3055 100p 2N1137 25p BC531 18p MJE3055 100p 2N1138 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3200V 340p 3A 3300V 350p 3A 3400V 360p 3A 3500V 370p 3A 3600V 380p 3A 3700V 390p 3A 3800V 400p 3A 3900V 410p 3A 4000V 420p 3A 4100V 430p 3A 4200V 440p 3A 4300V 450p 3A 4400V 460p 3A 4500V 470p 3A 4600V 480p 3A 4700V 490p 3A 4800V 500p 3A 4900V 510p 3A 5000V 520p 3A 5100V 530p 3A 5200V 540p 3A 5300V 550p 3A 5400V 560p 3A 5500V 570p 3A 5600V 580p 3A 5700V 590p 3A 5800V 600p 3A 5900V 610p 3A 6000V 620p 3A 6100V 630p 3A 6200V 640p 3A 6300V 650p 3A 6400V 660p 3A 6500V 670p 3A 6600V 680p 3A 6700V 690p 3A 6800V 700p 3A 6900V 710p 3A 7000V 720p 3A 7100V 730p 3A 7200V 740p 3A 7300V 750p 3A 7400V 760p 3A 7500V 770p 3A 7600V 780p 3A 7700V 790p 3A 7800V 800p 3A 7900V 810p 3A 8000V 820p 3A 8100V 830p 3A 8200V 840p 3A 8300V 850p 3A 8400V 860p 3A 8500V 870p 3A 8600V 880p 3A 8700V 890p 3A 8800V 900p 3A 8900V 910p 3A 9000V 920p 3A 9100V 930p 3A 9200V 940p 3A 9300V 950p 3A 9400V 960p 3A 9500V 970p 3A 9600V 980p 3A 9700V 990p 3A 9800V 1000p 3A									
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## Nimrod the Mighty Hunter

The latest addition to Britain's Airborne Early Warning (AEW) system was recently unveiled at a British Aerospace airfield 'somewhere' in Cheshire. The modified Nimrod aircraft is the first of a fleet of eleven ordered by the RAF.

The AEW radar system has been undergoing development

since 1977. Ground-based radar cannot see beyond the horizon. The airborne system carried by Nimrod can see further and, therefore, give earlier warning of approaching enemy aircraft.

Nose and tail radomes give the aircraft its odd bulbous appearance. The sophisticated avionics, designed by Marconi with electronic warfare in the crowded airways of Europe in mind, can detect ships and aircraft even against strong ground or sea 'noise' or deliberate jamming and can eliminate friendly craft. In ad-

dition to the active radar, there is a passive system, carried as sensors on each wing tip, to analyse and classify radiation received from targets.

Nimrod AEW has been designed to be fully compatible with other AEW systems, such as the American AWACS. Information can be transmitted from Nimrod AEW to the ground, ships, other aircraft or to virtually anywhere in the world via satellite link.

The first aircraft is due to make its first flight in August and enters service with the RAF in 1982.

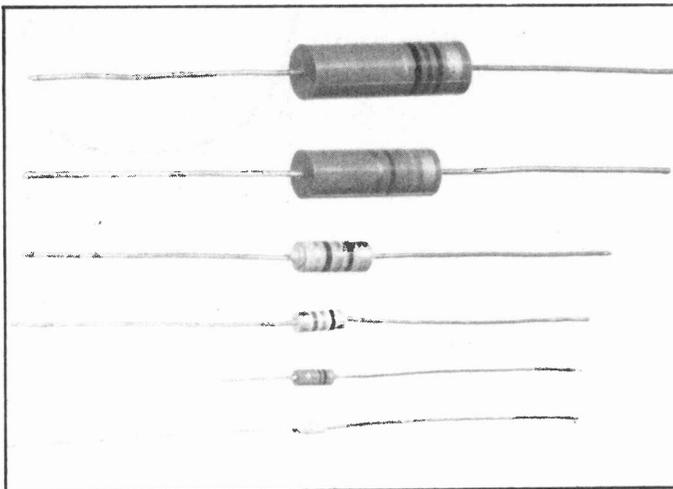
## Martian Gremlins

Hot news from our science correspondent on Mars — the Viking 2 Lander isn't a well space-craft at all. Its on-board battery is presenting a low profile: It's flat. There isn't sufficient charge to keep the transmitter going.

Viking Lander 2 now sits on the rusty planet at its landing site in Utopia Planitia, where the daytime temperature rarely gets above  $-115^{\circ}\text{C}$ . It has been working in that temperature since it landed there on September 3rd 1976.

## Circuit Handbook (June)

We missed a denominator out of the equation for  $E_0$  accompanying Fig.11 p.60. The first term of the equation should read  $(RA + RB)/RB$ . Also, on p.61, in the equation for  $E_{in}$  below Fig.12c, 'bandwidth' should not be squared. Therefore, two lines down, '20,000' should not be squared. In the design example the resistor noise effective resistor is  $RA/(RB + RC) \approx 1k\Omega$ . The thermal noise term is then derived from Fig.12b.



## Choked Up

Gone are the days when chokes looked like lumpy coils of wire. The new range of ultra miniature moulded RF chokes from RBS Capacitors look more akin to the common or garden carbon resistor.

The series 8 chokes have a body length of only 5 mm and a diameter of only 2 mm (free

magnifying glass with every order?). They come in values of 0.1  $\mu\text{H}$  to 10,000  $\mu\text{H}$  with minimum Q from 35 to 95.

These military spec components can tolerate up to 1000 V RMS and if you fancy fixing your private jet's radio with one, you can use it up of 70,000 feet. Ten percent tolerance is standard, but five percent is available.

For further information on the Series 8 chokes contact RBS Capacitors Ltd, Orchard Works, Vencourt Place, London W6.

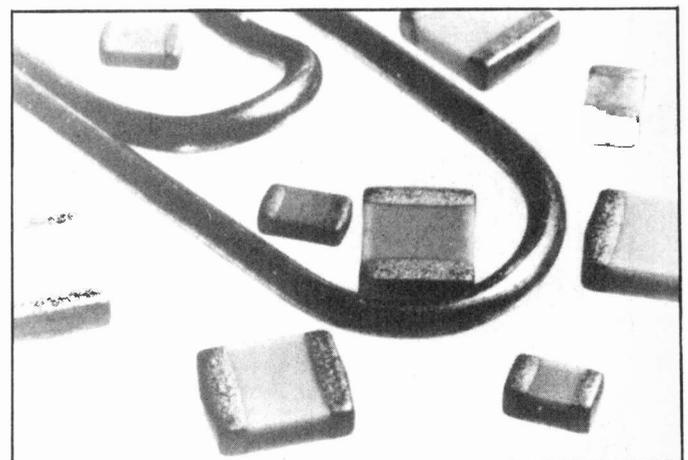
## Flat Caps

Looking a bit like microscopic liquorice all sorts, the new range of capacitors from Welwyn Electric are designed specifically for micro-microelectronic applications. The largest of the range is only 3 mm x 2.5 mm x 1.8 mm.

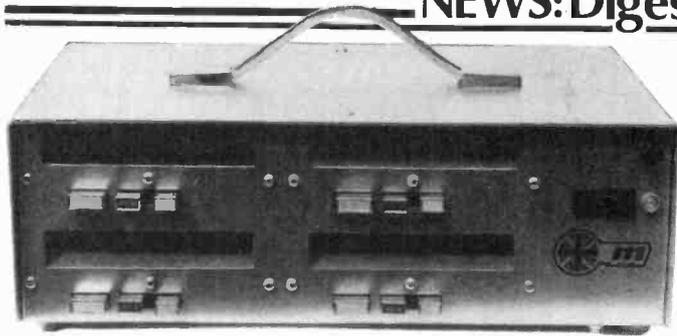
Initial production will cover values from 1 pF to 100 nF in two dielectrics. BX is suitable for most applications and NPO can be used where high temperature stability

is required. Three working voltages are available — 50 V, 100 V and 200 V. The components have no leads. They have palladium silver terminations for flat soldering onto a substrate or PCB.

For further information on the new range of small multilayer chip capacitors contact Welwyn Electric Ltd, Bedlington, Northumberland NE22 7AA.







## Cassette Copying

Foxebay have announced the introduction of the first portable machine capable of making three copies at a time. Despite its name, the 3-Kassette-Copier is British made. It costs less than all other two copies cassette copiers.

Foxebay's copier is compatible with both half track IEC and quarter track Japanese formats. It uses the compatible C-format

(erase tracks 3 & 4, record onto track 4). A Hi-Lo switch can compensate for over-recorded/distorted masters and the auto recording takes care of the rest.

There is also a portable seven cassette copying version, consisting of the three-cassette machine linked to a slave four-cassette unit.

The 3-Kassette-Copier (£398 plus VAT) and the 7-Kassette-Copier (£796 plus VAT) are available from Foxebay Ltd. 41/43 Charlbert Street, London NW8 6JN.

## Project 80

The Project 80 Modular Synthesiser is alive and well! A number of readers, who have already invested a great deal of time and money in Project 80 modules, are a little concerned that we do not feature a module in every issue.

The modular synthesiser was conceived as a series of projects, each of which was complete in itself. However, if you build all of them and put them in one box with a keyboard, you end up with a formidable synthesiser.

Occasionally we will miss amonth, but Project 80 will continue to the end of its natural life span.

## Inscrutable Japanese

JVC are holding their Third Tokyo Video Festival in December this year. In celebration of this they are holding a competition to judge video compositions from all over the world. The prize is an all expenses paid trip to Japan, a trophy and 300,000 yen (£699). So if you have a yen (ouch) to try for it, all you need is a video camera, recording on 1/2" or 3/4" tape in any format. The film should be no more than 20 minutes in length and black and white or colour programmes are equally acceptable.

## JVC Super Range

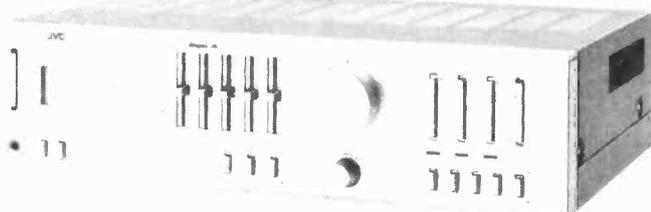
JVC have just revealed their new range of equipment, including three new turntables, four new amplifiers, four tuners, four receivers and five new metal tape cassette decks.

All four of the new AX series of amplifiers and two receivers incorporate what JVC describe as 'a remarkable innovation in amplifier design - the development of Super A amplification'. JVC claims that this combines low distortion and high efficiency. Well, we'll let you know what we think when we get one to play with.

Two of the new turntables

feature another JVC technical innovation, the Electro-Dynamic Servo Tonearm. The arm senses record eccentricity, warp, etc and compensates for their effects. Tracking force and anti-skating force can be adjusted electronically with no contact between the arm and other parts of the turntable.

The range of metal tape cassette decks includes a budget model selling for under £100. You can build up one of nine recommended, rack-mounting systems from the separates to suit your needs and your pocket.



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1BSWG — Mild steel — short face has slotted hole 6.5cm x 3.7cm long face has 3.7cm diam hole

0/NO: 1726 Height 15cm, length 15cm, width 10cm £0.06

0/NO: 1727 Height 25cm, length 15cm, width 10cm £0.07

### SWITCHES

Description	No.	Price
DPDT miniature slide	1973	£0.16
DPDT standard slide	1974	£0.17
Toggle switch SPST 1 1/2 amp 250V ac	1975	£0.38
Toggle switch DPDT 1 amp 250V ac	1976	£0.48
Rotary on-off mains switch	1977	£0.58
Push switch — Push to make	1978	£0.16
Push switch — Push to break	1979	£0.21

Description	No.	Price
Miniature SPST toggle 2 amp 250V ac	1958	£0.81
Miniature SPST toggle 2 amp 250V ac	1959	£0.86
Miniature DPDT toggle 2 amp 250V ac	1960	£0.92
Miniature DPDT toggle centre off 2 amp 250V ac	1961	£1.09
Push-button SPST 2 amp 250V ac	1962	£1.04
Push-button SPST 2 amp 250V ac	1963	£1.09
Push-button DPDT 2 amp 250V ac	1964	£1.38

**MIDGET WAFER SWITCHES**

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

Description	No.	Price
1 pole 12 way	1965	£0.55
2 pole 6 way	1966	£0.55
3 pole 4 way	1967	£0.55
4 pole 3 way	1968	£0.55

Description	No.	Price
Plastic button gives simple 1 pole change over action Rating 10 amp 250V ac	1970	£0.29

### ANTEX IRONS

1943	15 watt iron element ceramic fitted with 3/32" bit	£5.12
1947	Replacement element for 1943 iron	£2.33
1944	Iron coated bit 3/32" for 1943 iron	£0.58
1945	Iron coated bit 1/16" for 1943 iron	£0.58
1948	General purpose 18 watt iron fitted with iron coated bit	£5.12
1952	Replacement element for 1948 iron	£2.22
1949	Iron coated bit 3/32" for 1948 iron	£0.58
1951	Iron coated bit 1/16" for 1948 iron	£0.58
1951	Iron coated bit 3/16" for 1948 iron	£0.58
1931	Highly popular x 25 25 watt quality iron ceramic shafts to provide near perfect insulation breakdown voltage of 1500 volts AC and a leakage current of only 3.5uA and another shaft of stainless steel to ensure strength	£2.00
1935	Replacement element for 1931 iron	£0.58
1932	Iron coated bit 1/16" for 1931 iron	£0.58
1933	Iron coated bit 3/32" for 1931 iron	£0.58
1934	Iron coated bit 1/16" for 1931 iron	£0.58
1953	SK1 kit contains 15 watt iron with a 3/16" bit plus two spare solder, heat-sink and a booklet "How to solder", in presentation display box	£7.28

### VEROBOARD

2201	2.5"x5" .1 Copper	£0.71	2211	2.5"x2.5" .15 Copper	£0.63
2202	2.5"x3.75" .1 Copper	£0.81	2212	3.75"x1.75" .15 Copper	£2.38
2203	2.5"x1.1" .1 Copper	£2.14	2213	3.75"x5" .15 Copper	£0.90
2205	3.75"x3.75" .1 Copper	£0.71	2217	3.75"x1.75" .1 Plain	£1.79
2206	3.75"x1.75" .1 Copper	£2.76	2218	1.75"x2.5" .1 Plain	£0.44
2207	4.75"x1.75" .1 Copper	£3.61	2219	5"x3.75" .1 Plain	£0.68
2208	2.5"x1" .5 in jack	£0.85	2223	2.5"x3.75" .15 Plain	£0.37
2204	3.75"x5" .1 Copper	£0.79	2225	5"x3.75" .15 Plain	£0.56
2210	2.5"x5" .15 Copper	£0.64			

### BIB HI-FI ACCESSORIES

806	J Compact tape head cleaning kit	£1.22
810	23 Tape Editing kit	£2.65
811	24 Cassette Tape editing and joining kit	£2.76
813	29A Salvage cassette	£0.51
814	31 Cassette Head cleaning tape	£0.71
817	36A Record & Stylus cleaning kit	£0.46
818	41 Groove Kartidge tape head cleaner	£1.24
819	42 Groove Kleen auto metal record cleaner	£2.65
826	52A Cassette storage tray (holds 10)	£0.92
827	53 Hi-Fi stereo test cassette	£3.17
829	60 Chrome finish Groove Kleen (plastic)	£2.12
834	69 Anti-static Hi-Fi cleaning liquid	£0.35
838	78 Cassette hand tape winder	£1.50

### WIRE CONNECTORS

Entirely new range of connectors for Discrete wire. Uniquely designed Wirepost is soldered to the P.C. Board. A pre-stripped wire is inserted into the connector and easily locked by pressing the housing down. The wire is alternatively removed by lifting the housing. Tin alloy plated contacts ensure good as gold performance.

Housing consists of Thermo plastic polyester.		
1728	Single connector in red/black or white	£0.12 inc. VAT
1729	Threeway connector black ONLY	£0.23 inc. VAT
1730	Fourway connector black ONLY	£0.28 inc. VAT

### FUSE HOLDERS AND FUSES

Description	No.	Price
20mm x 5mm chassis mounting	506	£0.18
1 1/2" x 1/2" x 1/2" chassis mounting	507	£0.14
1 1/4" car in-line type	508	£0.18
Panel mounting 20mm	509	£0.23
Panel mounting 1 1/4"	510	£0.37

QUICK BLOW 20mm					
Type	No.	Type	No.	Type	No.
150mA	611	7p	1A	615	6p
250mA	612	6p	1.5A	616	7p
500mA	613	6p	2A	617	6p
800mA	614	8p	2.5A	618	7p

ANTI-SURGE 20mm					
Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2.5A	628
250mA	623	2A	626	3.15A	629
500mA	624	1.6A	627	5A	630

QUICK-BLOW 1 1/4"					
Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

NUTS AND BOLTS					
BA BOLTS — packs of BA threaded cadmium plated screws slotted cheese head Supplied in multiples of 50					
Type	No.	Price	Type	No.	Price
1/4" OBA	839	£1.38	1/2" OBA	846	£0.37
1/2" OBA	840	£0.86	3/4" OBA	847	£0.29
1" OBA	842	£0.75	1 1/4" OBA	848	£0.46
1/2" 2BA	843	£0.52	1/2" 6BA	849	£0.24
1/4" 2BA	844	£0.60	1/4" 6BA	850	£0.29
1" 4BA	845	£0.51			

BA NUTS — packs of cadmium plated full nuts in multiples of 50					
Type	No.	Price	Type	No.	Price
08A	855	£0.83	48A	857	£0.35
28A	856	£0.55	68A	858	£0.28

BA WASHERS — flat cadmium plated plain stamped washers supplied in multiples of 50					
Type	No.	Price	Type	No.	Price
08A	859	£0.16	48A	861	£0.14
28A	860	£0.14	68A	862	£0.14

SOLDER TAGS — Hot linned supplied in multiples of 50					
Type	No.	Price	Type	No.	Price
08A	851	£0.46	48A	853	£0.25
28A	852	£0.32	68A	854	£0.25

### AUDIO LEADS

No.	Type	Price
107	FM Indoor Ribbon Aerial	£0.69
113	3.5mm Jack plug to 3.5mm Jack plug. Length 1.5m	£0.86
114	5 pin DIN plug to 3.5mm Jack connected to pins 3 & 5. Length 1.5m	£0.98
115	5 pin DIN plug to 3.5mm Jack connected to pins 1 & 4. Length 1.5m	£0.98
116	Car aerial extension Screened insulated lead. Fitted plug and socket	£1.44
117	AC mains connecting lead for cassette recorders and radios. 2 metres	£0.78
118	5 pin DIN phono plug to stereo headphone Jack socket	£1.21
119	2+2 pin DIN plugs to stereo Jack socket with attenuation network for stereo headphones. Length 0.2m	£1.04
120	Car stereo connector. Variable geometry plug to fit most car cassettes. 8 track cartridge and combination units. Supplied with inlined fuse power lead and instructions	£0.89
123	6.6m Coded Guitar Lead Mono Jack plug to Mono Jack plug. Black	£1.73
124	3 pin DIN plug to 3 pin DIN plug. Length 1.5m	£0.86
125	5 pin DIN plug to 5 pin DIN plug. Length 1.5m	£0.86
126	5 pin DIN plug to Tinned open end. Length 1.5m	£0.86
127	5 pin DIN plug to 4 Phono Plugs. All colour coded. Length 1.5m	£1.50
128	5 pin DIN plug to 5 pin DIN socket. Length 1.5m	£0.92
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m	£1.21
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	£0.78
131	5 pin DIN plug to 3 pin DIN plug 1 & 4 and 3 & 5. Length 1.5m	£0.95
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£1.13
133	5 pin DIN plug to 2 Phono plugs. Connected pins 3 & 5. Length 1.5m	£0.86
134	5 pin DIN plug to 2 Phono sockets. Connected pins 3 & 5. Length 23cm	£0.78
135	5 pin DIN socket to 2 Phono plugs. Connected pins 3 & 5. Length 23cm	£0.78
136	Coded stereo headphone extension lead. Black. Length 6m	£2.01
178	AC mains lead for calculators. etc.	£0.52

### TRANSFORMERS

MINIATURE MAINS Primary 240V			
No.	Type	Price	
2021	6V-0-6V 100mA	£1.04	
2022	9V-0-9V 75mA	£1.04	
2023	12V-0-12V 100mA	£1.29	

MINIATURE MAINS Primary 240V with two independent secondary windings			
No.	Type	Price	
2024	MT780-0-6V 0-6V RMS	£1.84	
2025	MT150-0-12V 0-12V RMS	£1.84	

1 AMP MAINS Primary 240V			
No.	Type	Price	
2026	6V-0-6V 1 amp	£2.88	P & P 45p
2027	9V-0-9V 1 amp	£2.30	P & P 45p
2028	12V-0-12V 1 amp	£2.99	P & P 55p
2029	15V-0-15V 1 amp	£3.16	P & P 66p
2030	30V-0-30V 1 amp	£3.97	P & P 86p

**STANDARD MAINS Primary 240V**

Multi-tapped secondary mains transformers available in 1/2 amp, 1 amp and 2 amp current rating. Secondary taps are 0.1-9.25-33.40-50V. Voltages available by use of taps. 7.8, 10, 14, 15, 19, 25, 31, 33, 40, 25-0-25V.

No.	Rating	Price	
2031	1/2 amp	£3.91	P & P 86p
2032	1 amp	£5.06	P & P 86p
2033	2 amp	£6.27	P & P £1

2035 240V Primary 0-55V @ 2A Secondary

**SPECIAL OFFER**

2042 240V Primary 0-20V @ 2A Secondary. By removing 5 turns for each volt from the secondary winding any voltage up to 20V @ 2A is easily obtainable. Ideal for the experimenter.

£1.50 P & P 86p

### CASES AND BOXES

INSTRUMENT CASES. In two sections, vinyl covered top and aluminium bottom, front and back					
No.	Length	Width	Height	Price	
155	8in	5 1/2in	2in	£1.73	
156					

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# ETI NEXT MONTH

ON SALE JULY 4th

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## 100W MOSFET Amplifier

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Yet another in the long line of top line audio projects from ETI. Next month we give you a 100 + 100W power amp with bargraph output display, separate PSUs for each channel and a brilliant sound that puts this unit at the very top end of audio today. You will find it costs a lot less than you think to build, too.

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## Electromagnetic Pulse Effect.

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Never heard of it eh? Most people haven't — yet EMP could be the deciding factor in a nations fight for survival during nuclear attack. With the international situation steadily worsening around us, the facts ETI has turned up about Britain's susceptibility to EMP are very, very disturbing and make mandatory reading for anyone concerned with keeping civilisation alive in the age of the Bomb!

As an indication of the situation, did you know that in 1958 a small warhead test in the Johnstone Islands produced power systems failure in Hawaii, **SOME 1000 KM FROM THE EXPLOSION**, due to EMP? (The British Isles are approx. 800 km in length).

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## Video Today — And Tomorrow

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Next month ETI takes a detailed look at the expanding world of home video and offers a buyers guide to inform the intending purchaser. In addition we have a look at the next 12 months from Richard Dean (editor — TV and Home Video) — probably the leading writer in the field today.

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## Circuits Appetiser

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How many times have you glanced at book titles all neatly aligned on a shelf and wondered just how interesting they *really* are? Well, as of next month maybe we can help. "110 Timer Circuits for the Home Constructor" has just been released by Newnes and ETI is publishing a chapter from it next month. Circuits galore and full details of this very nifty little volume. It is hoped that more books will receive this treatment in the future.

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## Projects, Projects, Projects, Projects.

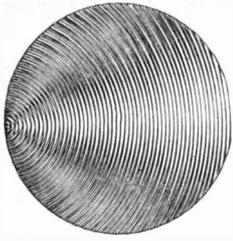
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In addition to that truly amazing MOSFET AMPLIFIER we have a further four constructional projects for you next month. There is an excellent VCA module which fits in with Project 80 if you're following it. Also we give full details of an ULTRASONIC BURGLAR ALARM which could ensure that any visitors you get are at least invited. Two test gear "quickness" are featured in the shape of a LINEAR CAPACITANCE METER with good accuracy and easy construction and a very versatile LOGIC PROBE to allow you to hunt out those missing bits.

With all this how can you possibly *not* buy ETI next month?

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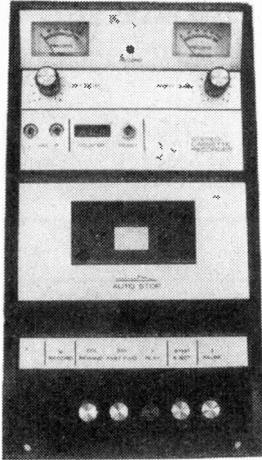
Articles mentioned herein are in an advanced state of preparation, however, circumstances may dictate changes to the final contents.



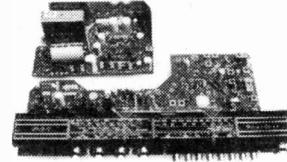
# B.K. ELECTRONICS

## A SOUND CHOICE

★ PROMPT DELIVERY ★ PRICES INCLUDE V.A.T. ★ AMPLE STOCKS  
A PERSONAL SERVICE FROM A SMALL EXPANDING COMPANY



**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 — 11 1/2in x 6 1/2in. Mechanism fits through a cut out 5 1/4in x 10 1/2in. Clearance required under top panel 2 1/4in. Supplied complete with circuit diagram etc. **Price £30.50** plus £2.50 postage and packing.



**GEC AM/FM STEREO TUNER AMPLIFIER CHASSIS.** Originally designed for installation into a music centre. Supplied as two separate built and tested units which are easily wired together. **Note:** Circuit diagram and interconnecting wiring diagrams supplied. **Rotary Controls:** Tuning, on/off volume, balance, treble, bass. **Push-button controls:** Mono, Tape, Disc., AFC, FM (VHF), LW, MW, SW. **Power Output:** 7 watts RMS per channel, at better than 2% THD into 8 ohms. 10 watts speech and music. **Frequency Response:** 60Hz-20kHz within ±3dB.

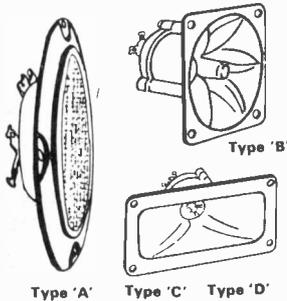
**Tape Sensitivity:** Output — typically 150 mV. Input — 300 mV for rated output. **Disc Sensitivity:** 100mV (ceramic cartridge). **Radio:** FM (VHF), 87.5MHz — 108MHz. Long wave 145kHz — 108kHz. Medium wave. 520kHz — 1620kHz. Short wave. 5.8MHz — 16MHz. **Size:** Tuner — 2 3/4in x 15in x 7 1/2 in approx. Power amplifier — 2in x 7 1/2in x 4 1/2in 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.



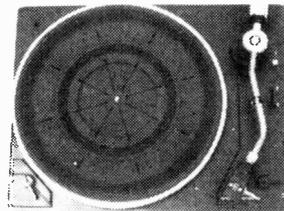
**SCOTT AM/FM STEREO TUNER MODEL 516.** This Scott tuner is one of the top American makes and is offered at a very realistic price. **Features:** ★ FM tuning range 87.5 to 108 MZ ★ AM tuning range 535 to 1605 kHz ★ Usable FM sensitivity 6.2dBf 2.2µV ★ 300 ohm & 75 ohm Aerial inputs for FM ★ Signal strength tuning meter ★ Stereo beacon indicator ★ Ferrite aerial for AM ★ Mute switch. **Size:** Height 5in, Width 14 1/2in, Depth 12in. Silver front panel. Black body. Modern stacking format. **Price £40.50** plus £2.50 postage and packing.

### PIEZO ELECTRIC TWEETERS — MOTOROLA

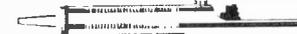
Join the Piezo revolution. The low dynamic mass (no voice coil) of a Piezo tweeter produces an improved transient response with a lower distortion level than ordinary dynamic tweeters. As a crossover is not required these units can be added to existing speaker systems of up to 100 watts (more if 2 put in series).



**Type 'A'** 3in round with removable wire mesh. Ideal for bookshelf hi-fi speakers. **Price £3.80 each.**  
**Type 'B'** 3 1/2in super horn. For general purpose speakers disco and PA systems, etc. **Price £4.80 each.**  
**Type 'C'** 2in x 5in wide dispersion horn. For hi-fi systems and quality disco etc. **Price £6.20 each.**  
**Type 'D'** 2in x 6in wide dispersion horn. Frequency response extending down to mid-range (2000 c/s) suitable for hi-fi systems and quality disco. **Price £9 each.**  
Post and Packing, all types, 15p each (or SAE for Piezo leaflets).



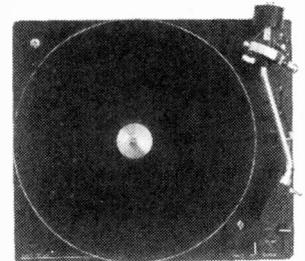
### DE-SOLDERING PUMP



**JVC TURNTABLE.** JVC Turntable supplied complete with an Audio Technica AT10 stereo magnetic cartridge.  
★ 'S' shaped tone arm.  
★ Belt driven.  
★ Full size 12in platter.  
★ Precision calibrated counterbalance weight (0.3 grms.)  
★ Anti-skate (bias) device. Nylon thread weight.  
★ Damped cueing lever.  
★ 240V AC operation, (50Hz).  
★ Cut-out template supplied.  
**Size** — 12 3/4in x 15 3/4in (approx).  
**Price £29** plus £2.50 postage and packing.

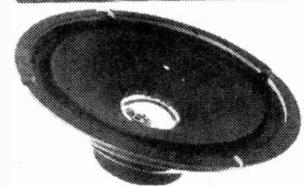
This de-soldering pump made to a very exacting specification is ideal for the removal of small components from printed circuit boards, etc. Comes complete with spare PTFE tip. **£5.30** post free.

**BSR P163 BELT DRIVE TURNTABLE.** This famous B.S.R. turntable is ideal for disco/hi-fi use and is offered at a special price of **£22** plus £2.50 postage and packing. Suitable stereo magnetic cartridge type TTC/J2203. **Price £4** post free. (Also available separately.)



### LOUDSPEAKER

High quality full range 8" loudspeaker. 10 watts RMS. 8OHM. Rolled surround with aluminium centre dome. **Price £3.50 each** + 75p Postage and Packing.



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# FILTER DESIGN

Following up his supplementary efforts last month, Tim Orr tackles the subject of Active Filters in the same explanatory manner.

The frequency response plot of a first order low pass filter (Fig.1) reveals several important features. The break frequency  $F_c$ , is defined as the point at which the output signal is attenuated by 3 dB. The curve then approximates to a -6 dB/octave roll off slope. By using a straight line approximation it is easy to calculate attenuations caused by the filter. For example, an 8 kHz sinewave filtered by a 1 kHz first order lowpass filter will be attenuated 18 dB, a reduction in level of almost one tenth. The calculation is simple; 8 kHz is 3 octaves above 1 kHz. The filter attenuates at 6 dB per octave, therefore the final attenuation is  $3 \times 6 = 18$  dB.

To increase the roll off slope, the filter order must be increased, figure 2. When constructing high order filters, it is necessary to assemble them out of smaller filter sections each having different Q factors. A high order filter constructed from sections all having the same Q factor will have a very 'unabrupt' frequency response curve, which is generally not what is required.

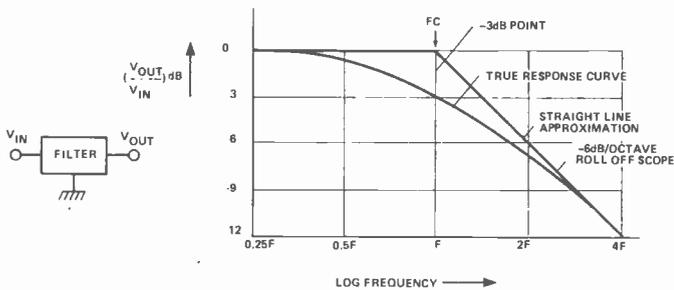


Fig.1. Frequency response of a first order low pass filter.

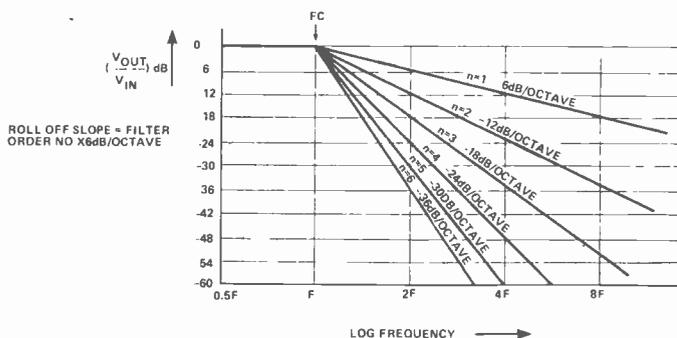


Fig.2. Filter roll-off slopes. As n increases so does the roll-off.

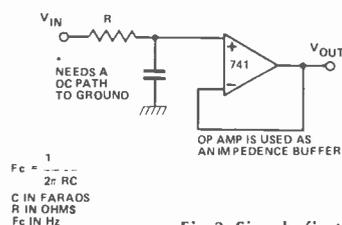


Fig.3. Simple first order low pass filter.

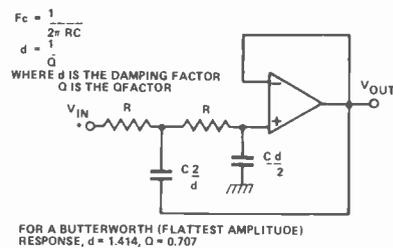


Fig.4. Second order unity gain Sallen and Key low pass filter.

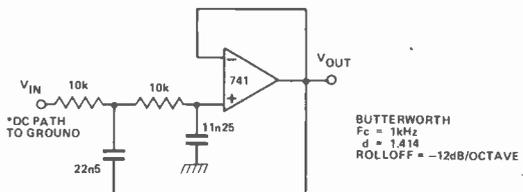


Fig.5a. Second order low pass filter, 1 kHz.

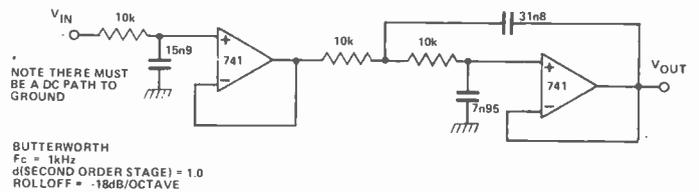


Fig.5b. Third order low pass filter, 1 kHz.

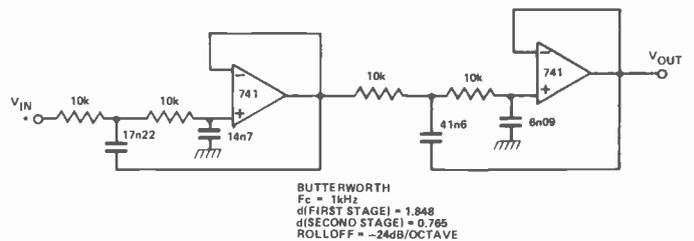


Fig.5c. Fourth order low pass filter, 1 kHz.

A simple first order filter (Fig.3) merely requires a resistor, a capacitor and a voltage follower. A second order filter (Fig.4) requires two RC networks. This circuit has a 'flattest amplitude' response (when it has a Q of 0.7) and is often referred to as a Butterworth response. The response may be modified by altering the Q factor, but in all the following examples a Butterworth response has been chosen. This design is known as a 'unity gain Sallen and Key' filter. The Q factor is determined by the ratio of the two timing capacitors. This often leads to a circuit design which employs non-preferred capacitor values as can be seen in the three filters by a process known as scaling. For instance, if the required break frequency is 5 kHz, then the resistors, or the capacitors in the filter should be reduced by a factor of five. If say the filter in figure 5a had to be redesigned to operate at 250 Hz,

then the required component changes would be to change the 10k resistors to 40k. Active filters generally employ op amps and so care should be taken so as not to operate them near to their bandwidth limit, which would cause the filter response to be degraded. A 741, for instance, should not be used for frequencies above 50 kHz.

Figure 6 shows the effect of varying Q in a low pass filter. Generally, the response that is wanted is the 'flattest amplitude' curve. A fourth order filter (Fig.5c) is constructed from a low Q and high Q filter. The overall response of this filter is seen in figure 7. Note that the flattest amplitude curve (A) is made up out of the product of curves B and C. The peak in the high Q curve (C) is flattened out by the droop of the low Q curve (B).

The problem of having different and unpreferred capacitor values is greatly reduced by using an 'equal component' design, figure 8a,b,c. The Q factors are controlled by the gain of the op amp and so the capacitor values are all the same. Note that these filters provide a voltage gain which is in fact

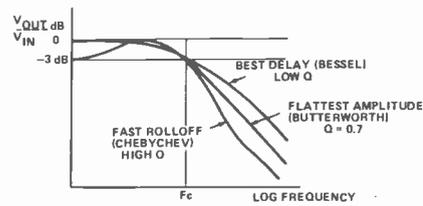


Fig.6. Frequency response versus Q factor.

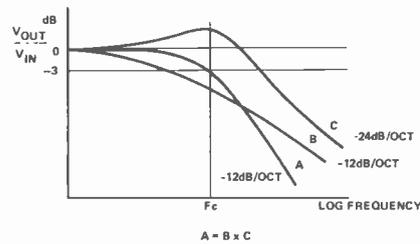


Fig.7. Combining high and low Q factors.

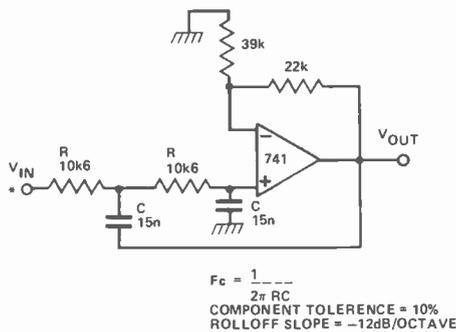


Fig.8a. Second order low pass filter, 1 kHz.

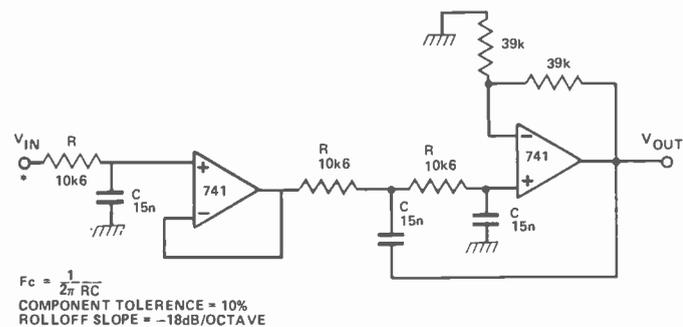


Fig.8b. Third order low pass filter, 1 kHz.

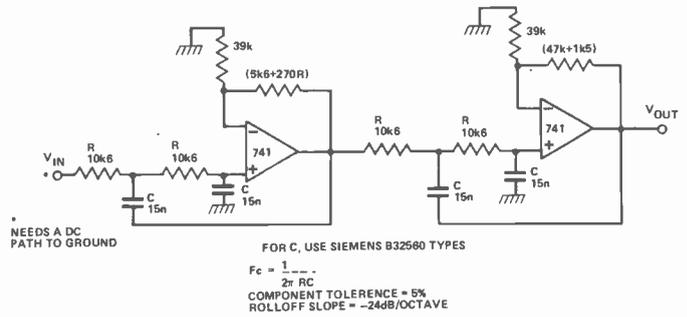


Fig.8c. Fourth order low pass filter, 1 kHz.

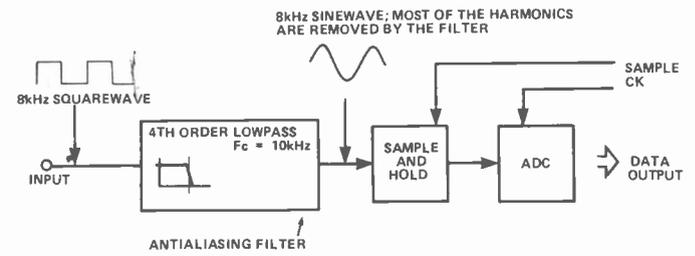


Fig.9. Use of a low pass filter in an ADC system.

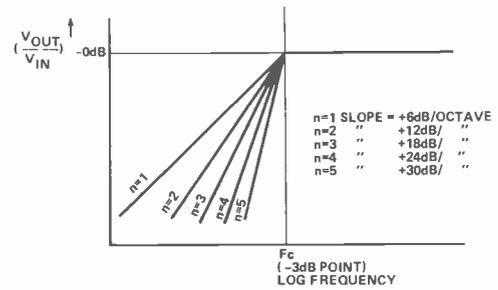


Fig.10. Frequency response of different orders of high pass filter.

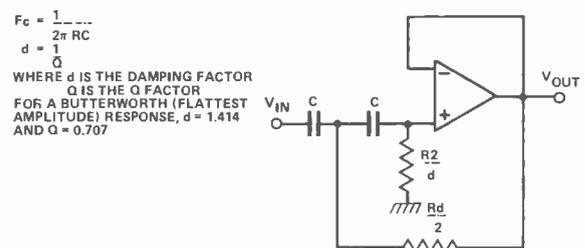


Fig.11. Unity gain Sallen and Key high pass filter.

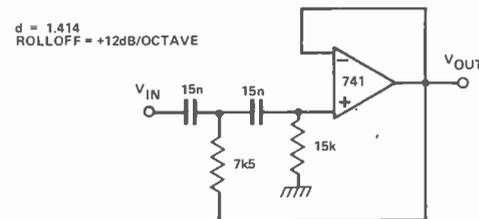


Fig.12a. Second order Butterworth 1 kHz high pass filter.

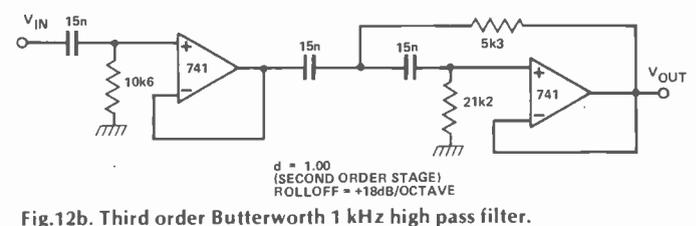


Fig.12b. Third order Butterworth 1 kHz high pass filter.

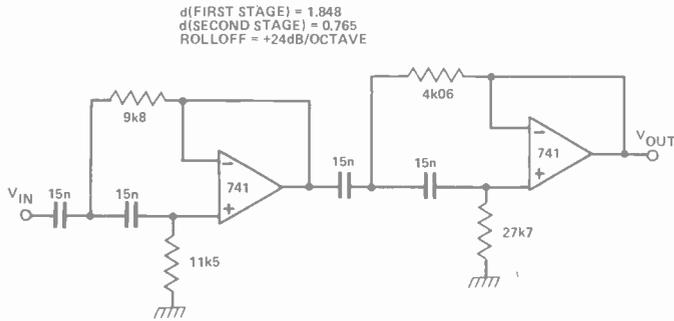


Fig.12c. Fourth order Butterworth 1 kHz high pass filter.

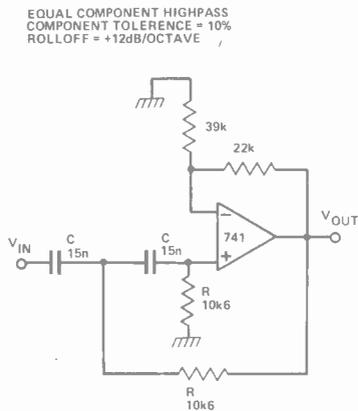


Fig.13a. Second order Butterworth 1 kHz high pass filter.

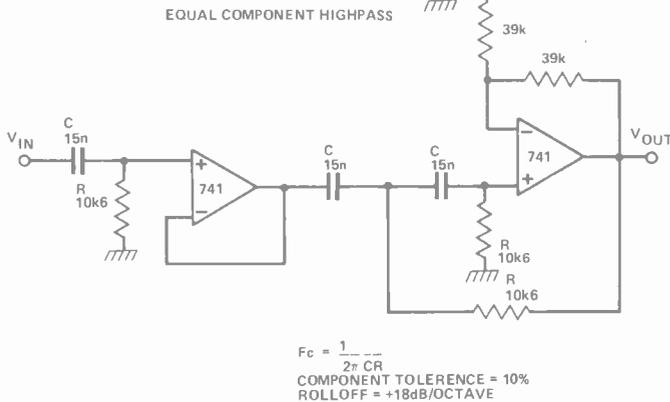


Fig.13b. Third order Butterworth 1 kHz high pass filter.

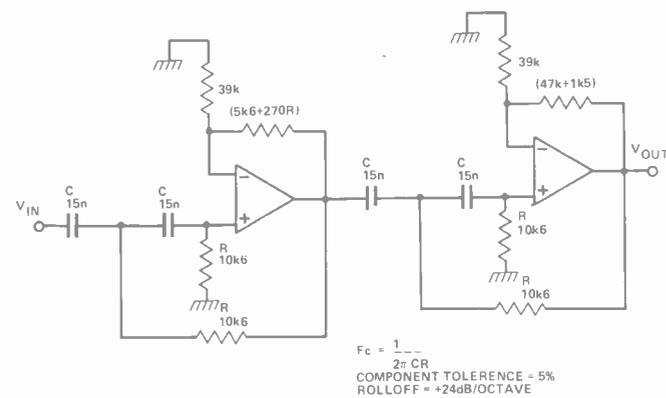
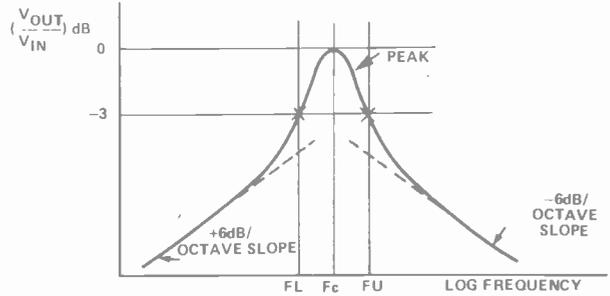


Fig.13c. Fourth order Butterworth 1 kHz high pass filter.



FC = CENTRE FREQUENCY  
FU = UPPER -3dB POINT  
FL = LOWER -3dB POINT

$FU - FL = \text{BANDWIDTH (FBW)}$   
 $Q = \frac{FC}{\text{FBW}}$

Fig.14. Band pass response (single pole).

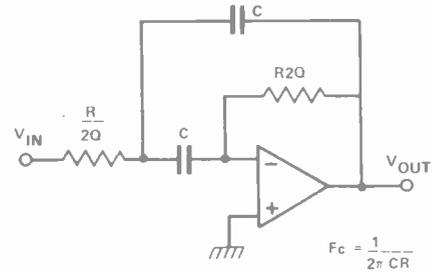
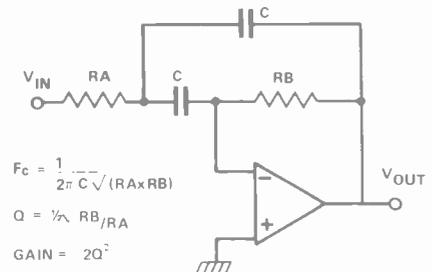


Fig.15. Single pole multiple feedback band pass filter.



C	RA	RB	Fc	Q	GAIN
15n	10k6	10k6	1kHz	0.5	x 0.5
15n	5k305	21k22	1kHz	1.0	x 2.0
15n	2k652	42k44	1kHz	2.0	x 8.0
15n	1k326	84k88	1kHz	4.0	x32.0

Fig.16. Multiple feedback filter selection chart.

the product of the DC gains of each amplifier. Frequency scaling can be performed by modifying the R and/or the C components. Capacitors generally are available in E6 or E12 values, whereas resistors can be obtained in the E24 series, and so it is usually much easier to scale the R components, keeping them within the range 1k to 100k. Low pass filters find many uses in audio processing and are often used in data acquisition systems (Fig.9). The high pass filter (Fig.10) is exactly complementary in operation to the low pass device. The unity gain Sallen and Key structure is seen in figure 11 with calculated values for second, third and fourth order filters in figure 12a,b,c. Also there are calculated values for 'equal component' realizations in figure 13a,b,c.

The band pass response is defined in figure 14. This can be realized with a single op amp circuit, the multiple feedback band pass filter, figure 15. Calculated values are seen in the chart of figure 16. The maximum Q should be kept below a

value of 20 at 1 kHz, otherwise the filter may become unstable and oscillate. Frequency scaling may be performed by multiplying the R or the C components with a constant. High Q, high frequency operation is not possible with this design because the op amp runs out of bandwidth.

The state variable filter (Fig.17) overcomes this problem by using the bandwidth of three op amps. Q factors of several hundred at 1 kHz are obtainable with this circuit. It also produces four outputs; high, low, band pass and notch, making it a very versatile design. The frequency may be scaled by altering the R or the C components and also the Q factor is separately programmable and is invariant with frequency. The all pass filter (Fig.18) has a flat frequency response, which in

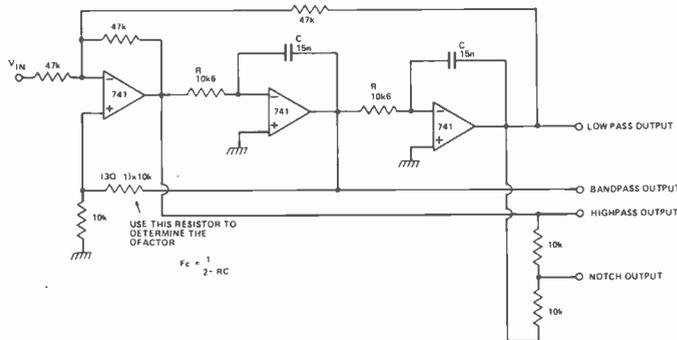
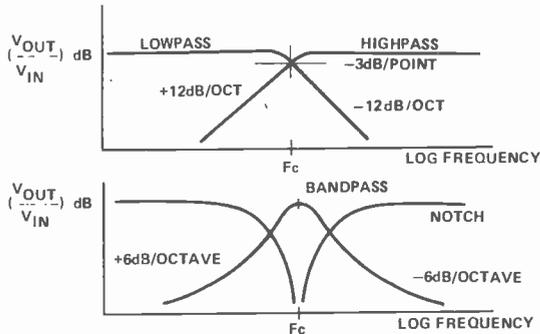


Fig.17. State variable filter.

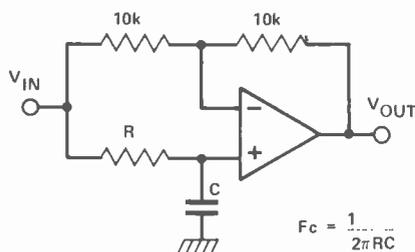
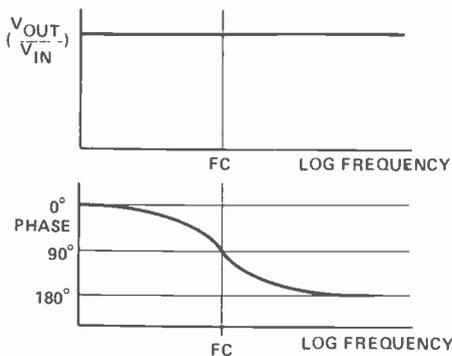


Fig.18. All pass filter.

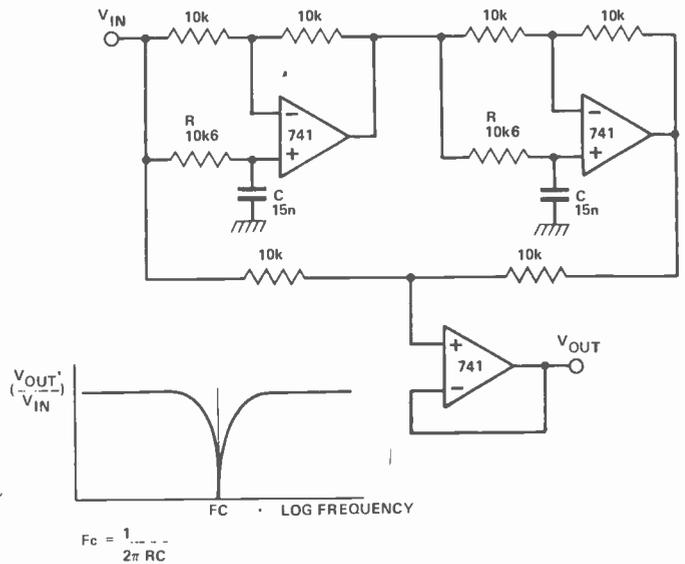


Fig.19. Notch filter using all pass sections.

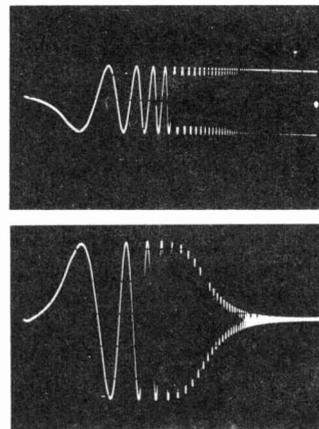
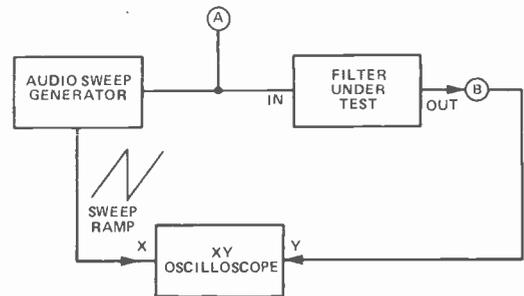


Fig.20. Testing filter design with an oscilloscope. 'Scope traces from points A and B are shown left (A above, B below).

itself is of no use at all. However, it does suffer a 180° phase shift as a function of frequency. By cascading two stages (Fig.19) it is possible to obtain a 180° phase shift at the frequency Fc. This phase shifted signal when mixed with the original will give a notch response due to the cancellation of the two signals.

Testing active filters is very easy if you have a swept sine wave generator and an XY oscilloscope (Fig.20). The frequency response appears as a linear amplitude versus log frequency display. It is generally possible to sweep five times a second, which gives an almost continuous display and allows you to see immediately the effect of any changes that you make to the filter.

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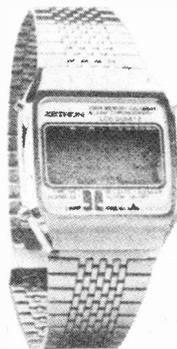
Brand new 1980 style. Basic working modes of chronograph. 24-hour alarm and dual time zone. Constant display of hours, mins, secs and weekday indication with am/pm, T2 and A1 flags. Date indication. The chrono runs to 1/10th sec, with the 1/10th's running along the bottom of the watch. It has a twelve hour capacity. The 24-hour alarm system is actuated for a full 60 seconds. Dual timing facilities give the watch the added touch of compactness. Back-light, closely woven adjustable stainless steel strap.



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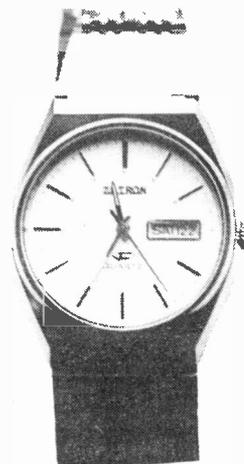
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The chronograph has a 12-hour capacity and runs at 1/10's. Split and lap mode facilities are available.

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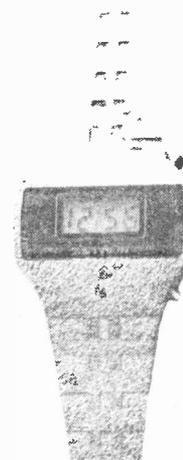
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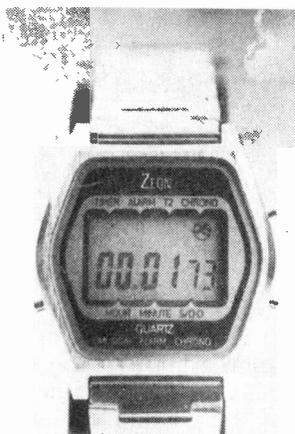
(2) Countdown Alarm: Presetable to 24 hours, with the musical tune playing for 1 minute. (3) Ordinary alarm which can be set within a 24-hour period and lasting for 60 seconds.

(4) Dual timing facilities.

(5) Chronograph: This runs to a 1/100s. Freeze and split and lap mode facilities are standard.

This watch is finished in 3 micron gold and comes with a closed strap.

Back Light.



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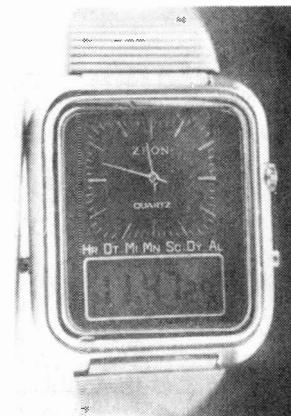
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The alarm can be set to any time within a 24-hour period and is actuated for a full 60 seconds.

The chrono runs to a 1/10th Sec. with a maximum capacity of 24 hours. Lap Time and Freeze Facilities are available.

Dual timing facilities are readily available.

Back Light. Fully adjustable stainless-steel strap.

This watch is available in gold or silver.

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## GENT'S MELODY MULTI-CHIME ALARM CHRONO

Latest technology! Constant display of hours, mins and secs, week-day, date and month with mode and chime indication display. The musical alarm once actuated plays the tune "Oh Suzanna". Two further alarm systems are incorporated in this outstanding watch: (i) 24-hour alarm, (ii) count-down alarm. The watch can be set to chime on every full hour. A 1/100th sec chrono is standard to the watch. Can be switched off. Mineral glass face. The watch also has a battery hatch backlight and infinitely adjustable stainless steel strap.



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# A HISTORY OF SPACECRAFT

Ian Graham takes a well illustrated look at Spacecraft past and present and discovers just how far we've come in the twenty three since Sputnik.

**O**n April 12th 1961, a charred ball weighing over 10,000 lbs lay in a field near the village of Smelovka. Inside lay Yuri Gagarin, the first man to orbit the Earth and begin Man's adventure in space. Gagarin's flight marked the culmination of a research programme going right back to the first artificial satellite, Sputnik 1. Less than a month after Sputnik 1 proved the orbital equations correct, Sputnik 2 carried the first live passenger into orbit (apart from stowaway bacteria on-board Sputnik 1). The first 'cosmonaut' was a dog called Laika.

America boldly went where only one man had gone before, when, barely a month after Gagarin, Alan Shepard made a fifteen minutes sub-orbital hop to a height of 116 miles. In February 1962 a silver-suited John Glenn wedged himself into the cramped confines of his Mercury 6 capsule and made the first three orbits of the American experience in space. By then, however, Russia had established a commanding lead. Herman Titov had already spent more than a day orbiting the Earth in Vostok 2. The list of Russian firsts continued — first double flight, first woman in space, first three-man craft, first space-walk, etc. The six Vostok flights (from April 1961 to June 1963) made 259 orbits, in comparison with a grand total of 34 orbits for the six Mercury flights from May 1961 to May 1963.

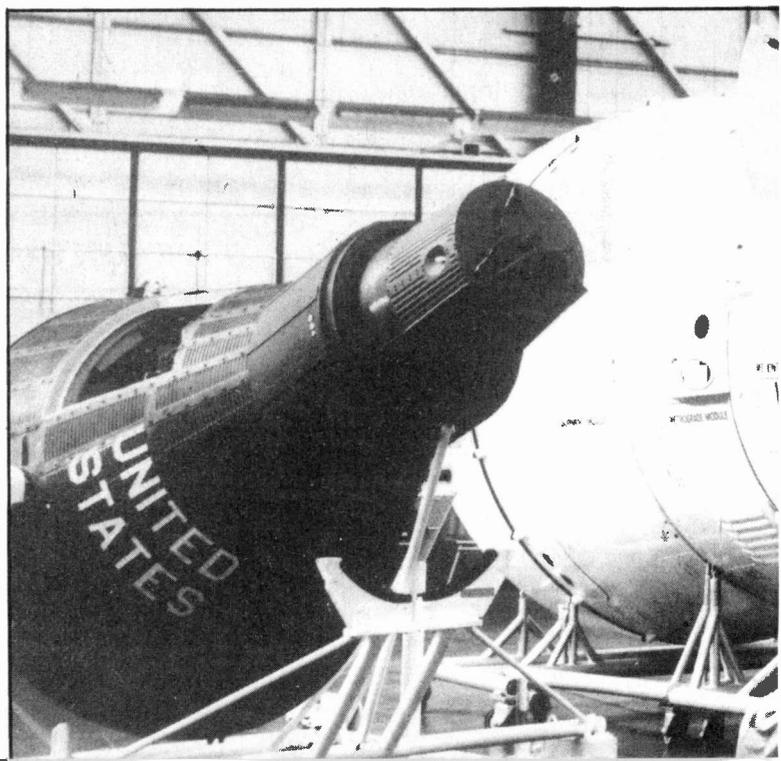
## Human Satellite

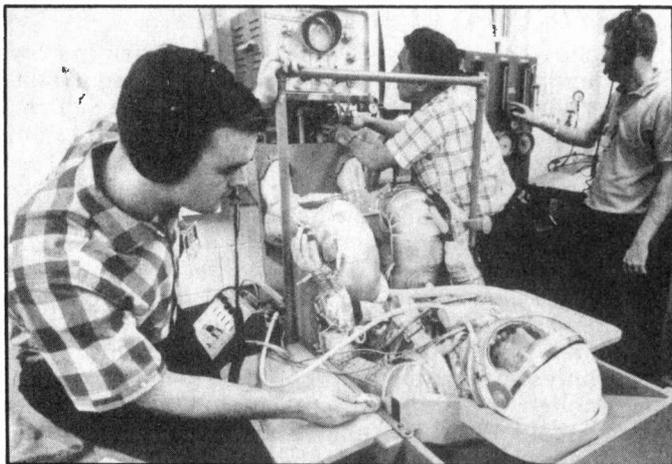
Gemini gave astronauts invaluable experience in long duration flight and the rendezvous and docking manoeuvres necessary for an Apollo-type moon mission and for future space station operations. In less than two years there were a staggering ten Gemini flights. In the same time Russia flew only one mission — Voshkod 2. (Voshkod 1 was the first three man spacecraft. It flew four years before the first Apollo. Voshkod 2 carried a crew of only two). It achieved yet another first for Russia — Alexei Leonov's space-walk. It was the first time a man had left his craft and orbited the Earth as a human satellite, albeit still tethered to his craft. Three months later Ed White spent 21 minutes outside his Gemini 4 spacecraft for America's first space-walk.

Gemini 3 carried the first computer into space. Although it was glossed over at the time, largely overshadowed by the impact of Leonov's space-walk, it was an important development in manned spaceflight. The astronaut was no longer a passenger carrying out predetermined routines or commands from the ground.

He could make independent decisions on, for example, course corrections based on information on position, thrust, etc from his on-board computer. In addition, whereas most of the Mercury systems were carried inside the pressurised compartment with the astronaut, many of the Gemini systems were removed to a separate instrument module. The astronaut benefited by gaining a more spacious cabin and the system became more flexible, allowing the astronaut to work outside the craft on any defective instrument. Gemini 5, an eight day flight, proved that men could work in space without any adverse effects for the duration of a moon-landing mission.

Rendezvous and docking manoeuvres were practiced between two manned Gemini craft and between Gemini and the unmanned Lockheed Agena target vehicle. Gemini 6 should have rendezvoused with an Agena but when the Agena failed it used Gemini 7 instead. The craft manoeuvred to within 2m of each other. Gemini 8 achieved the first docking, but the operation nearly ended in disaster. Shortly after docking, a jammed open thruster rocket started the couplet tumbling faster and faster. The crew, Neil Armstrong and David Scott, broke free from the target vehicle and ended the mission two days earlier than planned — survivors of the first major emergency in space. Gemini 11 carried out the first computer-controlled re-entry.



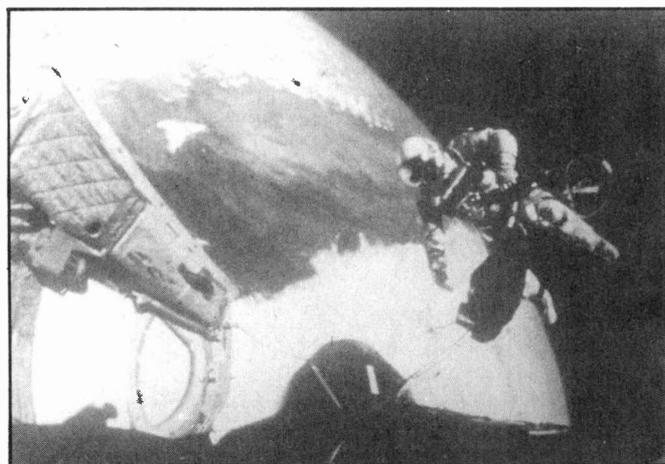


Before flight a Mercury astronaut's pressure suit was thoroughly tested.

## Apollo

The next stage in America's successful space programme, now well ahead of Russia's, was the flight testing of the Apollo moon-landing systems and procedures. A Saturn 1 lifted the first Apollo Command Module into Earth orbit in May 1964. The first Apollo crew (Virgil Grissom, Roger Chaffee and Ed White) climbed aboard Apollo 204 for a countdown rehearsal on January 27th, 1967 and the Command Module hatch was bolted down. A fire started unseen, somewhere below Grissom's feet and spread to nylon netting, fastenings and insulation material. In the 100% oxygen atmosphere it took only 15 seconds from Chaffee's first warning for the fire to burn through to the outer shell of the spacecraft. All three astronauts were dead before the hatch could be opened.

The Apollo programme was immediately suspended. A quick release mechanism was developed for the access hatch. Although pure oxygen continued to be used in space, ground operations were carried out with the safer 60/40 oxygen/nitrogen atmosphere (gradually changed to 100% oxygen after launch by the environmental control system). Less flammable materials were used in the cabin. Where non-metallic materials had to be used, they were positioned so as to behave as a fire break. The design of electrical equipment, location



The first American astronaut to make a space-walk — Ed White in orbit around Mother Earth.

of wiring and equipment checking procedures were also reviewed.

Nearly two years after the fire, the Apollo programme was resumed. Apollo 7 successfully tested the hardware in Earth orbit for eleven days in October 1968. Only two months later NASA reached for the moon. Apollo 8 was the first manned craft to be launched by the giant Saturn 5, necessary for the circumlunar mission. You may remember Commander Borman's reading of a passage from Genesis against the backdrop of another world on Christmas morning, 1968. Borman, Lovell and Anders could not have landed on the moon if they'd wanted to — they did not carry a Lunar Module.

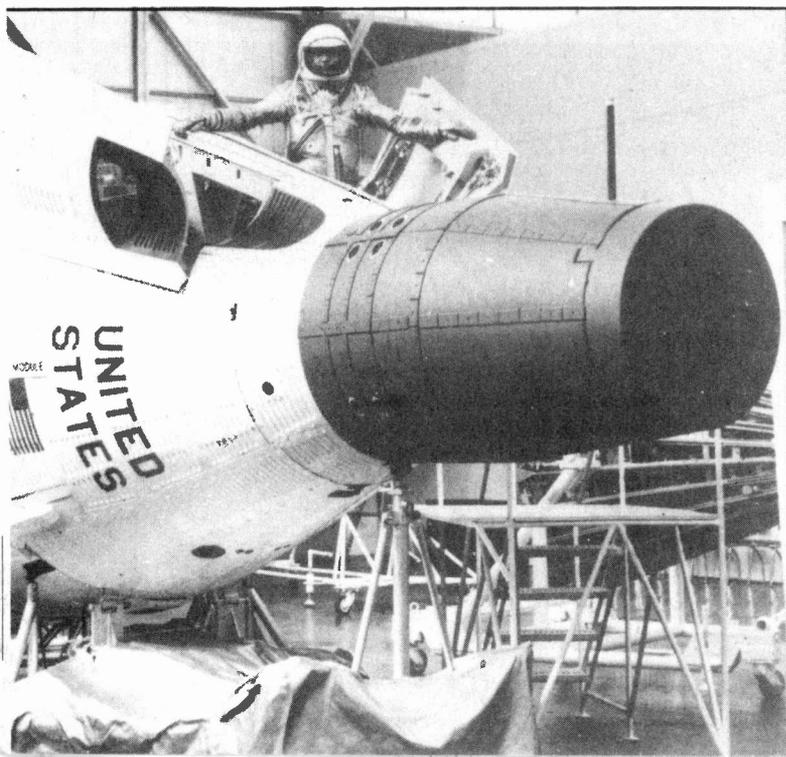
Apollo 9, the first manned mission with a Lunar Module, remained in Earth orbit rehearsing rendezvous and docking manoeuvres with the LEM (Lunar Excursion Module). While Schweickart was standing on the LEM porch he took the memorable photographs of Scott's head and shoulders out of the CM access hatch. Apollo 10 combined the experience gained from Apollo 8 and 9, taking the LEM to within 15 kms of the moon's surface.

## Tranquillity Base

Approximately one million people were at Cape Canaveral on July 16th 1969 to see Apollo 11 blast off for the moon. The television audience was around 500 million. After a trouble-free flight, Armstrong and Aldrin separated their Lunar Module from Collins' Command Module and began their descent. Armstrong interrupted the automatic landing sequence and flew the LEM manually when he saw boulders ahead, making it impossible to land. He finally touched down with only 2% of his fuel left.

I've met many, many people (not all space nuts like me) who sat up all night to watch the fuzzy image of Armstrong descending the LEM ladder and stepping off the landing pad on to the dusty surface of another world at 3.56 am on July 21st, 1969. Aldrin joined him and together they loped around the surface placing scientific instruments and collecting samples. On their return to Earth the astronauts put on Biological Insulation Garments and were transferred to the Mobile Quarantine Facility to isolate any bacteria which they may have brought back from the moon.

The Mercury capsule was just large enough to carry one astronaut. By comparison Gemini was a deluxe model.





Apollo 10's Saturn 5 stands on the launch pad atop its mammoth transporter.



Edwin Aldrin deploys the Apollo 11 solar wind experiment.

## Strike A Light

Apollo 12 and 13 were more eventful than the first moon landing. Apollo 12 was struck by lightning at take-off. Fortunately, neither the spacecraft nor the Saturn 5 launch vehicle were damaged. When the Apollo 13 Command, Service and Lunar Modules were more than 200,000 miles from Earth on their way to the moon, the astronauts felt a jolt and saw power and oxygen readings rapidly fall on their control panel. The moon-landing was abandoned. To conserve fuel it was decided to let the spacecraft swing round the moon and return to Earth. The crew moved into the Lunar Module, now aptly nicknamed the 'lifeboat'. Systems were powered down — the only way that the craft could be kept operational long enough for the return to Earth. Reduced power meant a cold, dimly lit cabin. The LEM air conditioner could not cope with the extra volume of both CM and docking tunnel. To keep carbon dioxide down to a safe level, the crew improvised an air conditioner from materials on board.

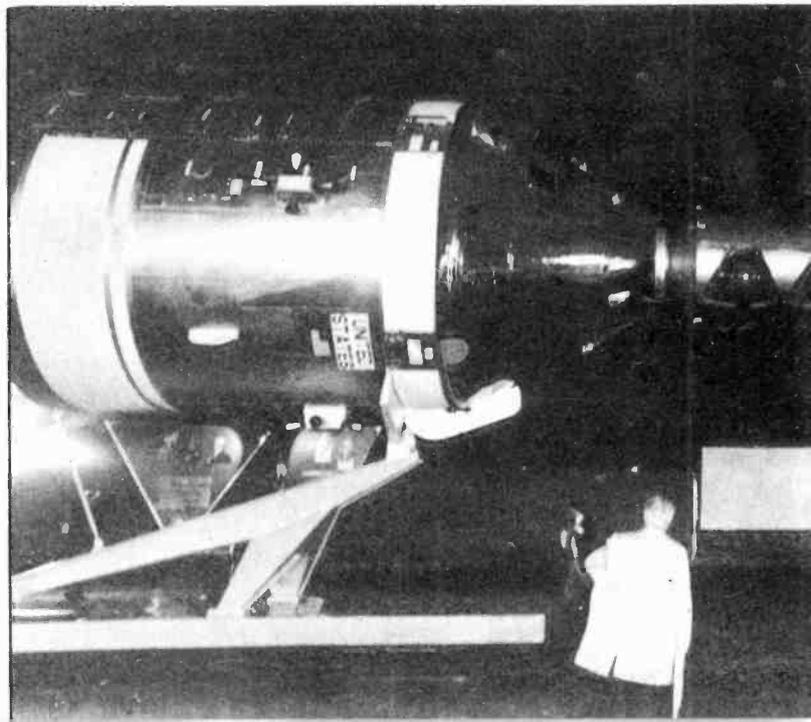
When the Service Module was discarded just before re-entry, the crew saw for the first time the extent of the damage. One panel (4m x 1.8m) had been blown away completely, exposing a tangle of pipes and tanks. It was later found that heater switches had welded closed causing an oxygen tank to overheat and explode. It wasn't known if the explosion had damaged the CM's heat shield. However, re-entry went as planned and the crew of Apollo 13, launched at 13.13 (Houston time) on April 13th, returned safely to Earth. In 1972, four flights later, the programme was brought to a close with Apollo 17, the last of three missions intended to devote more energy to Apollo's scientific potential. Despite six moon landings and the return of over 380 Kg of rock samples, the origin of the moon is still not conclusively proven.

Meanwhile in the USSR

## Meanwhile In The USSR

Like Apollo, the Soviet Soyuz programme had its setbacks. The test flight of Soyuz 1 seems to have been cut short. After re-entry, the parachutes failed to open properly and the spacecraft crashed to Earth, killing the one-man crew (Vladimir Komarov).

Further flights achieved the first docking of two manned craft and the first welding in space. Soyuz 11 (June



1971) spent 23 days docked with Salyut 1. The flight went well until re-entry, when contact with the crew was lost. On opening the access hatch after a normal re-entry, the three man crew was found to be dead. The craft had suffered rapid depressurisation in the upper atmosphere. From then on the crew wore spacesuits (during re-entry at least) instead of light overalls and flying helmets. The additional life support gear carried meant that the crew had to be reduced from three to two.

The Soyuz programme continued, successfully carrying out astronomical, Earth resources, EVA (space-walking) and hardware experiments.

The first post-launch abort occurred several minutes after what would have been Soyuz 18 lifted off. When the third stage began to go astray, the spacecraft was automatically detached from the launcher and brought down. The next flight (Soyuz 18) prepared the way for the joint US/USSR Apollo/Soyuz link-up.

The Apollo/Soyuz Test Project (ASTP) was agreed on as early as 1972, with a planned launch date of July 15th 1975. Both craft did, in fact, take off on July 15th 1975 and docked for a total of 48 hours. Minor problems included failure of the Soyuz TV system. The huge television audience had to be content with pictures of Soyuz taken from Apollo. Stafford became the first US astronaut to fly in a Russian Spacecraft.

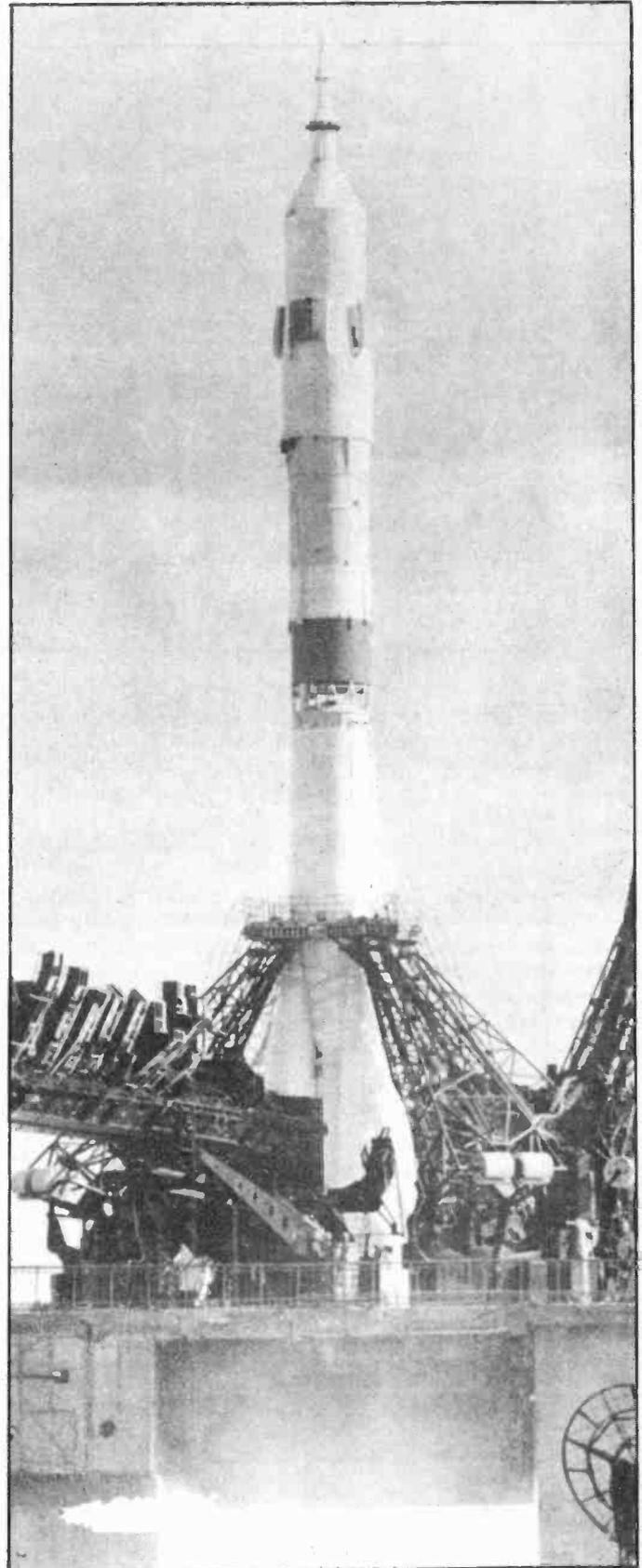
### Secret And Wet

Soyuz 22 achieved the dubious honour of being, it is believed, the first manned spy satellite. Its unusual orbit took it over a major NATO exercise. Soyuz 23 achieved yet another first — the first Soviet splashdown. During its descent high winds pushed the craft off course and into a lake. The crew were unhurt.

### Stations In Space

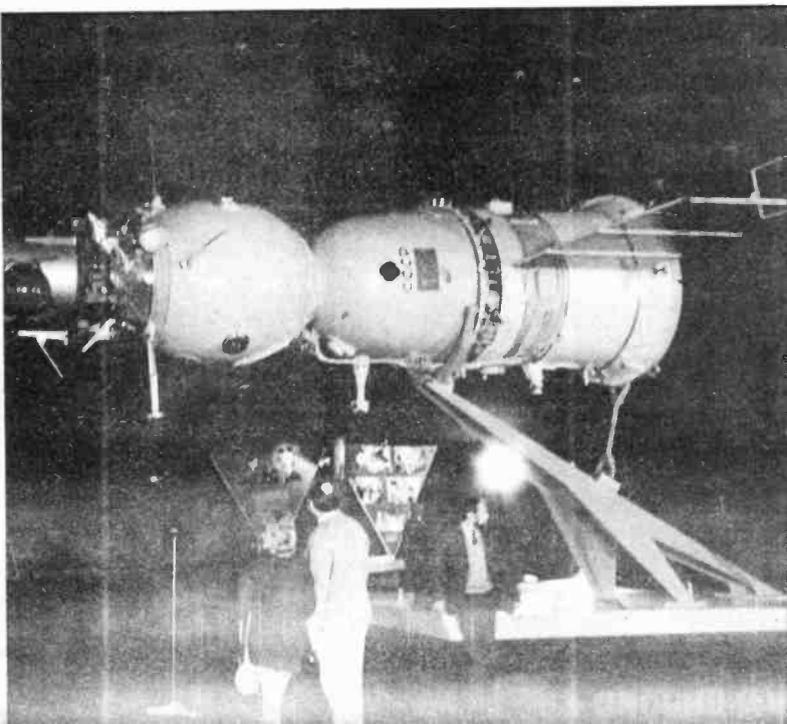
In the early to mid seventies, both the Soviet and American space programmes moved into their second generation. The hugely expensive one-shot all or nothing flight gave way to the space station. Once again Russia led the way with Salyut 1 (April 1971). The first few years of the programme were beset with technical problems with both the Salyut space stations and the Soyuz crew transporters, but Soviet persistence had paid off by 1975. The Soyuz 18 crew set up a new Soviet duration record of almost 64 days on-board Salyut 4.

Unlike Skylab, there appear to be two distinct types



The Russian end of the Apollo/Soyuz Test Project — Soyuz, still clamped down to the launch pad.

The Soyuz/Apollo spacecraft cluster with the newly designed docking module.





The first captive flight of America's Space Shuttle on the back of a NASA 747.

of Salyut craft. One performs a civilian role, similar to Skylab, but the other is part of a separate military programme.

## Skylab

In May 1973 Skylab 1 lifted off, launch vibration being so great as to seriously damage the craft. The meteoroid/thermal shield had been torn away completely, turning the workshop interior into an orbiting oven. The debris from the shield had also ripped off one of the solar panels, giving the spacecraft its familiar lop-sided appearance.

The laboratory was only made habitable by the installation, by the Skylab 2 crew, of a makeshift sun-shade over the workshop.

## Life Out There

Astronauts complained of stuffiness and congestion of the inner ear for as long as twelve weeks. Red blood cell production was disturbed for about nine weeks. Hygiene and waste management seemed to constitute the most annoying problems. Urine was spilled. Astronauts found if they missed a meal they would experience flu-like symptoms. Heavy exercise helped

crews make more rapid recovery after their return to Earth. Health problems amounted to minor skin infections and eye trouble.

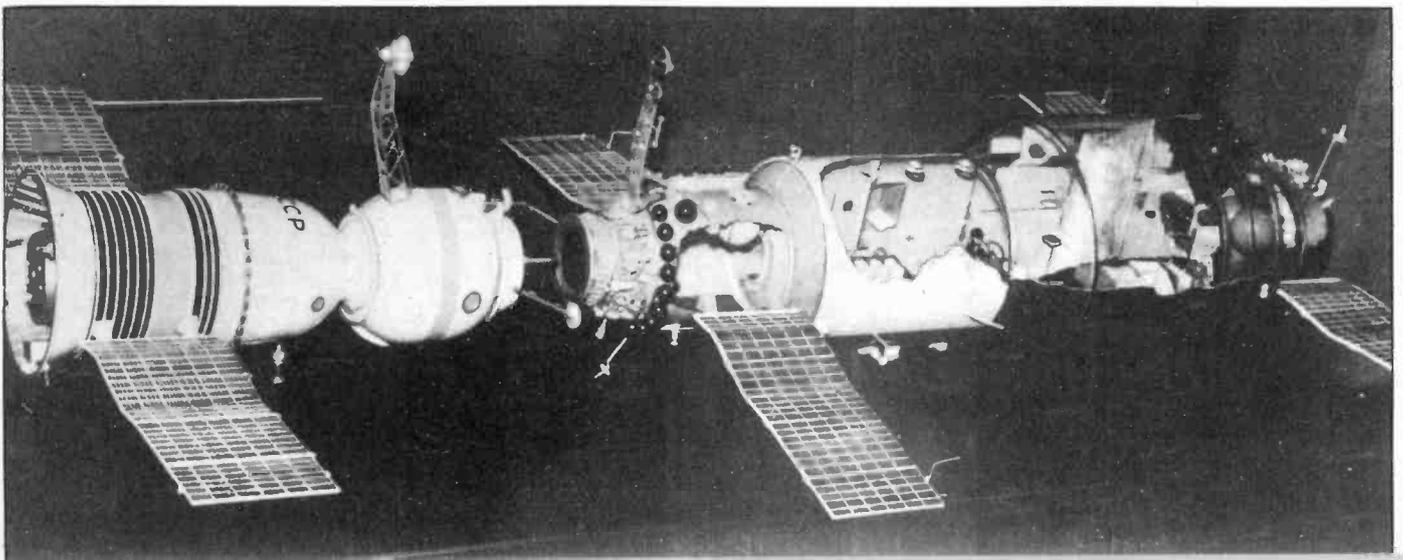
Results from the first few years of space station operation will themselves take years to analyse. The Skylab crews brought back over 40,000 pictures of the Earth's surface and over 180,000 frames of film of the Sun. They also carried out melting, welding and brazing experiments. One of the Earth Resources experiments identified a possible deposit of copper in Nevada. It may be worth several billions of dollars — more than the cost of the entire space programme to date.

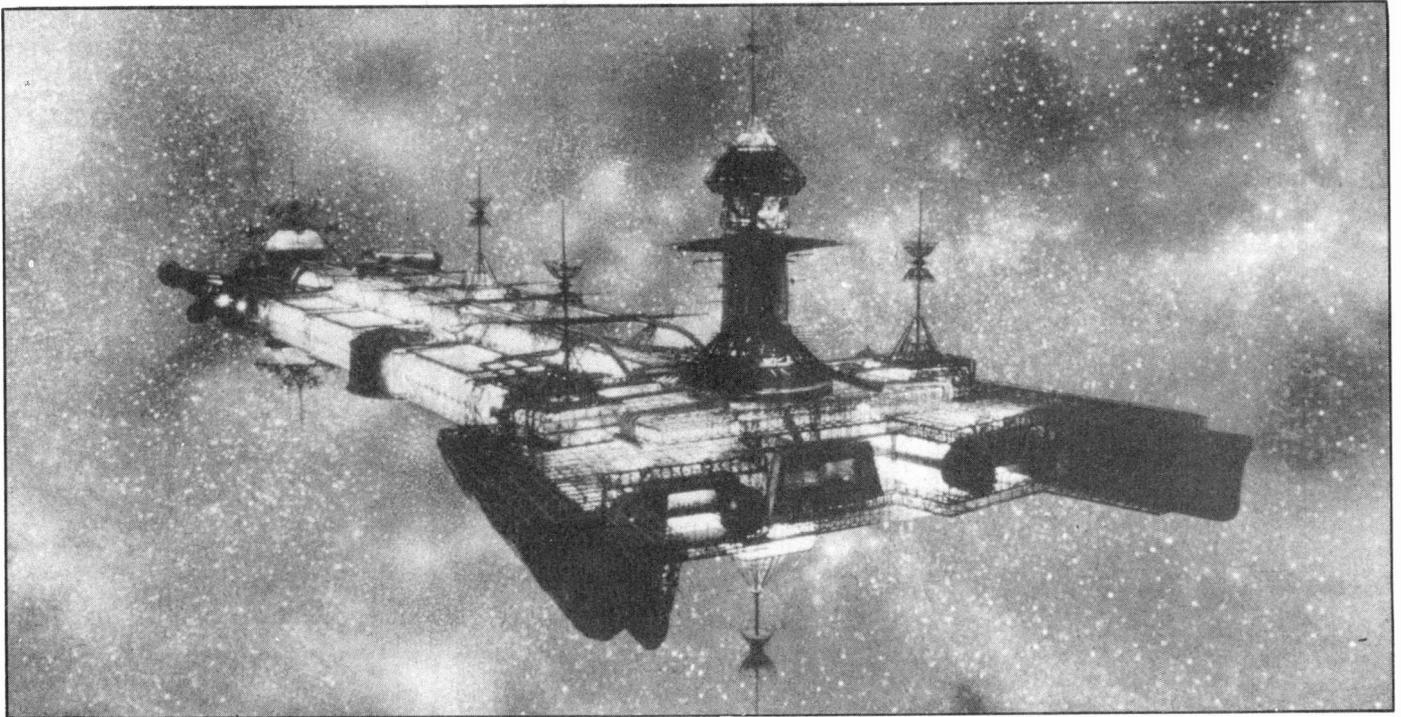
## Planes In Space

The most exciting development so far in space hardware is that of the Space Shuttle — a plane capable of being launched with the aid of strap-on boosters, flying on to orbit and returning to Earth, landing like a conventional aircraft.

Although the Commander and Pilot could take

A cut-away model of the Salyut space station with Soyuz 11.





The shape of things to come — the mile-long 'Palomino' spacecraft featured in Walt Disney's 'The Black Hole'.

manual control, the Space Shuttle is such a complex flying machine that it is usually flown with the aid of computers or completely under computer control.

After take-off the two boosters fall away and are recovered from the ocean to be used again. The huge external tank, whose fuel powers the Orbiter's three main engines almost to orbit, is discarded and breaks up in the atmosphere. Once in orbit, 44 tiny rocket motors position the Shuttle accurately.

With the cargo doors open, satellites can be launched or collected for repair by using the Remote Manipulator System — a remotely controlled arm made by Spar Aerospace in Canada.

A variety of materials protect the craft from the enormous temperatures of re-entry. The nose of the Orbiter reaches over 1400°C. Normally the crew will not interrupt the completely automatic landing sequence. After landing, the Orbiter is serviced and repositioned on the launch pad for its next flight.

Technical problems have caused a serious of post-

ponements to the first launch, which is now not expected until at least November 1980.

### The Competition

America may appear to be way ahead of the Soviet Union, but there is already news of a Soviet Space Shuttle. So far very little information has been released. Known as the Raketoplan (Rocket Plane), it measures 60m long (probably including the launcher) and 8m across with three main engines. A prototype has already been test flown, dropped from a Tu-95 bomber.

### Coming Soon

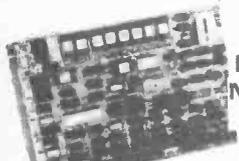
What does the future hold? The Space Shuttle is the first spacecraft to offer the possibility of carrying into orbit raw materials of prefabricated elements from which larger structures can be constructed. Film buffs may recall the Space Shuttle approaching the spinning wheel station in Stanley Kubrick's film of Arthur C Clarke's '2001: A Space Odyssey'. Which of the current rash of space westerns will prove as prophetic as 2001 is sure to be — 'The Black Hole' perhaps, with its spaceship modelled on Brighton pier, or Star Wars, with its World War I dog fights in space?

Table 1. A comparison of manned spacecraft to date.

	MERCURY	GEMINI	APOLLO	SKYLAB	SHUTTLE	VOSTOK	VOSHKOD	SOYUZ	SALYUT
LAUNCH WEIGHT (kg)	1935	3792	5558	90265	68000	2400	5320	6000	18700
BASE DIAMETER (m)	1.89	3.05	3.90	6.58	.	2.3	.	2.63	4.1
LENGTH (m)	2.90	5.60	3.48	36.12	37	2.3	.	10.63	22
WORK VOLUME (m <sup>3</sup> )	.	1.558	5.97	361.4	71.5	.	.	9	100
WINGSPAN (m)	.	.	.	.	23.7	.	.	10.06	.

ETI

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(MK 4118), 1K work space/User  
RAM  
(MK 4118) (8K Microsoft Basic)  
(MK 3600 ROM) (8K Static RAM/  
2708E).

**Microprocessors** Z80A, 8 bit CPU. This will run at 4Mhz but is selectable between 2/4 Mhz. This CPU has now been generally accepted as the most powerful 8 bit processor on the market.

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**I.O.** On-board UART (Int. 6402) which provides serial handling for the on-board cassette interface or the RS232/20mA teletype interface.

The cassette interface is Kansas City standard at either 300 or 1200 baud. There is a link option on the NASCOM-2 for 2400 Baud.

The RS232 and 20mA loop connector will interface directly into any standard teletype.

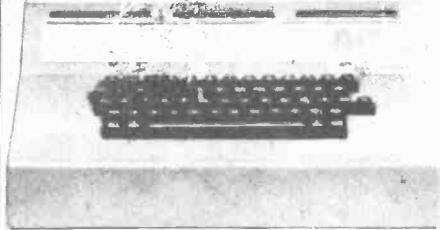
The input and output sides of the UART are independently switchable between any of the options — i.e. it is possible to have input on the cassette and output on the printer.

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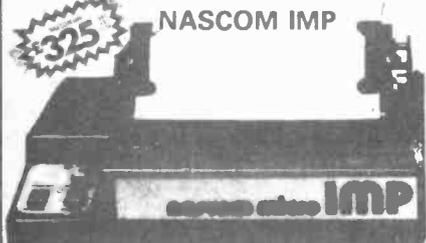
The MPU is the standard Z80 which is capable of executing 158 instructions including all 8080 code.

NASCOM-1  
**£125** + VAT  
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Nas-sys monitor in 2 EPROM	25.00
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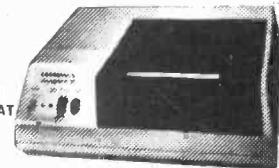
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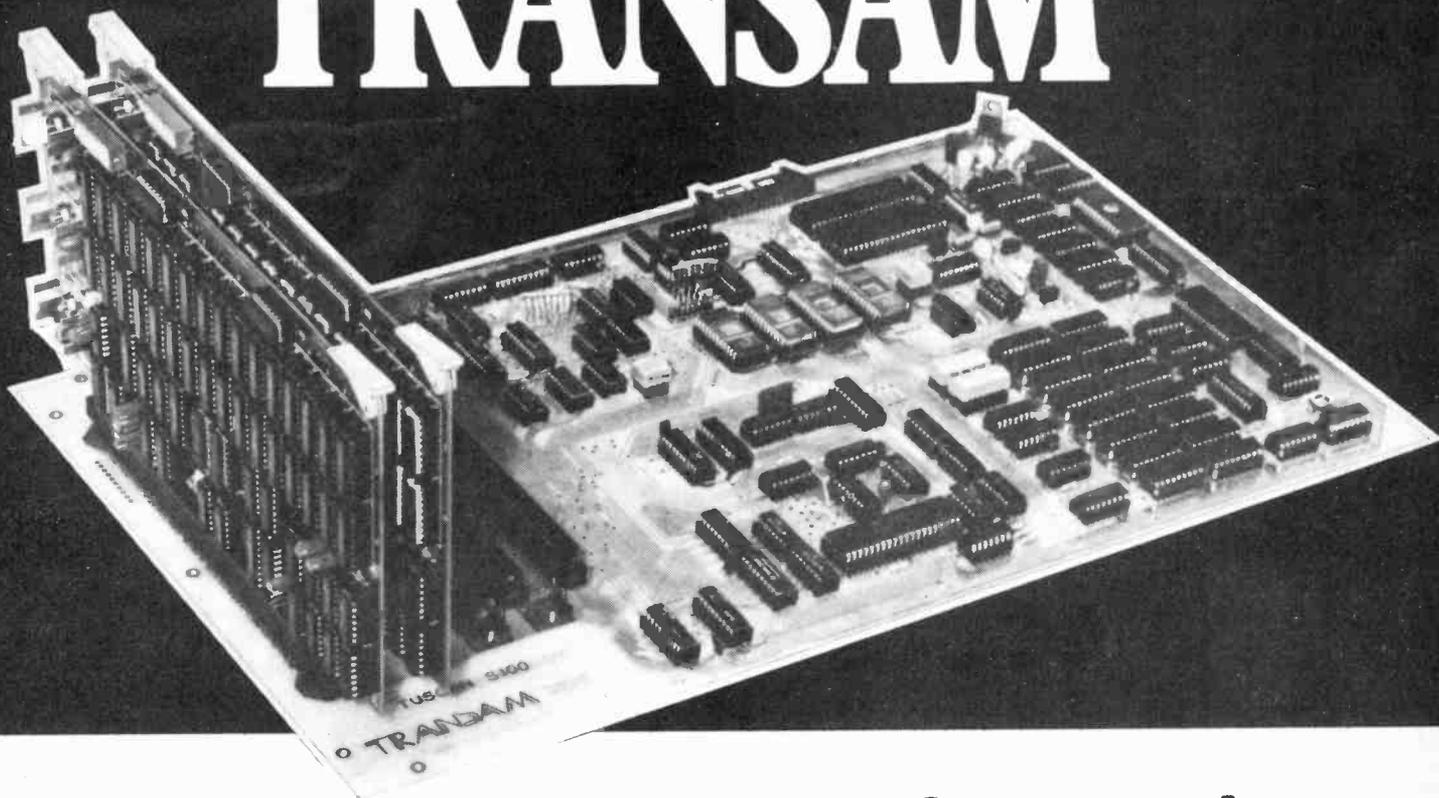


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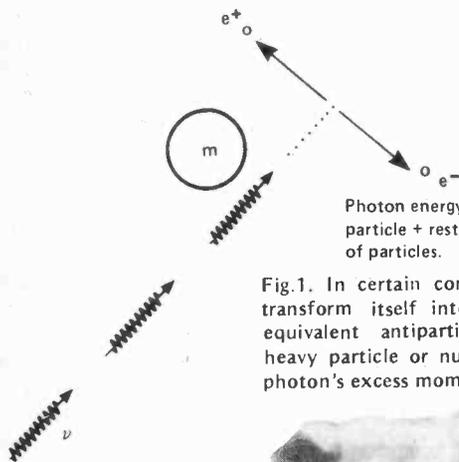
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# ANTI~ MATTER

Does antimatter really exist or is it a figment of your imagination? Have you an antimatter double in another universe? A.S. Lipson explains.

**A**ntimatter is, figuratively speaking, the very stuff of which science fiction is made. Most of us have heard of it somewhere or other, but the most we actually know about it can be summarised in the immortal sentence from a TV series that will remain un-named, 'Ye cannae mix matter with antimatter, Captain. . .'. So what is this stuff? If it's 'antimatter' does it have 'antiweight'? Has it actually been made? Read on . . .

In 1928, a British physicist, Paul Dirac, had developed an equation which seemed to solve an awful lot of the problems current in physics at the time. (Among these was the prediction and explanation of a quantity known as the 'giromagnetic ratio' of the electron — but that is really another story.) There was only one slight snag. In addition to ordinary matter, the equation seemed to be saying something about something rather different — a sort of 'negative energy' particle, previously unknown. Well, to cut a long story short, this eventually led to a theoretical understanding of what became known as 'antimatter'. The only thing left to do was to look for it and in due course antimatter was actually found! (Physicists are



Photon energy = recoil energy of heavy particle + rest mass energy of particles + kinetic energy of particles.

Fig.1. In certain conditions, a photon can spontaneously transform itself into an electron and a positron (its equivalent antiparticle). The photon must pass by a heavy particle or nucleus which absorbs most of the photon's excess momentum.

ingenious fellows; they have to be to get their grants.) In fact, it turned out that antimatter had already been noticed in sub-atomic reactions, but had been interpreted as anomalous results!

## Doing The Impossible

We have said that antimatter was found. It would be more correct to say that antimatter equivalents of sub-atomic particles were found. It all started off with the antimatter equivalent of the electron, in fact, and the people involved with its discovery were so excited about it that, instead of just calling it an 'anti-electron', they gave it a special name — the positron.

It wasn't long before other 'anti-particles' began to be discovered. Corresponding to the already known proton and neutron, which exist in the nuclei of atoms, there were an 'anti-proton' and 'anti-neutron'. In fact, right through to the present day, as more and more sub-atomic particles were discovered, it has been found that each has, corresponding to it, an anti-particle of equal mass (with the exception of a few particles which appear to be their own anti-particles). This was exciting! If every particle known had a corresponding anti-particle, then just as ordinary matter is made up of atoms, themselves made up of sub-atomic particles, it might be possible for there to be matter which was in the same way made up of 'anti-atoms', which would themselves be made up of anti-particles. . . Antimatter! Fine. There was just one small problem — anti-matter in any form, even just anti-particles, isn't very easy to contain. In fact, it would probably be fair to say that containing anti-matter is one of the closest things to 'impossible' that the physicists have cooked up yet. To understand this, we'll have to go right back to the discovery of the positron. . .

## Disappearing Act

So far, we have completely omitted to say exactly what it is that is so special about antimatter. We can find this out most easily by looking at the way the positron — the 'anti-electron' — behaves. Now, the positron had a few rather interesting properties. In every way possible, it seemed to be the exact opposite of the electron; whereas the latter was negatively charged, the positron was positively charged (hence its name) and so on. The positron did not have negative mass, though. Negative mass, so far, is still in the realms of science fiction. Antimatter has positive mass, and hence, weight. This was interesting enough as it was, but things only really started to get going when a positron met an electron. If this happened the two particles would disappear into nowhere and a high energy particle of light, or 'photon' would be created. This was, in fact, an actual demonstration of the truth of Einstein's equation  $E = mc^2$ , which says that mass and energy are equivalent. Under the right circumstances (such as meeting antimatter) mass can be turned into energy. When an electron collides with a positron, then the mass in each of them gets turned into pure energy and this is given off in the form of light photons. Pretty impressive eh? The same thing happens when other particles meet their own anti-particles; they disappear and all their mass is turned into energy, which is given off in the form of photons. The more massive the sub-atomic particle, the more energy is contained in the photons. When a proton and anti-proton meet and 'mutually annihilate', for instance, the energy produced is 1836 times as much as that produced when an electron and positron meet, because the proton and anti-proton have masses 1836 times as great as the electron and positron.

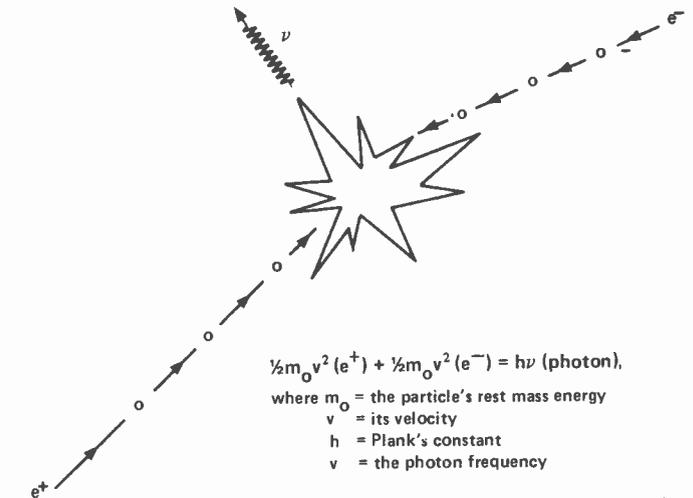


Fig.2. When an electron and positron meet, they annihilate one another and produce a photon whose energy ( $E=h\nu$ ) equals the combined rest mass energies of the particles.

## Let There Be Light

It now becomes apparent why it is so difficult to contain antimatter in normal containers; if we tried to do so, the positrons would quickly meet electrons, the anti-protons would meet protons and so on. All in all, the antimatter, together with an equal mass of the container, or whatever else was handy, would disappear and a lot of energy would be produced. A lot of energy. According to Einstein's equation (which has been very thoroughly tested), even a very small amount of mass, is equivalent to an incredibly large amount of energy. If a matchstick could be completely turned to energy, there would be enough produced to keep a 100 watt light bulb burning brightly for several centuries!

So far it looks as though the only likely way of containing antimatter would be to hold it in very strong magnetic fields, but the technique is far from perfected. Even if we could contain it easily, which so far we can't, there would remain the problem of obtaining antimatter in reasonable quantities. It is extremely rare and when it is found, (or made, in high energy particle accelerators) it always consists of sub-atomic particles; nothing anything as complicated as 'anti-atoms'. Certainly, antimatter has not been made in sufficiently large quantities even to weigh, with the most sensitive instruments available — supposing that we could weigh it without it reacting with matter and producing enough energy to blow up the balance we were using . . .

The rarity of antimatter has presented a problem to physicists, who like everything to be symmetrical in the universe; there is no apparent reason why there should be more matter than antimatter in the universe and yet antimatter seems to be very rare. This has led some people to suggest that, in fact, there is just as much antimatter as matter, but not in this galaxy. Perhaps about half of all galaxies are made out of antimatter, and half of matter; so, there is just as much of each kind of matter and the universe is nicely symmetrical. If this is so, then it is possible that, sometimes, out in space, a large quantity of matter might meet a large quantity of antimatter and the whole lot would disappear, giving off vast quantities of energy in the form of radiation. If this happens, our astronomers might see this radiation, and deduce what was going on. . . It is a fascinating idea. And just think; if there are 'anti-galaxies', then maybe some of them carry life. Perhaps, somewhere, an 'anti-person' is reading a positronics magazine and wondering about the possibility of galaxies made of matter. . .

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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
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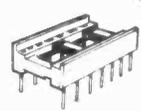
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4013 45p	4040 110p	4095 110p
4015 85p	4042 85p	4510 90p
4016 48p	4046 110p	4511 100p
4017 80p	4048 60p	4518 90p
4018 90p	4049 50p	4520 110p
4020 110p	4050 50p	4527 165p
4022 100p	4052 80p	4528 100p
4023 25p	4060 120p	4532 125p
4024 60p	4066 63p	4543 170p
	4068 25p	4583 80p
	4069 25p	4585 115p
	4070 25p	
	4071 25p	

### SKTS

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



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7402 15p	7472 35p	74126 60p
7404 16p	7473 38p	74132 70p
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	7488 35p	74165 120p
7430 30p	7490 45p	74174 100p
7432 35p	7492 55p	74175 95p
	7493 45p	74190 100p
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	7496 70p	74192 100p
	7497 70p	74196 100p

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		3p

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ETI JULY 1980

# DESIGNER'S NOTEBOOK

In this month's 'Notebook' Ray Marston looks at practical applications of a neat little eight pin National chip, the LM3909 LED flasher/oscillator

A common and seemingly trivial task often facing the design engineer is that of providing an illuminated (glowing or flashing) indication of the ON state of a piece of electronic equipment or the location of a passive device (fire extinguisher, emergency switch, etc) in a darkened room.

These tasks are obviously easily solved if mains power is readily available, but can present serious problems when battery powered equipment is concerned. LED indicators typically draw 12 mA or more when illuminated and can thus place a fairly heavy strain on small supply batteries. LEDs, in any case, drop two or more volts under the ON condition and can thus not readily be powered from battery voltages below 3V or so.

National Semiconductors provided an ingenious solution to this problem some years ago when they introduced the eight pin LM3909 LED flasher/oscillator chip. This device acts basically as a low duty cycle (brief ON period, long OFF period) oscillator that provides a voltage-doubled high-current pulse to an external LED. Because of the voltage-doubling facility, the IC can flash a LED even when powered from cell voltages down to 1V1. Because of the low duty cycle facility, the device can provide high pulse currents (up to 100 mA) while still drawing very low mean currents (typically 0.3 to 1.5 mA) and can thus provide months, or even years, of continuous operation from a single 1V5 cell.

CELL SIZE	ESTIMATED BATTERY LIFE UNDER CONTINUOUS OPERATION	
	STANDARD CELL	ALKALINE CELL
AA	3 MONTHS	6 MONTHS
C	7 MONTHS	15 MONTHS
D	1.3 YEARS	2.6 YEARS

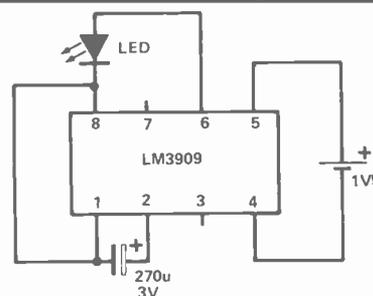


Fig.2. Practical 1V5 LED flasher with details of estimated battery life. Nominal flash rate is 1 Hz and typical average drain current is 0.63 mA.

## The LM3909

The internal circuit of the LM3909, together with typical external connections for 1V5 flasher operation, is shown in Fig.1. In this application, the LED receives current (via the 270 uF capacitor and the internal 12R resistor and Q3) for only about 1% of the time. For the remaining part of each operating cycle all transistors except Q4 are off. The 20k resistor from Q4's emitter to supply common draws only about 50 uA. The 270 uF capacitor is charged through the two 400R resistors connected to pin 5 and through the 3kΩ resistor connected to pin 4 of the circuit.

Transistors Q1-3 remain off until the 270 uF capacitor becomes charged to about 1 V. This voltage is determined by the junction drop of Q4, its base-emitter voltage divider and the junction drop of Q1. When the voltage at pin 1 becomes a volt more negative than that at pin 5 (the supply positive terminal) Q1 begins to conduct and then turns Q2 and Q3 on.

The LM3909 then supplies a pulse of high current to the LED. The current amplification of Q2 and Q3 is between 200 and 1000: Q3 can handle over 100 mA and rapidly pulls pin 2 close to supply common (pin 4). Since the 270 uF capacitor is charged at this time, its other ter-

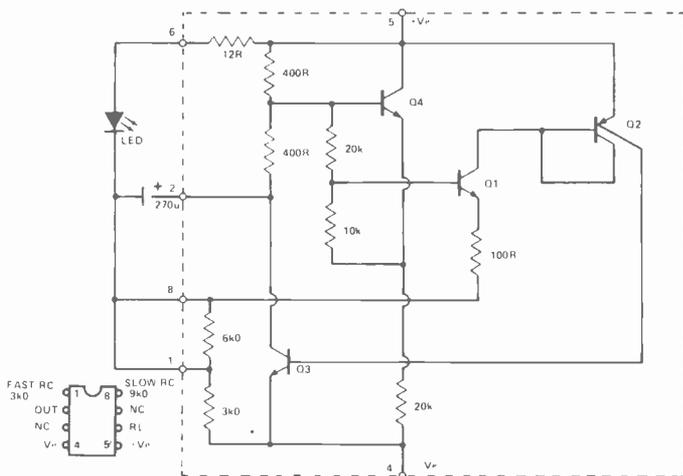


Fig.1. The internal circuit and practical connections of the LM3909 low voltage LED flasher/oscillator IC. The IC outline is also shown.

minal at pin 1 goes below the supply common; the voltage at the LED is then higher than the battery voltage; the internal 12R resistor (between pin 5 and 6) limits the LED current to a safe value.

Thus, the 270 uF capacitor alternately charges via the 3k0 timing resistor and discharges via the LED and 12R resistor. In some other applications, the short between pins 1 and 8 can be removed, enabling the capacitor to charge through a total of 9k0, with a consequent reduction in duty cycle and mean current consumption.

If voltage boosting is not needed (with or without current limit), loads can be hooked directly between pins 2 and 6 or pins 2 and 5 of the IC.

Let's look now at some practical applications.

## LED Flasher/Indicator Circuits

Figure 2 shows the Fig.1 1V5 flasher circuit redrawn in a practical configuration. The circuit gives a brief flash once every second or so and typically draws an average current of only 0.63 mA. As you can see from the table, this circuit will give from three months to 2.6 years of continuous operation from a battery, depending on the size and type of cell that is used.

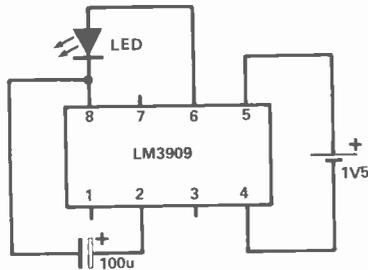


Fig.3. Minimum power 1V5 flasher. Nominal flash rate is 1.1 Hz and average drain current is 0.32 mA.

An even longer life can be obtained from the 'minimum power' flasher circuit of Fig.3. This is similar to the one described above, except that the short is removed from between pins 1 and 8, causing the capacitor to charge via 9k0 of internal IC resistance and so operate with a reduced duty cycle and reduced mean current consumption. The circuit has a typical current drain of 0.32 mA.

The Fig.2 and Fig.3 circuits are of particular value as 'indicator' or 'locator' beacons for use on fire extinguishers, emergency lanterns, torches, emergency switches, etc. The operating frequencies of these circuits are heavily dependent on supply voltage, as indicated in Fig.4. This circuit is similar to that of Fig.3, except that it is designed for 3 V operation, in which case the timing capacitor value has to be increased by a factor of 2.7 for approximately the same flash rate.

Figure 5 shows another variation of the 1V5 flasher circuit. In this case the internal timing resistors are

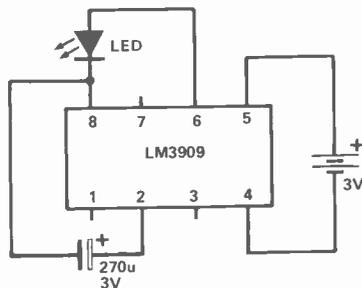


Fig.4. 3V 1 Hz flasher consumes an average current of 0.77 mA.

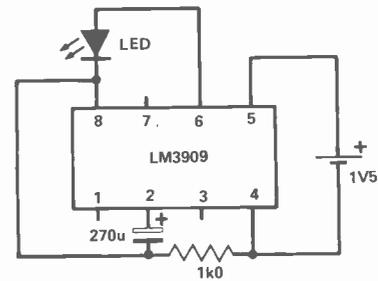


Fig.5. Fast 1V5 blinker. Flash rate is 2.6 Hz and drain current is 1.2 mA.

shunted by an external 1k0 resistor, thereby reducing the charge time constant of the circuit and causing the flash rate to increase (to 2.6 Hz) and the duty cycle and mean current consumption to rise. The circuit gives a more noticeable flasher indication than the three earlier circuits, but at the expense of 1.2 mA of mean current drain.

If you enjoy experimenting with circuits, you can build the variable rate flasher of Fig.6. The rate is variable from zero to 20 Hz via the 2k7 potentiometer. The two external 68R resistors are used to stabilise the duty cycle of the circuit and maintain a fairly steady apparent brilliance level in the LED as the rate is varied.

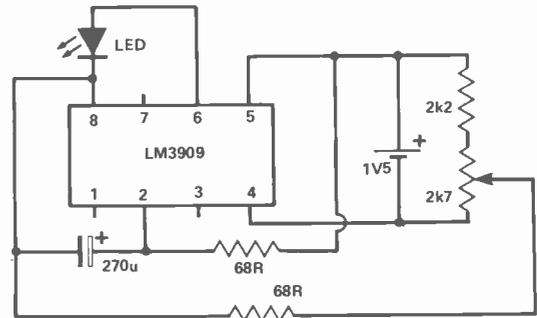


Fig.6. Variable rate flasher. The rate is variable from zero to 20 Hz.

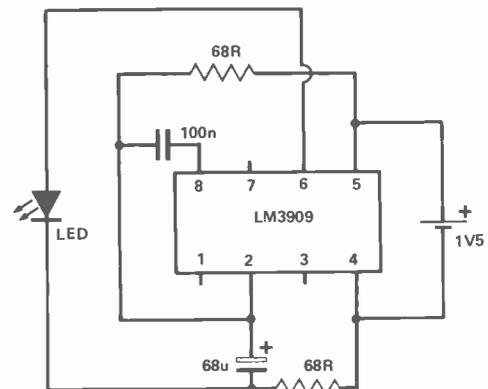


Fig.7. High efficiency 'continuous' 1V5 LED indicator. The circuit provides a steady but dim illumination by pulsing the LED at 2 kHz. Drain current is 4 mA.

The Fig.7 circuit is designed to give apparently continuous illumination of the LED when powered from a 1V5 cell. The circuit in fact acts as a 2 kHz square wave generator, the two external 68R resistors being used to approximately equalise the on and off times of the generator. The circuit gives a dim LED illumination and has a battery drain of about 4 mA. LED brilliance can be increased, if required by using the alternative connections of Fig.8, but at the expense of 12 mA of battery drain.

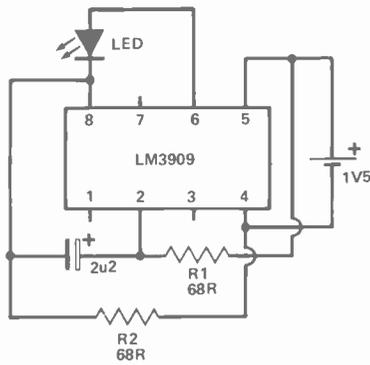


Fig.8. This 1V5 circuit gives an apparently steady and continuous LED indication. Battery drain is 12 mA.

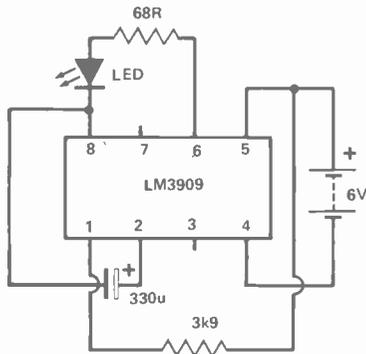


Fig.9. This 6 V flasher operates at about 1 Hz.

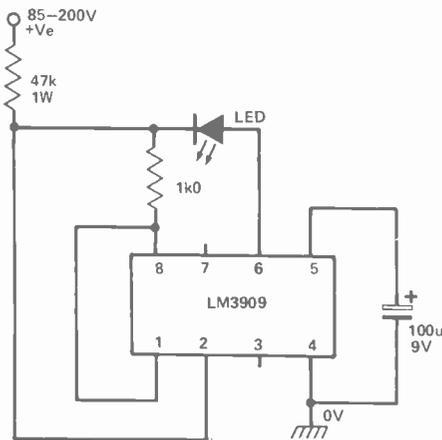


Fig.10. This LED flasher circuit can be operated from any supply in the 85-200 V range.

All of the LED flasher circuits that we've looked at so far are intended for operation from 1V5 or 3 V supplies. Most of these designs can in fact be used, in slightly modified form, at voltages up to 6 V, as shown by the circuit of Fig.9. Note in this case that a 68R resistor is wired in series with the LED, to limit its drive currents.

The LM3909 IC has a 6V5 zener built in between pins 2 and 4 (not shown in Fig.1). This fact is put to practical use in the flasher circuit of Fig.10, which can be powered from any DC supply in the 85-200 V range. The 100 uF timing capacitor is connected between pins 4 and 5 in this application.

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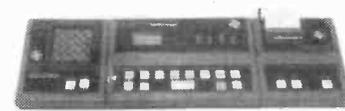
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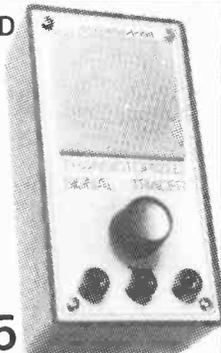
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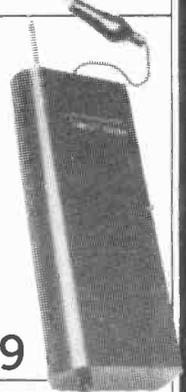
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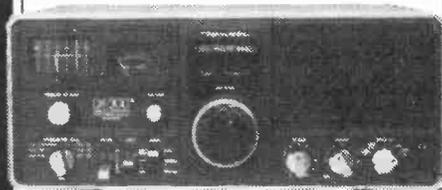
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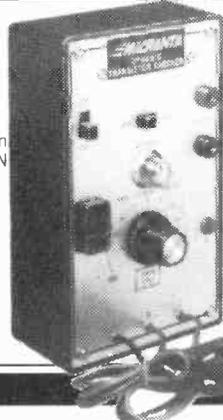
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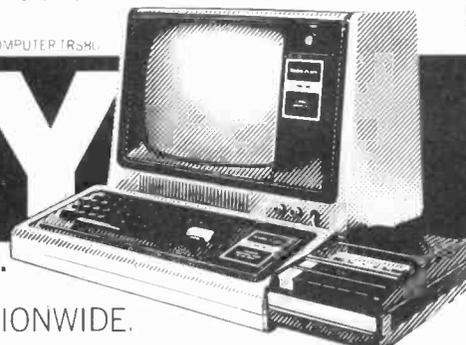


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# AUDIOPHILE

**A small step for an electron, a quantum jump for amplifiers? Being unable to resist the obvious puns, Ron Harris takes a searching look at one of Britain's newest amplifier stars.**

**S**how-time again this month. Spent an editorial hour or eight wandering around the hallowed halls of the Cunard Hotel. My annual pilgrimage to the Far East (or London) this — all face the Mecca Bingo Hall and pay homage to the gods of high technology.

Frankly, though, I thought this year's offering a little below the standard that this event has set itself in the past. Somehow there did not seem to be that charisma, that indefinable something, that electric charge to propel the visitor from room to room, eyes goggling at the plethora of mind mangling miracles wrought since last he trod these boards. . . . .

Or to put it another way a lot of it was boring. Naturally there were exceptions, but somehow the best demos were given by companies showing established products. One which particularly caught my ear was the minute A4-14 active loudspeakers, from Audio Pro. These have a sub-woofer built in to the enclosures and are capable of bone bleaching sound levels with a bass that sounds a lot larger than its 20' x 12 x 10 inches. The sound is simply stunning and would appeal to a very large number of people, I think.

Also making an impressive debut was the new JBE loudspeaker, with its unusual 'four-box' approach. The bass drivers are separately housed and would win no prizes for appearance despite the well finished enclosures. Still, the sound was very nice indeed, being well balanced and possessing excellent transient ability. Nice legs, shame about the facia?

B & W's new offspring is also worth a listen if you get a chance.

Aside from that people like Trio, Shure, Goldring, STD, Quad and Crimson made the most pleasing noises to be detected, others being either too full of people or too empty of ideas to attract the attention. KEF 105s appeared to have been breeding quietly between the staircases — there were hundreds of them everywhere.

The prize for making WORST use of your equipment (if you'll pardon the expression) goes to Audiostatic of Holland. They were showing off a quite incredible electrostatic 'panel' speaker with built-in valve amplifier — and making a right mess of it when we went in. I only

hope things improved later on. The sounds I heard have done much to persuade the average audio man that perhaps his idols have clay feet after all.

One little twenty second burst of a very well recorded opera is the only reason I bother to mention them at all. Inspid musical wallpaper and delicate solo flute is no way demonstrate such a systems capability in a crowded, noisy environment.

If you've got it — flaunt it, don't flute it.

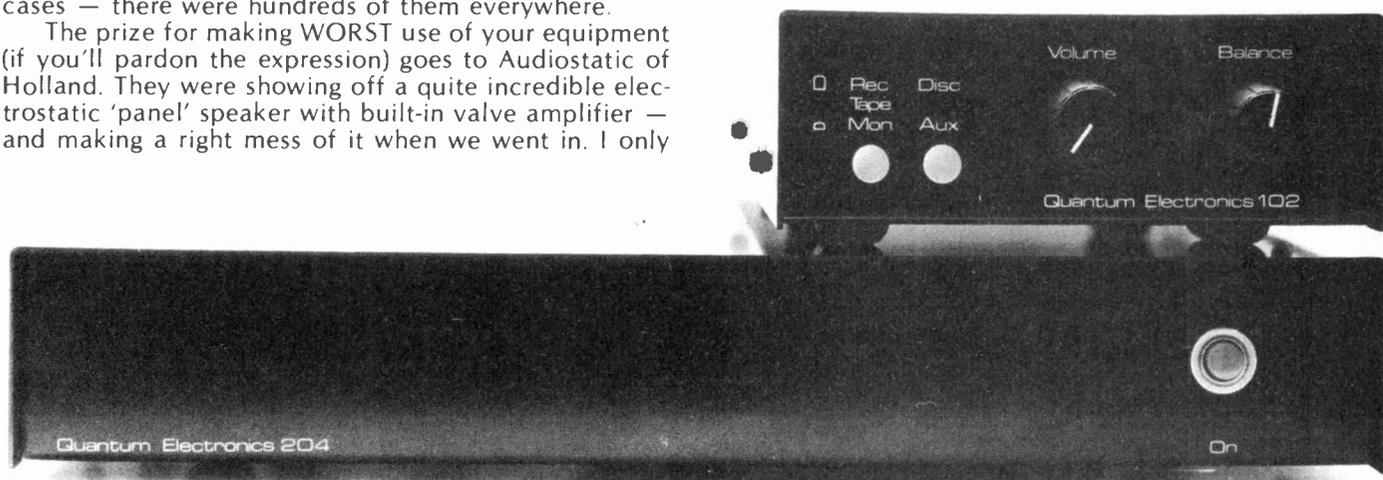
## Quantum Amplification

Having started somewhat slowly, Quantum Electronics are well on the way to becoming one of Britain's most successful amplifier manufacturers. At that miserable Hi-fi 80 exhibition their room was one of the few that was continually carpeted with wall to wall people, which did detract considerably from the demonstration, admittedly. This sort of thing need not concern the Audiophile reader, however, as I'd already arranged for a review model.

Listening is infinitely more pleasant sat sitting at home, in front of the speakers you know and love, than packed into a tiny hotel room like a demented sonic sardine trying to pick up some of the sound waves being absorbed by the solid wall of bodies around you.

The particular combination from Quantum under scrutiny here is the 102 pre-amp and 204 power amp. It is available in many many forms, from ready built and tested, down to modules and hardware. In former form it will cost you £80.41 (102) and £153.42 (204). Modules (minus metalwork) cost £51.75 and £109.42 (204 kit).

It is worth a few words to point out that Quantum are in no way, shape, size or form connected with, or any



part of; Crimson Elektrik, the company that is now their biggest rival. Tim Nind, Quantum's designer and brain trust, left Crimson to form Quantum and is rightly giggled by being repeatedly referred to as part of the company he is now in battle against. The products are both black(!) and that is as far as any similarity goes.

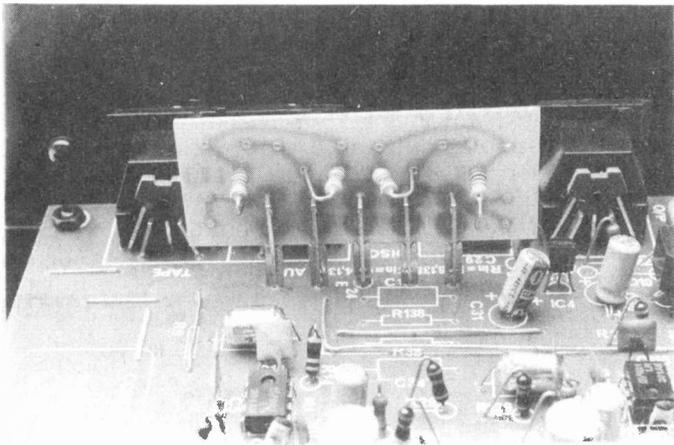
## One Oh Two Preamp

The 102 replaces Quantum's earlier 'dual-version' machine, employing instead a very well thought out 'matching card' system to cater for all sorts of pickup cartridge from moving coil on down through any sort of magnetic variation.



Above: the 102 Quantum pre-amp full frontal. It is black, of course.

A small edge connecting PCB is plugged into the main PCB and carries the input matching components. Thus by changing card any pickup loading can be optimised. Handy for people upgrading, the pre-amp never dates. Even handier for deranged souls like me who are always swopping cartridges around. A link has to be made/removed on the board for MC/MM, however, and I fail to see why this could not have gone on the matching card, too.



Above: the matching board for the pickup input in close-up. Note the nicely worked up edge connections. This particular board is for a Shure V15 IV pickup, I think. Trouble was I tried so many it is now impossible to remember which one was in when the camera went off!

Inputs and outputs are via DIN, with phono for disc. As I cannot abide DIN plugs of any sort, this drove me around the nearest loop, but no criticism intended, of the Quantum. As you can see from the photographs, controls have been "minimised" to a volume and balance with input selector arrangement. Adequate in most situations, but Baxandall help you if you live in an

awkward room as there is no tonal correction facility at all. Still, if you need it build an equaliser as treble and bass probably won't help anyway.

Tape sensitivity is variable by on-board switching and as all hardware is of board mounting variety there is little chance for noise/hum et al to creep in past the shielded cables that festoon most other equipment.

Table One displays the numbers, both claimed and measured, to which I'll return some paragraphs further on.

## Two Oh Four Power?

Long black boxes would appear to be the only way British companies can produce amplifiers. Where has all the chromium gone? I think the correct word to describe this shade of approach is functional.



Above: the 204 power amplifier. Finished in an unusual black (!?)

The 204 unit consists of two 110W audio modules, PSU with toroidal transformer (which buzzes audibly!) and separate supply for the pre-amp ( $\pm 15V$ ) One DIN (yeuk!) carries out the pre-amp volts and carries in the signal for amplification. Neat. Speaker output is via 4mm plugs. Thank God *this* isn't DIN.

The hardware package is more or less standard across the range, so that you can house any power you like, up to around 200W, in the same box.

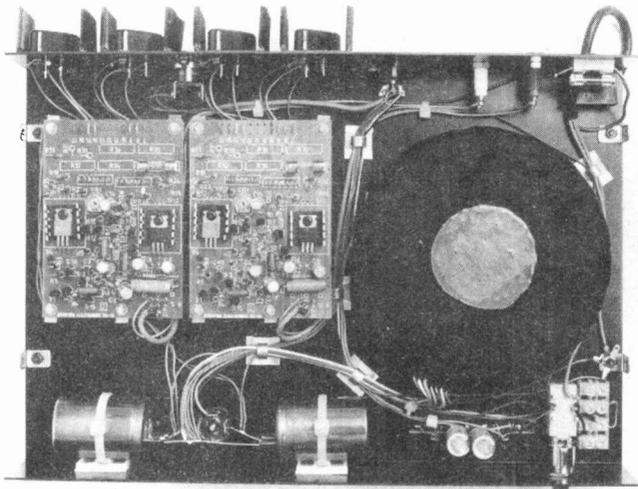
Table One

PARAMETER	SPECIFIED	MEASURED
THD	< 0.15% to clipping Moving Coil < 0.1% to clipping	below noise floor unmeasurable
Input Sensitivity & Overload	Disc 3.5mV or 100uV standard Variable Tape 150mV Disc 34dB Tape infinite	Disc overload 35dB at 3.5mV and 100uV
Signal to Noise	Disc 70dB ref 3.5mV or 52dB ref 100uV Tape 96dB	65dB/50dB 85dB
Frequency Response	Disc $\pm 1dB$ RIAA 50Hz-20kHz Tape —	agreed $\pm 1dB$ , 20Hz-20kHz
Separation	46dB at 1kHz, 36dB at 20kHz	45dB, 38dB (R on L)
Outputs & Impedances	775mV and 150mV tape 600R max, 1k $\Omega$ on disc, 10k on aux	agreed agreed

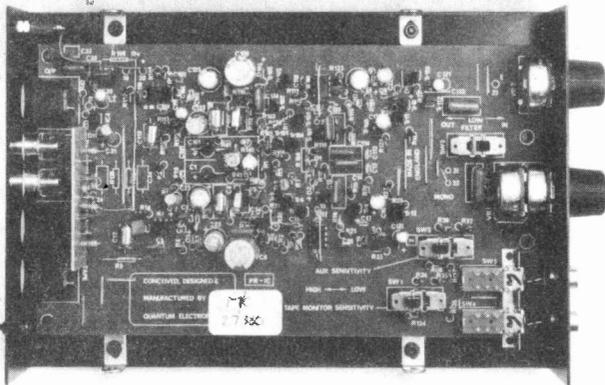
Table Two

PARAMETER	SPECIFIED	MEASURED
Output Power (RMS, 8R at 1kHz)	110W	121W
Peak Delivery	300 VA	205W
Signal to Noise Ratio (unweighted)	> 100dB	102dB
THD (any level to clipping)	< 0.015%	below noise
Gain	30dB	agreed
Power Bandwidth ( $-3dB$ )	6Hz-50kHz	5Hz-45kHz
Damping Factor (50Hz)	80	agreed
Input Impedance	50k	agreed
Protection Operation Load	[4R]	[4R3]

Tables One and Two. These are for the pre-amp and power amp respectively, comparing the claims against the measurements.



Above: the 204 power amp revealed. Note the huge toroidal mains transformer and pre-amp PSU board away to the left. Separate heatsinks are used for each power output device. Below: a de-cased 102 pre-amp. Most components are PCB mounted to cut down interwiring. Instructions on pickup matching are written on the inside of the lid! (not shown).



## Figuring Out The Figures

In summary of Tables One and Two we can say that the Quantum 102/204 is an amplifier of better than average noise performance with excellent distortion figures — or lack of them — which has a high enough overload on the disc input to ensure that no problems will ever be encountered in normal use.

The S/N on moving coil input is very good indeed, practically up to moving magnet input standards and has little hum component to give trouble. No mean feat this. My review model was set-up, to match the inevitable Coral MC81 as a 'norm', but I spent many a happy hour playing with the matching cards for Ortofon, Goldring and Shure moving magnet designs. The moving coil input bettered Coral's own H300 head amp for noise and distortion — which suggests that the self-standing Quantum moving coil pre-amps would be worth a look or two.

The 204s figures are unimpeachable — with the exception of that minimum impedance into protection. I would like to have seen around 2R there — the lower the better I suppose. Still it is honestly specified and lower impedance driving modules are available if you're troubled. In use the 204 drove my 105 IIs with no sign of distress at all. Check your speaker impedance curves before matching though. Better safe than burning.

## What A Turn On

Funny how all reviewers leave discussing the sound of equipment until the end of an article, as though we test it all out first, THEN sit and listen. No chance. Just like everyone else it's a case of home with the packages, out of the boxes and CLICK . . . . . In fact unwiring it all to start injecting boring test signals is the worst part of this job.

Quite frankly I didn't know what to expect from the Quantum, I knew the sound of its competitor Crimson well and respected it as the best module sound around and comparisons are inevitable I suppose. A direct AB test will have to wait though as our German edition has our Crimson set-up at present and is more than a little reluctant to part company with it. Damn cheek if you ask me, who won the war anyway?

So it is to the Lecson AC1/AP3 II combination that the Quantum was to be referenced, using KEF 105 II speakers and Coral MC81 and Ortofon/SME 30H cartridges. (The sound of the latter grows on me the more I hear it.)

With the 102 set to moving coil, the first thing I noticed was the much better noise performance. At first I thought something wasn't connected! The sound is open and beautifully rich in all the little things that make music on a good system worth listening to. The pre-amp is very good indeed, but I felt that against the Lecson the 204 lacked bass punch. The lowest registers were not as well defined, or as 'coherent'. Mid-range and treble were little different.

## Summary

In a word — yes. A good solid product which does its job superbly and gives excellent value for money, both in terms of its sound quality and its engineering. Home built hi-fi has a new championship contender!

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Below: the new Marantz Esotec TT 1000 turntable. This employs a glass and aluminium 'sandwich' as a base and a 5mm thick glass turntable mat. The idea is to cancel any resonances due to the base material and produce a truly non-resonant support. Air suspension is employed to hold this massive machine clear of the ground and the motor is claimed to have sufficient power to reach full speed in ¼ turn. Released in September — price not yet fixed, but will be VERY high.



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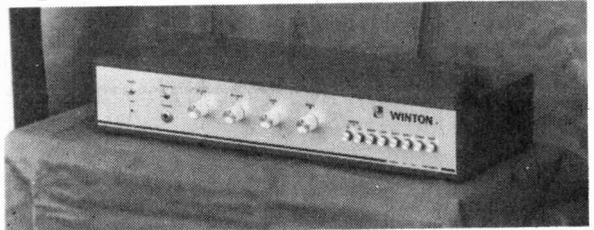
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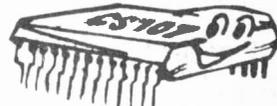
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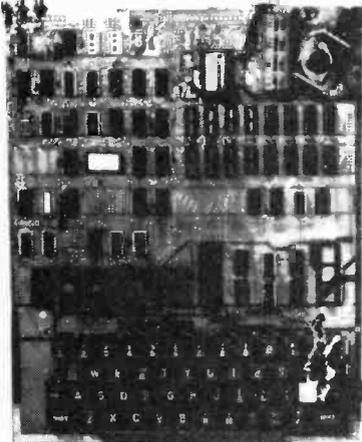
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# CAPACITORS AND TIME CONSTANTS

A.S.Lipson takes the bull by the time constants and explains how to use capacitors in timing circuits.

Those little brown discs or large blue cylinders that do funny things to your multimeter if you try to measure their resistances are frequently used as AC coupling devices, but they are also of great use in timing circuits. A resistor and capacitor together can produce a changing voltage whose magnitude at any moment can easily be calculated.

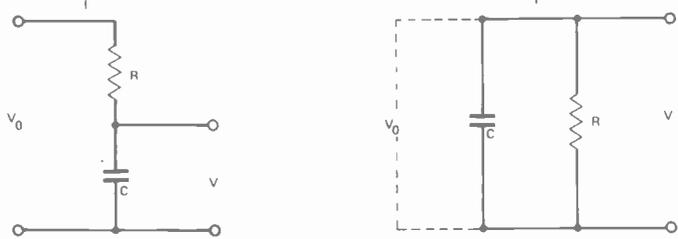


Fig.1 Series and parallel RC networks.

## First The Circuits

The first circuit in Fig. 1 consists of a resistor,  $R$  in series with a capacitor,  $C$ . A voltage,  $V_0$ , is applied across the combination and the output voltage (that across the capacitor) is monitored. The output voltage ( $V$ ) slowly rises from zero, coming closer and closer to the value of  $V_0$ , although it never actually quite reaches it. A graph showing output voltage plotted against time is shown in Fig. 2a. It is found by experiment that the rate of increase of voltage becomes smaller if either  $R$  or  $C$  are increased, and greater if either is decreased. That is, the voltage rises more slowly for large values of  $R$  and  $C$  than it does for small values of  $C$ . In fact, if we take the product  $R \times C$ , ( $R$  in ohms,  $C$  in Farads) we find that this gives the time (in seconds) required for the output voltage  $V$  to reach about two thirds the value of  $V_0$ .

The second of the two circuits consists of a capacitor and resistor connected in parallel. The capacitor is charged by an external source to a voltage  $V_0$ , and then disconnected. The output voltage,  $V$  is monitored once again. Here, we find that  $V$  slowly decreases from  $V_0$  to zero, getting smaller and smaller, but, again never quite making it (Fig. 2b). Again, it is found that the voltage changes more slowly if either the resistance or the capacitance (or both) are increased and changes faster if they are decreased.

## Time Constant

The product  $R \times C$  is called the 'time constant'  $\tau$  (the greek letter Tau) of the circuit and it can be used to find rough values for  $V$  at different times. It turns out that, no

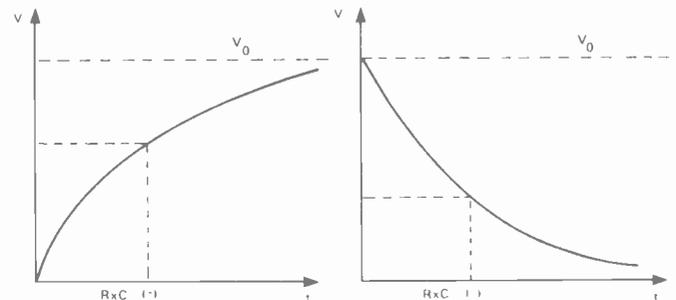


Fig.2 The output voltages associated with the RC networks of Fig.1.

matter how long the voltage has been changing in the circuit, it always takes  $\tau S$  for the voltage across the capacitor (in the first circuit) to increase by two thirds of the remaining voltage. eg If  $V_0$  is 9V, and the output voltage  $V$  at a time  $t$  is 4V, then after  $\tau S$ , at time  $t + \tau$ ,  $V$  will have risen by two thirds of  $(9 - 4)$  volts, or 3 1/3 volts. This can be used to plot a graph of  $V$  against time. At  $\tau$  seconds,  $V$  will be two thirds of  $V_0$ . At  $2\tau S$ ,  $V$  will have risen by two thirds of the remaining voltage, ie by two thirds of  $1/3 V_0$ , and will thus have risen to eight ninths (approximately) of  $V_0$ . Similarly, voltages at  $3\tau S$ ,  $4\tau S$  and so on may be calculated and plotted on a graph (Table 1 and Fig. 3). A line may then be drawn in freehand, joining the points, and approximate values for  $V$  at different times calculated.

This is all very well for rough values, but it is of considerably less use if we want to find exact figures — especially at times much less than the time constant. Fig. 4 shows a freehand curve drawn onto the first three calculated points on a graph. We know nothing from our method about the voltage before it reaches 2/3 of its final value, except that it starts at zero. The correct graph could be A or B or anything in between — we have no way of knowing,

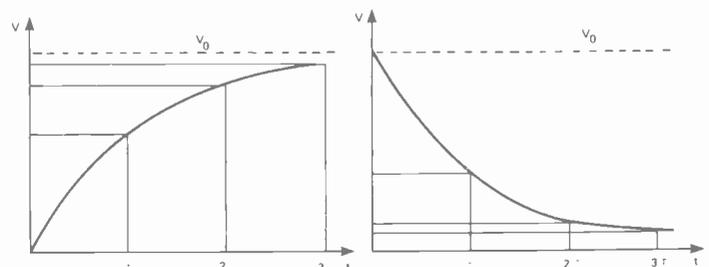


Fig.3 Plotting graphs of output voltage against multiples of time constant.

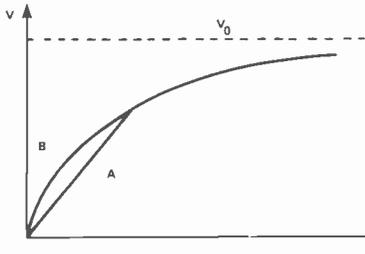


Fig.4 A freehand curve drawn onto the first three points calculated.

## Curve Drawing (No, Not . . .)

It is an interesting and useful property of the way in which the voltage changes in these circuits that, at any instant, if the voltage continued to increase (or decrease) at the same rate, it would reach its final value in exactly  $\tau S$ . The reason why it doesn't actually do this is simply that the rate of increase is not constant. As the voltage becomes larger (Fig.1a) or smaller (Fig.1b) its rate of change decreases. However, as has been stated, if the rate of increase of the voltage,  $dV/dt$  was constant from any time  $t$ , then  $V$  would reach  $V_0$  (or zero, as the case may be) at time  $t + \tau$  (Fig.5).

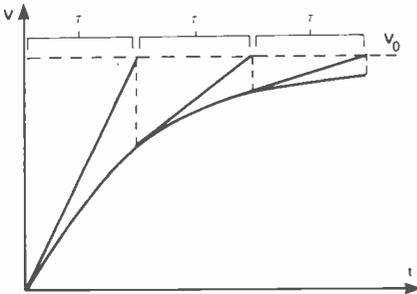


Fig.5 V tends towards  $V_0$ .

We can make use of this property of the curve. Mark on the graph (Fig.6) a line representing the final voltage,  $V_0$ , of the system. Now mark along this line a distance  $\tau$  from the beginning (point A) and draw in a straight line from this point to the origin, 0. This, then, will give a fair approximation to the voltage as it changes in the first few moments. Now choose a point on this line, near the bottom (P1). Mark a distance  $\tau$  along from P1 and find the point on the line representing  $V_0$  directly above. Call this point B. Draw a line from P1 to B. Now choose a point P2, near P1 on this line, and repeat the same process. Eventually, the lines shape themselves round a curve, which turns out to be a fair approximation to the graph of voltage plotted against time.

This method is fine, but it has three great disadvantages; it takes a long time to draw the curve this way, it isn't very accurate beyond about  $2\tau$  and (as you will have realised if you had to read the last few paragraphs more than four times) it's complicated. If we want to find values of  $V$  beyond  $\tau$  seconds, we can use the first method of drawing the graph and if we want values of  $V$  for times less than  $\tau$  seconds, this second method can be used, but it is simpler, if we only want to know one value,

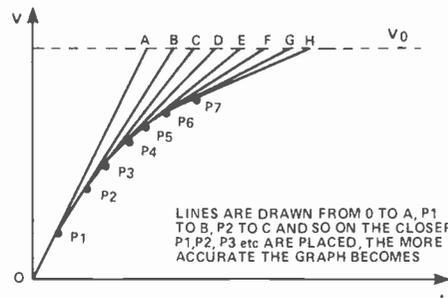


Fig.6 This method of drawing graphs is reasonably accurate up to twice the time constant.

LINES ARE DRAWN FROM 0 TO A, P1 TO B, P2 TO C AND SO ON THE CLOSER P1, P2, P3 etc ARE PLACED, THE MORE ACCURATE THE GRAPH BECOMES

## Capacitors.

We are so used to thinking in terms of currents and voltages that it is very easy to forget the existence of a more basic quantity — charge. Charge is what passes when a current exists. Current, then, is actually rate of passage of charge. Now capacitance is defined as the ratio of the charge stored in a component to the voltage developed across it. That is, if  $C$  is the capacitance in Farads,  $Q$  is the charge in coulombs and  $V$  is the voltage,

$$C = \frac{Q}{V} \quad \text{or} \quad Q = VC$$

We can differentiate each side of the equation:-

$$\frac{dQ}{dt} = \frac{d}{dt}(VC) = V \frac{dC}{dt} + C \frac{dV}{dt}$$

Now  $C$  is a constant, so  $dC/dt$  is zero:-

$$\frac{dQ}{dt} = C \frac{dV}{dt}$$

Finally, we can see that, since current is rate of flow of charge,  $dQ/dt$  is the current flowing into the capacitor, so

$$I = C \frac{dV}{dt}$$

Now let's take another look at the circuit in Fig.1a. If we assume that no current is being drawn from the output, then the current into the capacitor must equal the current through the resistor. The voltage across the resistor, though,  $V_R$ , is obviously equal to  $V_0 - V$ , and by Ohm's law;

$$(V_0 - V)/R = I$$

Therefore,

$$(V_0 - V)/R = C \frac{dV}{dt} \quad \text{or} \quad V_0 - V = RC \frac{dV}{dt}$$

This is the differential equation that must be solved to find  $V$ . The mathematicians out there might like to show that the equation is solved by

$$V = V_0 (1 - e^{-t/RC})$$

where  $e$ , as any scientific pocket calculator will tell you, is 2.7182818 and  $t$  is the elapsed time. This is the equation we can use for precise values. We'll do an example; a 9V power source is connected across a series combination of a 47k resistor and a 10uF capacitor. What is the voltage across the capacitor after 0.6 S? Fitting the values into the equation:-

$$\begin{aligned} V &= V_0 (1 - e^{-t/RC}) \\ &= 9 \times (1 - \exp(0.6 / (4.7 \times 10^4 \times 10^{-5}))) \\ &= 6V49 \end{aligned}$$

(If you don't believe me, try it . . .)

A similar sort of argument works for the circuit in Fig.1b. The output voltage  $V$  is given, by Ohm's law, by

$$V = IR$$

However,  $I$  in this case is the current flowing out of the capacitor, and so it is given by the relation

$$I = -C \frac{dV}{dt}$$

Hence we have

$$V = -RC \frac{dV}{dt}$$

And we find that this differential equation has the solution

$$V = V_0 e^{-t/RC}$$

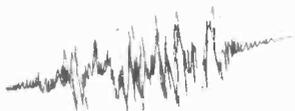
where  $V_0$  is the voltage to which the capacitor was charged.

Let us suppose we have a 200 uF capacitor in parallel with a 330k resistor. The capacitor is charged up to 12 V and the supply removed. What is the voltage across it after 2 S? Well, plugging these values into our equation,  $V_0$  is 12 V,  $t$  is 2 S,  $R$  is  $3.3 \times 10^5$  ohms, and  $C$  is  $2 \times 10^{-4}$



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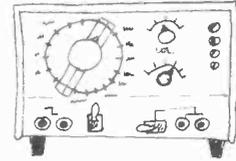
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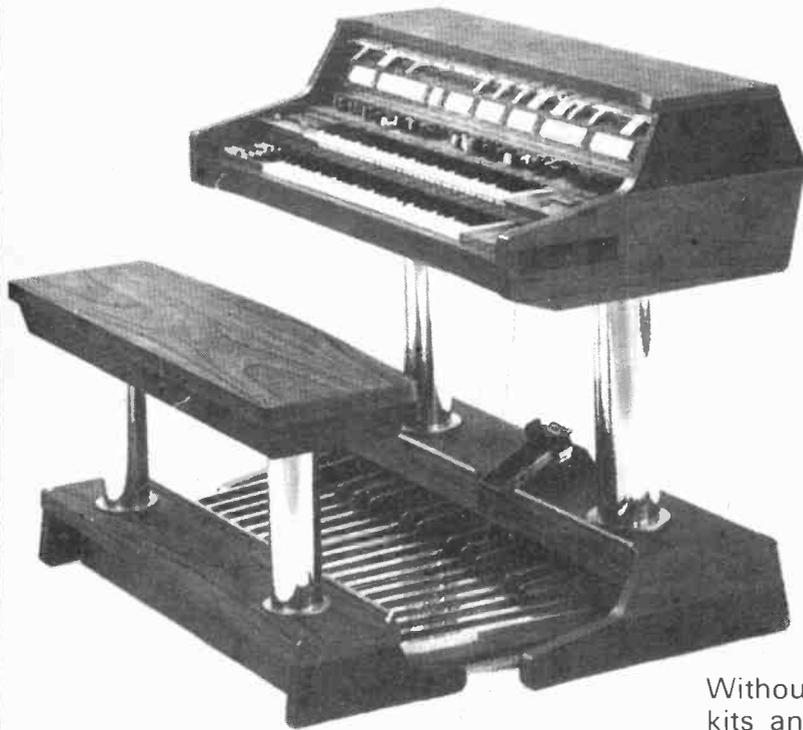
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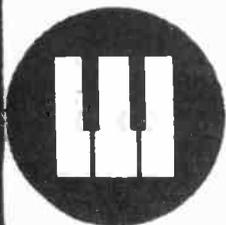
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# MICROFILE

By popular request Henry Budgett reviews the Sinclair ZX 80 microcomputer kit.

Ever since the first announcements and press comments on the new Sinclair ZX 80, Microfile's phone has been ringing with readers asking for a review. Well, after a few months of controversy and careful study here is the report you've all been waiting for.

## Kitted Out

If a system such as the ZX 80 is offered in kit form, it is often worth buying it in this form to save the odd few pounds and so we took a kit and built it. There are few components that raise any eyebrows and the whole thing was slotted neatly together in less than two hours. Whilst we were putting it together we also built in the suggested modification to change the video from black on white ("standard") to white on black ("normal") and this has proved very useful.

The instructions supplied with the kit are adequate and clear enough to allow any reasonably competent constructor to achieve success. There is a circuit diagram of sorts. We found great difficulty in deciphering the various bits and pieces so it would not be of any great help in debugging a "dead" system.

## The Great Turn On

The first thing to be said about the ZX 80 is that it worked, albeit a little hesitantly. I am rather accustomed to full size keys and have yet to come to terms with a touch keyboard. It does work very well, though, and shows no signs of wearing away even after weeks of hard use. The TV picture produced by the system is less than satisfactory. The much publicised juddering when keys are pressed is not in the least beneficial and, when you actually get round to running a program, the blank and flickering screen is positively unnerving.

The BASIC has been another point of considerable controversy. Inside the 4K ROM is a compressed Integer BASIC, the character set and the (minimal) operating system or monitor. This BASIC may give the beginner a feel for high level language programming but anyone who has used systems such as PETs or Apples will find it very restrictive. The single keystroke programming facility is certainly not my cup-of-tea. I'm too used to typing the whole thing out, but it would be of benefit to the beginner.

## Manual Intercourse

The "Course in BASIC Programming" that is supplied with the system is a very poor substitute for books such as "Basic BASIC" and "Illuminating BASIC" but is adequate for finding your way round the ZX 80. The format needs to be considerably improved, odd and even chapter numbers are aimed at different people. There are a number of errors; some are corrected in an addendum, but several trap the unwary.



The explanation of many of the functions of the system is very poor indeed and in some cases can lead one rather up the garden path. The best function concealed within the system is the Editor, truly a marvellous system. We did wonder why they had made it so good. It must use up a fair proportion of the available space which, it could be argued, would be better used by providing more BASIC functions.

## The Ins And Outs

Tape interfaces come in many different disguises. The ZX 80 is no exception and offers an "around 300 Baud" audio cassette interface which works tolerably well. You can experience trouble if you leave both input and output jacks connected to the tape recorder but I gather a note to this effect is being included in the manual. The VDU is less praiseworthy, the aforementioned flicker being just one of its little quirks. The problems really start to occur when you find that the program crashes every time you fill the screen. The cause is that the VDU is acting as a serial output device and needs a buffer. When the buffer is full it stops everything and tells you — nasty!

We also encountered another interesting VDU quirk for which there appears to be little explanation. On some TVs you encounter you will find that white on black is unreadable but black on white is, or vice versa. We also discovered, again no explanation is offered, that the system would produce a double (ghost) image on some colour sets. The designer assured us that the modulator was not, as we had suspected, a cheaper version that could not handle the bandwidth so there must be something funny going on.

## Hardware Design

A certain number of design features of the ZX 80 are worthy of note. It is generally understood that an eight bit micro, with its sixteen bit address bus, can have up to



NewBear's New Brain — a professional, hand-held micro ..... coming soon.

64K of memory hung on it. The ZX 80 offers a maximum of 16K of RAM and a (possible) 16K of ROM, done by moving PC tracks around. What you may well ask has happened to the other 32K? Sorry chaps, but it is used for other things like decoding the keyboard, so the thoughts of giant, disc based systems fade rather rapidly. Whilst on the topic of memory it should be noted that the 3K Sinclair RAM boards are *not* capable of being "piggy backed", you'll have to wait for the 15K RAM plane. You cannot use the cheaper dynamic RAM either because the RFSH signal produced by the Z80 CPU is utilised by the video synchronisation circuitry and this means that instead of getting a mean refresh every 2 mS that the dynamic memory needs, it may have to wait 20 mS, which is cutting things very fine. Under normal operating conditions this might not cause problems, but if the temperature of the RAM chips rises then they may well start to lose data.

The final oddity in the design of the hardware is the lack of a crystal controlled clock. It uses a ceramic filter instead. This is not to be recommended as it simply isn't accurate enough. The ZX 80 runs at 3.25 MHz, which is a multiple of the TV linebase frequency. The filter appears to be used to save a couple of divider chips and possibly pass this saving on in a reduced price, but it should be remembered that the earlier Sinclair computer, the now defunct Mk 14, was equipped with a crystal and cost about half the price.

## Expansion Capabilities

Apart from the memory expansion problems mentioned earlier, there is another, more subtle, problem that will occur when the user wishes to attach that most popular of peripherals, the printer. This problem arises because the ZX 80 does not use the normal ASCII character code set but its own. This means that to interface to a printer, a task of more than average complexity, the user will have to write a look-up table routine to convert between the two code sets.

However, the first thing that any expansion minded user must do is to put buffers onto all the bus lines. Space and pricing have omitted these and, although it is hoped that Sinclair will produce a buffer board, it does not appear to rank highly on their list.

Mention has been made of certain possible add-ons like Prestel and it is worth making the point that, because the ZX 80 uses a serial output screen format rather than a memory mapped type, it will be almost im-

possible to connect exotic systems such as Viewdata and Teletext. In the same way it is impossible to use the ZX 80 for playing interactive video games of the Space Invaders type.

## Software

At the moment there is not much commercial software available. The Users Group is probably the best source after magazines like Computing Today, but there are very strong indications that a professional software house will be supplying the user with a range of programs. For users who are looking for software now the following points should be borne in mind;

- a) the BASIC is Integer only,
- b) the cassette format is not "standard",
- c) you can't use interactive graphics, PEEK and POKE,
- d) The BASIC is not compatible with Microsoft types, in *either* direction.

## Conclusion

Sinclair and his Science of Cambridge team have produced what is probably the forerunner of the 1980 generation of personal computers and in common with most "firsts" it has a number of faults that its competitors will rapidly seek to iron out of their, yet to be released, products. The currently poised opposition include Acorn with their Atom, NewBear with the New Brain and (allegedly) Sharp with a similar type of system. The competition is going to be fierce and as yet Sinclair is the only runner in the race.

As regards the system we feel that it would probably make a starting point for the complete beginner, but for anyone experienced in microcomputing it may not have sufficient facilities compared with other low cost systems like Acorn and Tangerine. The lack of proper machine code access may put the system down in some people's opinions but as a first time system for the complete beginner, be they in the classroom or at home, it is currently the cheapest and that may well be the overriding factor.

## New from NewBear

Newbury, the terminal company who opened the NewBear computing shops to gain access to the world of microcomputing, have launched a professional hand-held micro for anyone from businessmen to the hobbyist. Called New Brain it contains a 16K Compiling BASIC, 2K RAM which is expandable to 4K in static or 16K in dynamic, a full size QWERTY keyboard, single line display with direct video output and enough I/O to make most systems look a bit undernourished. The whole thing is battery powered, with charger capability and uses a COPS chip from National Semi to look after the keyboard and display (which powers down after 60 seconds of inaction). The main computing is provided by a Z80 which only powers up when you actually RUN a program. The machines we were shown at the Press launch were unfortunately only half built and they are not expected to be available until at least September, so we can't get our hands on one yet. When we do we'll tell you what it does but expect the prices to be from £150 (video only) to £250 (full system). One feature that I will tempt you with is the fact that they have committed themselves to Prestel — it has a button on the front marked Viewdata.

**ETI**

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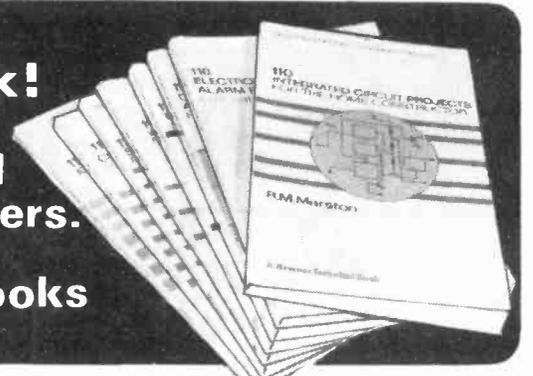
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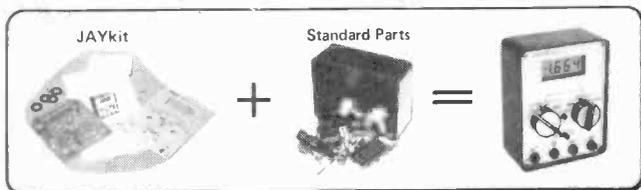
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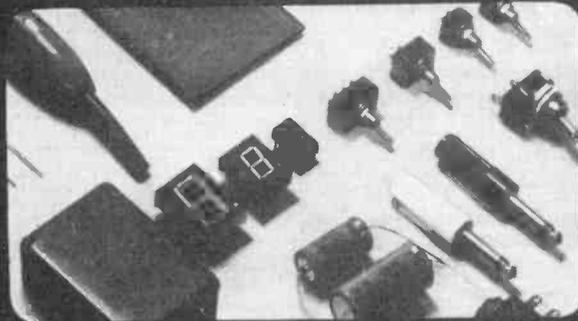
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# TECH TIPS

## Multi-Flash Trigger

R O'Rourke, Eastleigh

This circuit provides a cheap and safe system for parallel connection for electronic flashguns and prevents damage to shutter sync. contacts.

Electronic flashguns used for photography usually have a voltage of between +200 V and +400 V present at the trigger input connector.

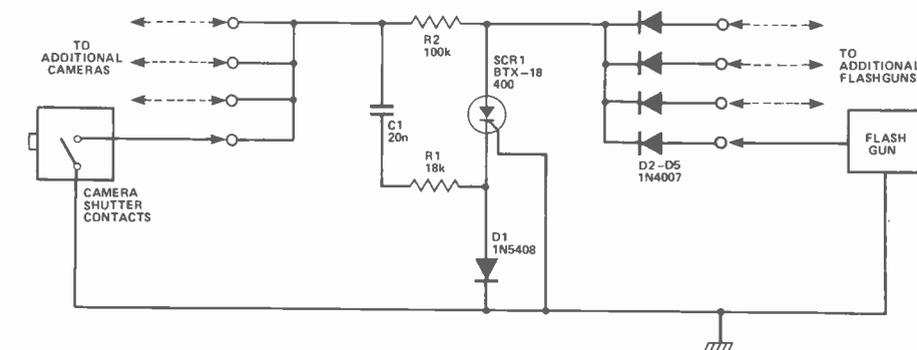
The flash unit operates when the trigger is grounded (by the shutter sync. contacts) and a current pulse of between 1 and 3 amps, lasting about 10 to 30 microseconds is carried by the sync. contacts.

Direct connection of electronic flashguns in parallel can cause two major problems:

- (a) Different makes or powers of flashguns may have different operating voltages and may therefore be damaged by parallel connection.
- (b) Shutter contacts could be damaged or burned by the excess current of multiple gun operation.

This circuit overcomes these two problems as follows:

- (a) Diodes D2 to D5 effectively isolate the hot side of each flashgun from the next and also prevent the high voltage appearing on the unused flashgun contacts.
- (b) The SCR trigger circuit operates as follows:



When one or more flashguns are connected to the unit, the cathodes of D2-D5 rise to a high positive value, say +200 V.

C1 is charged via R2, R1 and D1 in a time constant  $C1 \times (R1 + R2) = 0.02 \times 118 \text{ k} = 2.36 \text{ ms}$ .

SCR1 is non-conductive at this time as its cathode is slightly positive and its gate is grounded.

When the shutter contacts of a camera connected to the device are closed the R2 end of C1 is grounded and therefore the R1 end is driven negatively to -200 V. This enables a negative current pulse to be delivered to the cathode of SCR1 (D1 allows SCR cathode to go negative) of about 11 mA, for about 360  $\mu\text{s}$  duration, this

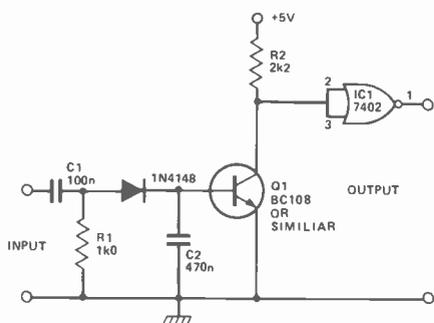
pulse turns on the SCR which then carries the trigger current of the flashguns.

When the flashguns fire the trigger voltage drops to zero and the SCR turns off. C1 will recharge as the voltage of the flashguns recover ready for the next flash.

As can be seen, the maximum current through the camera contacts is thus reduced even with a flashgun voltage of 400 V, to only 22 mA.

When using more than one flashgun in a direct lighting system, allowance should be made for the increased guide number:-

$$\text{Effective Guide Number} = \sqrt{a^2 + b^2 + c^2 \dots}$$



## Simple Cassette Interface

R Thomas, Port Talbot

The cassette interface on my NASCOM1 has never worked correctly and despite many frustrating fault finding sessions the only solution was to replace it. No originality is claimed for this circuit. Indeed anyone with a basic knowledge of electronics or radio will recognise part of it as an envelope detector or demodulator. No alteration of the cassette output of the NASCOM is required assuming it dumps properly.

Take the output of the 7402 to the serial input link LK3.

Component values are not that critical and by inserting another resistor and capacitor of the same value in front of C1 and R1 the response will be improved, although I did not find these necessary. The interface does require a fairly large input signal and the volume setting is rather precise but once set the interface should work perfectly. Although built for the NASCOM, the interface will work with any low speed cassette interface system that switches an audio frequency on or off.

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.

## VDU Shift Control

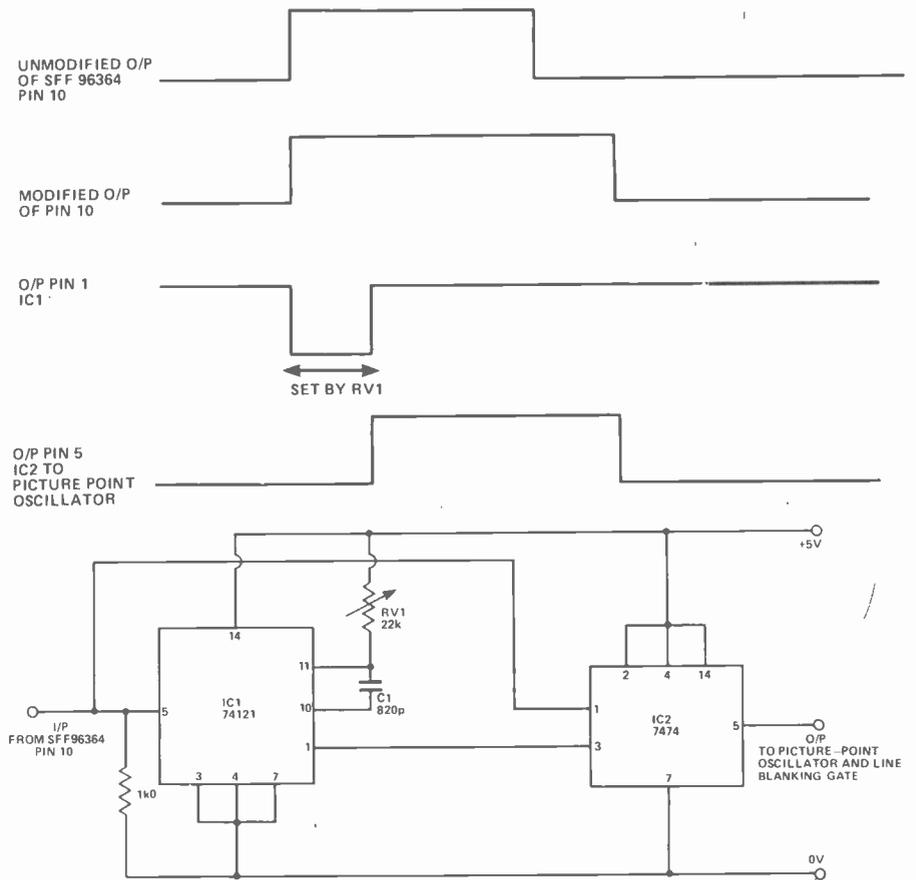
R J Cheason, Fareham

Most low cost VDU boards using the SFF96364 do not have the facility to adjust the monitor/TV picture left or right. This circuit was developed for a VDU board using the 'Triton' design but is suitable for any board using the same controller.

The SFF96364 outputs a pulse on Pin 10 enabling the picture - point oscillator. The counter/divider then outputs a pulse to the controller every character, stepping the character address. After 64 characters Pin 10 goes low.

The modified circuit uses the positive going edge from Pin 10 to trigger a monostable whose pulse length is set by RV1 and C1. When the monostable's output goes high it triggers a flip flop into the high state. After the current line has been output, the input from Pin 10 goes low clearing the flip flop and stopping the picture - point oscillator.

In practice slight jittering was caused by interference on the supply lines, but it was found that a capacitor of about 100 uF across the supply close to IC1 cured this problem.



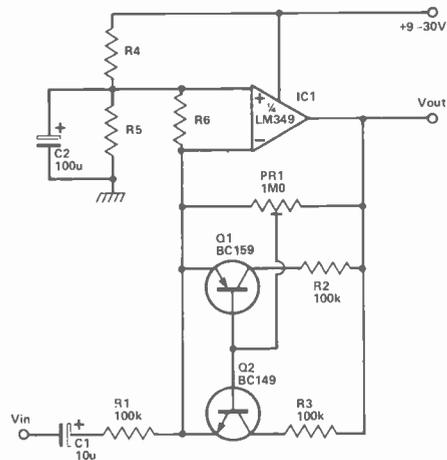
## Soft Limiter

J.P. Macaulay, Crawley

One of the fundamental differences between valve and transistor amplifiers is their behaviour when driven into clipping. The valve amps go into so-called soft clipping whilst their transistorised counterparts generate large quantities of harmonic distortion. The circuit shown simulates the soft clipping of valve amplifiers and is intended to be used between the power amplifier's input and the preamplifier's output.

R4 and R5, decoupled by C2 set a half supply reference for the non-inverting input of the op amp. Input signals are fed into the inverting input via the DC blocking capacitor and R1, the latter defining small signal gain and input impedance.

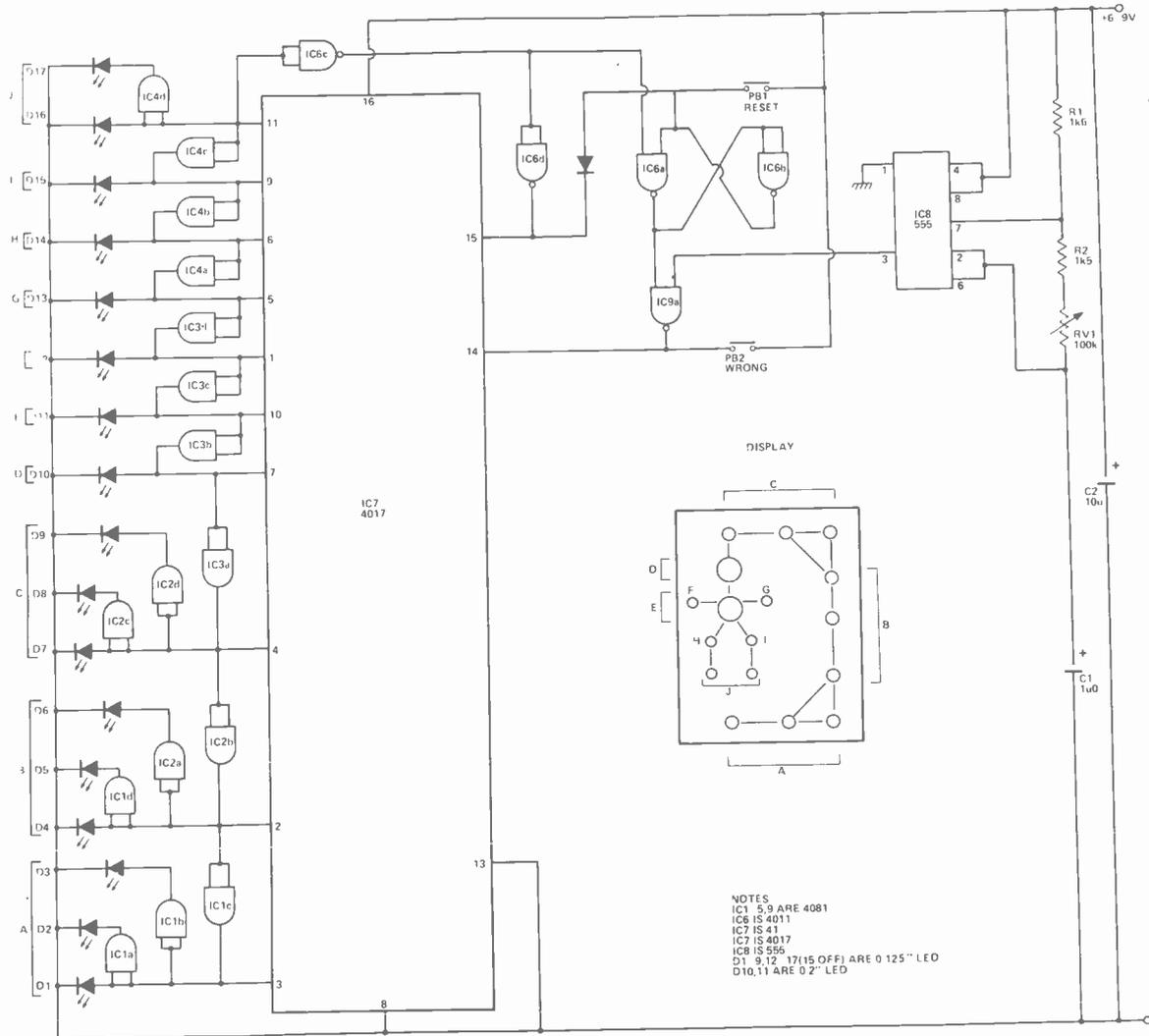
For small signals the amplifier's output is an exact unity gain copy of the input. As the signal level increases, however, the time will come when the voltage across the output and slider of PR1 will be sufficient to bias Q1 or Q2 on. When this occurs the feedback



increases due to the shunting effect of R2 and R3.

The net effect is that musical peaks above a certain threshold are reduced in amplitude to prevent the power amplifier going into hard clipping. As a result distortion is noticeably decreased, whilst the subjective loudness appears unaffected.

The circuit is adjustable in operation between 130 mV and 10 V rms input sensitivity by means of PR1. To set the circuit up simply set the slider so that it is shorted to the output of the amp. Play some music at high volume through the system and adjust until the harshness just disappears. It's easier to do than describe.



## Electronic Hangman

G.N. Durant, Selby

The circuit diagram shows a design for an Electronic Hangman Game. The scoring display is made up of 0.125" and 0.2" LEDs, as shown. The controls consist of two one pole make push-buttons. The first button is pressed every time a letter is wrongly guessed. At the start of the game, the other button is pressed, to reset the display, blanking it. When a letter is wrongly guessed the 'wrong' button is pressed once, and the first part of the display, (A), is illuminated. Every time another wrong letter is guessed, the 'wrong' button is pushed, and the next part of the display is lit up. When the display is all lit up, and the victim is 'hung', the display automatically blanks.

Now this is where the clever bit comes in. To show that the victim has lost, the display is blanked, then the first part of the display lights itself, then the next part and then the one

after that. In fact, all the parts light up in sequence, until the last part lights, when the display blanks again, and the whole 'chasing' process starts again. This process repeats itself until the 'Reset' button is pressed, when the display blanks, ready for a new game to begin.

The circuit consists of eight ICs, one of them being a 4017B CMOS device. This device is a ten stage decade counter. Each output is fed directly to its own LED and, because some outputs require more than one LED and there is not enough current from the 4017 to drive more than one, the affected outputs are connected to a CMOS 'AND' gate which is in turn connected to a LED, so the required power is obtained from the power supply and not the outputs of the 4017. The input of the 4017 is triggered by a push button connected to the positive supply rail, so when it is pushed (Wrong button) the IC is triggered and the next part of the LED display is illuminated. The 'lower' LEDs are kept lit by another

AND gate, connected as a chain linking each output of the 4017, so their outputs will go high, when a 'higher' LED is lit.

When the top LED is lit, another AND gate (gate 3, IC 6) goes low, locking a latching flip-flop formed by gates 1 and 2 of IC6, a CMOS NAND gate. This latch allows the output of an astable multivibrator to go to the trigger input of the 4017 and to start the automatic sequencing. The reset button makes the input of one of the gates go high, unlatching the flip flop and resetting the display. The small preset varies the clock rate over a wide range, speeding or slowing the sequencing.

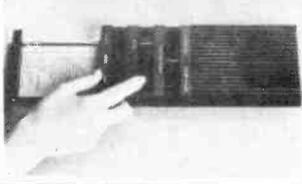
If desired, a 'Display PCB' can be designed to ease the LED wiring. When the circuit is known to be functioning correctly, lines can be painted onto the display to join up the LEDs, and to make them appear as a 'picture'.

When all the LEDs are illuminated, the circuit will take a great deal of current, so a mains power supply is advised.

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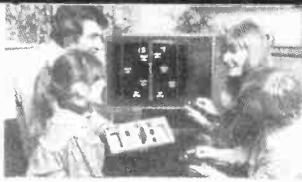
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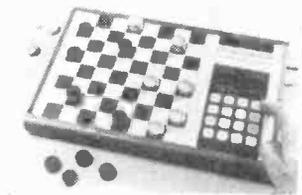
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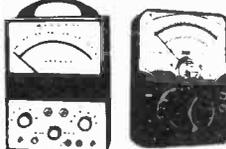
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100						100			100	100	100	100	100	100	100	100	100
150						120			120	120	120	120	120	120	120	120	120
220						150			150	150	150	150	150	150	150	150	150
330						180			180	180	180	180	180	180	180	180	180
470						220			220	220	220	220	220	220	220	220	220
680						270			270	270	270	270	270	270	270	270	270
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HEF4014	105	HEF4057	475	HEF4522	235	74LS11	26	74LS109	45	74LS196	162	74LS294	207	LM339N	78	IN4011	5	2N4017	21	BC247L	13	CL850B	2850
HEF4015	100	HEF4058	475	HEF4523	150	74LS12	26	74LS112	45	74LS197	132	74LS295	207	LM339N	78	IN4012	5	2N4019	46	BC247L	13	CL850C	2850
HEF4016	57	HEF4059	22	HEF4524	138	74LS13	48	74LS113	45	74LS198	132	74LS296	207	LM339N	78	IN4013	5	2N4020	46	BC247L	13	CL850D	2850
HEF4017	100	HEF4060	22	HEF4525	138	74LS14	74	74LS114	45	74LS199	132	74LS297	207	LM339N	78	IN4014	5	2N4021	46	BC247L	13	CL850E	2850
HEF4018	100	HEF4061	22	HEF4526	138	74LS15	26	74LS125	53	74LS200	206	74LS298	207	LM339N	78	IN4015	5	2N4022	46	BC247L	13	CL850F	2850
HEF4019	58	HEF4072	23	HEF4527	98	74LS16	19	74LS126	53	74LS201	206	74LS299	207	LM339N	78	IN4016	5	2N4023	46	BC247L	13	CL850G	2850
HEF4020	112	HEF4073	23	HEF4528	98	74LS17	26	74LS132	78	74LS202	206	74LS300	206	LM339N	78	IN4017	5	2N4024	46	BC247L	13	CL850H	2850
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HEF4023	22	HEF4076	22	HEF4531	214	74LS20	19	74LS139	99	74LS205	117	74LS303	206	LM339N	78	IN4020	5	2N4027	46	BC247L	13	CL850K	2850
HEF4024	76	HEF4077	23	HEF4532	214	74LS21	27	74LS143	88	74LS206	117	74LS304	206	LM339N	78	IN4021	5	2N4028	46	BC247L	13	CL850L	2850
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HEF4026	244	HEF4079	23	HEF4534	122	74LS23	19	74LS145	93	74LS208	321	74LS306	206	LM339N	78	IN4023	5	2N4030	46	BC247L	13	CL850N	2850
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HEF4028	89	HEF4081	80	HEF4536	149	74LS25	27	74LS147	93	74LS210	117	74LS308	206	LM339N	78	IN4025	5	2N4032	46	BC247L	13	CL850P	2850
HEF4029	113	HEF4082	80	HEF4537	149	74LS26	35	74LS148	93	74LS211	117	74LS309	206	LM339N	78	IN4026	5	2N4033	46	BC247L	13	CL850Q	2850
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HEF4031	250	HEF4084	219	HEF4539	149	74LS28	60	74LS150	93	74LS213	117	74LS311	206	LM339N	78	IN4028	5	2N4035	46	BC247L	13	CL850S	2850
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HEF4035	107	HEF4088	107	HEF4543	149	74LS32	35	74LS154	117	74LS217	117	74LS315	206	LM339N	78	IN4032	5	2N4039	46	BC247L	13	CL850W	2850
HEF4036	107	HEF4089	107	HEF4544	149	74LS33	35	74LS155	117	74LS218	117	74LS316	206	LM339N	78	IN4033	5	2N4040	46	BC247L	13	CL850X	2850
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# RAVEN ON

Dave Raven of Metac Electronics reports on a revitalised Swiss watch industry and the programmer catastrophe.

To make a fortune in electronics is not an unrealistic ambition in the 1980's. It compares favourably with the earlier successes of entrepreneurs at the turn of this century, making fortunes from the boom in bicycles and then motor cars. Similarly, young dynamic companies have emerged all over the world feverishly setting up new businesses that are associated with the enormous boom in the microchip industry.

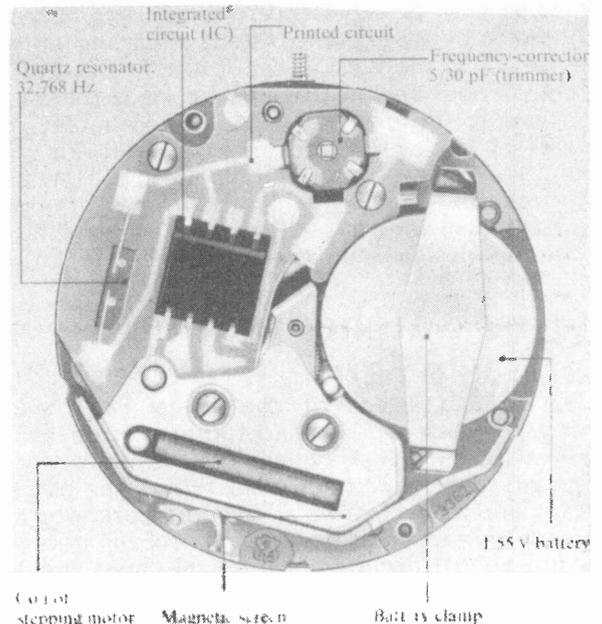
At this time of year students face a major challenge in the examination room which they perceive as directly affecting their future careers. With the right results at hand the next task is to start selecting a suitable job with prospects for the future. If electronics and cash are the big motivators, then much thought must be given, since some areas of this industry will in the next decade be prepared to part with larger sums than others. Supply and demand is still the order of the day, even in science, and if cleaning ladies are in short supply then they will command a higher salary than say a PhD Physicist.

The increasing popularity of microcomputers has placed industry on a direct collision course with a major obstacle. With some careful planning now our intrepid students may find this rich in rewards by the mid 1980's. A software crisis large enough to slow down the whole business of microcomputer expansion is looming high over the horizon. The simple arithmetic which can confirm this shows that although the numbers of microcomputer designs is increasing by 30% a year the cost of implementing the designs will double. In the USA it has been estimated that by 1990 they will require at least one million software engineers and since the electrical engineers graduating at present can be numbered in only thousands it is described as a "programmer catastrophe".

In addition to the limited educational system which is seen as a further major contribution to the potential software crisis, the cost of developing software is also seen as having serious consequences. The cost of purchasing the hardware is expected to change little since this reflects the increased memory capacity of the microchips. However, software costs have risen dramatically. The alternative open to the semiconductor giants is to develop more complex microchips which contain software packages within. Thus a programmer can reduce the time taken to assemble his software. This is similar to the developments of earlier circuit designs which have progressed from single discrete transistor design to designing with complex blocks of circuits. The cost of these new developments are enormous and only a few very large manufacturers can undertake projects on this scale.

## Microchip R & D

In the USA the Department of Defence have decided to implement a 200 million dollar programme for the development of very high speed integrated circuits (VHSIC). This money will be granted to companies in private industry to make it easier for them to build the



The new quartz analogue watch modules now look very similar to their digital counterparts. Typical thickness for these models is about 3.9 mm. Swiss companies have a great deal of experience in producing these and it will present a major challenge to Japanese and Hong Kong assembled watches.

advanced chips the military need and to stimulate the development of "integrated systems". Other American companies such as Intel will spend up to 150 million dollars on capital equipment in 1980 as part of their "integrated systems" programme. For the next decade or so I sincerely hope we don't have cause to fall out with the Americans since, as the decline of our own ability to fabricate microcircuits continues, we will be less able to compete in the manufacture of industrial equipment without supplies of devices from the USA.

Whilst other major industrialised countries are sinking cash into research programmes the UK Government have just announced that they intend to resist pressure for further state aid. The micro-electronics Industry Support Programme has been cut (not increased) from £70 million to £55 million over a five year period. Also the microprocessor Awareness Programme has retained its budget of £55 million over a three year period. This total cash is less than one medium sized USA company will spend on R & D during the same period. As for spending £55m on making people aware of micro-electronics I would have thought that regular reading of the electronics Press in the UK and USA would wake people up sufficiently to what is happening. This would of course be a lot cheaper and the real spending should be done on making devices. I suspect that most of this money will be spent on making up for the lack of technical education and ignorance that results from the narrow curriculum of the schools and universities where many of the nation's leaders spend their youth.





New generation of quartz LCD Watches. Sabre Alarm Chronograph uses standard watch cells and measures only 3.9 mm thickness.

It is easy to grow cynical on matters which are not every day problems to government. However, I am personally convinced that urgent attention must be given to our country's future role in electronics. The solution to our avoiding a software crisis and indeed an industrial crisis in Britain lies here within our shores. We can very soon find plenty of aware people if the cash is available to support them. Personalities like Derek Roberts who currently heads the GEC Hirst Research Centre and John Bass from Plessey, to name but two individuals, must have quite a lot of experience in organising microchip development between them. Instead of carting parties of TUC officials to the West Coast of America in search of awareness about how microchips are made they should take a bus to Towcester, Swindon or Wembley. Here they will see just as much technology and its all British. Forget Inmos factories in Colorado Springs. How about setting up something twenty minutes from Heathrow Airport or at least within easy distance of some of the best microcircuit designers in the world, here in England.

## Swiss watches return at Basle Fair.

The annual event of the Basle Fair, held in Switzerland each Spring, incorporates probably the largest exhibition held anywhere in the world for watches and clocks. This very traditional fete is the assembly point for watch buyers from all over the world who place orders for their full year's requirements. Exhibitors at the show are almost exclusively from the Swiss Industries with just a smattering of other European companies. Walking through the lavish exhibits of such famous names as Omega, Tissot and Rolex it was very hard to believe that the Swiss watch industry had just emerged from five years of nightmare competition. This of course was a result of the enormous increase in quartz electronic watches during this period.

The sudden arrival of LED and then LCD watches and the continued rapid developments of microchip technology produced shock waves which must have threatened the existence of many of the smaller watch producers. Hong Kong, who were at the very heart of this watch revolution, increased their market share in watches from being a net importer of watch modules from Switzerland to becoming the world's largest watch exporter and in terms of value of watch exports they now rank third.

The way in which the Swiss watch manufacturers operate must have considerably altered in the past five years, with a number of mergers and trading agreements taking place. The saving grace, however, seems to be the Swiss watch manufacturers' strong financial resources and also their ability to withstand change and rapidly learn new techniques.

The presentation by manufacturers at Basle for both digital and analogue display watches was of a very high standard. My biggest surprise, however, came from the strong contingent of quartz analogue watches. These models, which I previously thought were extinct, have risen once again in quite a different form. The first impression was that this was confirmation of the demise of the Swiss watch industry. Then after closer inspection I realised how much slimmer and neater these little beasts looked. I was left in little doubt that these will be well received in the watch market place despite my own prejudices towards mechanical displays. I feel their

popularity stems from the neater, cleaner looking design and also this new slimline case, which dispels the cause for much complaint in the past. Also quite a number of people, particularly those over a certain age, experience difficulty in seeing the digital display without spectacles. My additional suspicion for the strong emergency of quartz analogue was that the Swiss were probably struggling to keep up with the current level of high technology in the digital quartz. This was also quickly dispelled, I am pleased to report, since the electronic varieties were every bit as advanced as anything yet seen coming out of the Far East.

Quartz analogue watches deserve some further mention in particular because of the technical achievements which have occurred during their redevelopment. The Swiss have of course a long tradition in the manufacture of traditionally designed watches and they also have a large number of credits for new development work in the manufacture of watches. It was here that the thinnest watch ever made was produced in 1975 (1.2 mm). Its conception was quite revolutionary and was described at the time as defying the logical laws of watch mechanics. This same company incidentally has been taken over this past year by one Japanese company called K. Hattori, who, you may or may not know, own the brand name of Seiko.

On the new technology front, Bulova announced their rather unusual watch which drives its energy from the body's own heat. A voltage produced from the thermoelectric elements is transformed through a sophisticated electric circuit to the required voltage necessary to operate the watch. On attaining the required level of voltage, this energy is directed towards an accumulator, which is in effect a rechargeable battery. The average body temperature of 37°C delivers at the case back more than 1000 uW of "heat" power. The power consumed to operate a typical quartz wristwatch containing a tiny battery is approximately 2 uW. The device that Bulova has perfected receives from the thermo-generator approximately 8-12 uW. Therefore, the electric energy produced is four to six times greater than that which is consumed in operating the watch.

One other Swiss company in strong evidence was Buler, whose range of ultra slim analogue and digital models will certainly be serious competition for the Japanese quality watches. The new twelve digit quartz electronic model from Buler must be the most advanced module coming on the market this year and will further increase the market share for Swiss-made electronic watches.

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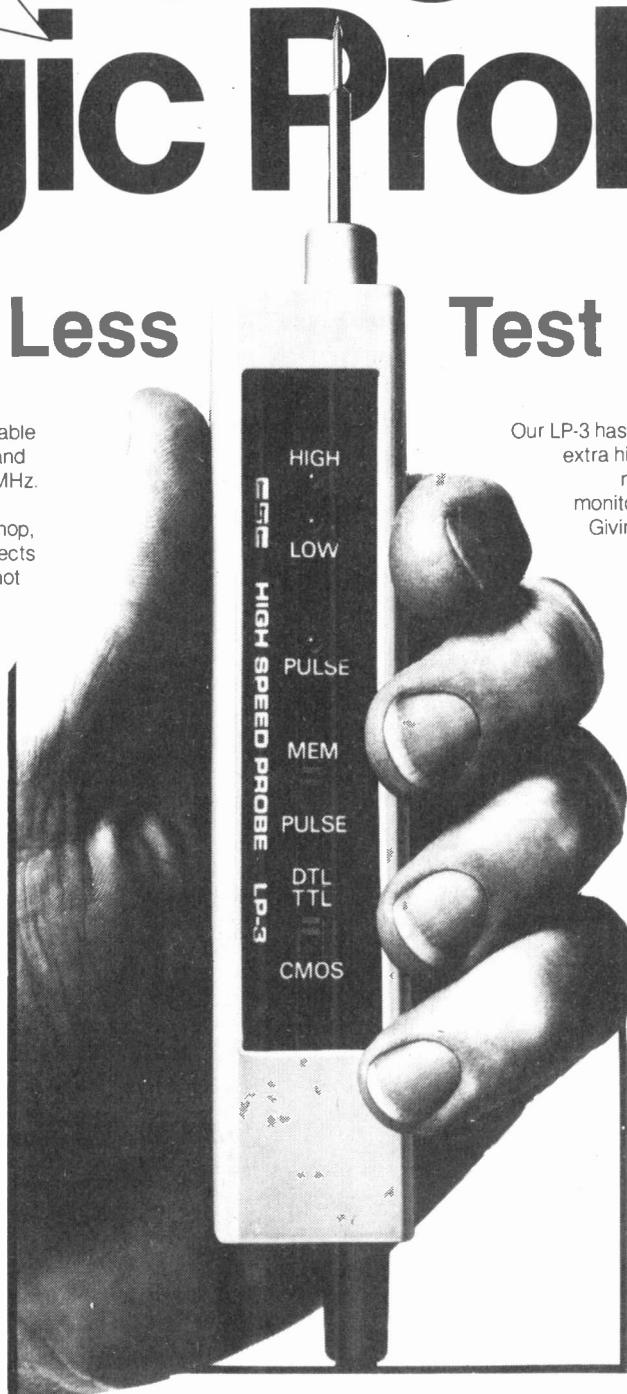
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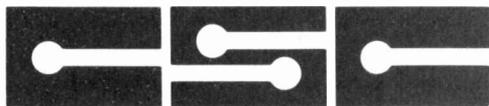
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BC160	35p	2N2217	20p
BC167A	10p	2N2219A	20p
BC178	12p	2N2221	18p
BC182	8p	2N2368	15p
BC182L	9p	2N2369	14p
BC183	9p	2N2894A	20p
BC183L	9p	2N2904	15p
BC184L	9p	2N2904A	15p
BC186	20p	2N2905	15p
BC212	9p	2N2906	15p
BC212L	9p	2N2926B	10p
BC213B	9p	2N2926C	10p
BC227	13p	2N3442	102p
BC232B	13p	2N3702	8p
BC337	16p	2N3704	8p
BC338	11p	2N3705	8p
BC440	32p	2N3708	8p
BC547	9p	2N3709K	8p
BC548	9p	2N3866	35p
BC550	14p	2N3906	10p
BC558	12p	2N4058	12p
BCY34	99p	2N4427	60p
BCY39	229p		
BCY58	16p	AA119	10p
BCY70	12p	BA154	9p
BCY71	12p	BA156	9p
BCY72	12p	IN4001	4p
BF179	25p	IN4002	4p
BF183	25p	IN4003	5p
		IN4005	5p
		IN4148	5p
		IS44	3p

## OPTO

Leds		
125 Red	10p	
125 Orange	10p	
125 Yellow	10p	
2 Red	10p	
2 Green	10p	
2 Clear	10p	

## DISPLAYS

704	110p
727	160p
741	160p
747	160p
750	160p

## REGULATORS

7805	57p
7812	57p
7815	57p
7818	57p
7824	57p
7905	140p
7912	140p
7915	140p
7918	140p
7924	140p
LM320T5	149p
LM320T8	149p
LM320T15	149p
LM330T18	149p
LM340T5	74p
LM340T15	74p
LM340T18	74p

## TRIACS

4A 400V	54p
4A 600V	66p
6A 400V	60p
6A 600V	66p
8A 400V	66p
8A 600V	72p
10A 400V	72p
10A 600V	84p
15A 400V	108p
15A 600V	126p

## TTL

7400	9p
7401	9p
7402	9p
7403	9p
7404	10p
7405	14p
7406	30p
7407	30p
7408	17p
7409	17p
7410	12p
7412	12p
7413	25p
7414	45p
7416	25p
7417	25p
7418	25p
7419	24p
7420	28p
7427	28p
7430	14p
7432	22p
7438	26p
7442	48p
7447	50p
7450	15p
7451	15p

## with internal trigger diac

74LS124	115p
74LS132	89p
74LS139	79p
74LS151	89p
74LS155	91p
74LS156	89p
74LS157	69p
74LS165	69p
74LS168	139p
74LS174	99p
7485	25p
7491	63p
7492	35p
7493	28p
7494	63p
7495	63p
74100	110p
74107	30p
74121	25p
74122	36p
74123	44p
74145	72p
74154	80p
74157	60p
74161	85p
74175	63p
74180	84p
74181	151p
74191	80p
74192	80p
74193	80p
74194	80p
74LS175	89p
74LS190	110p
74LS192	115p
74LS194	115p
74LS195	115p
74LS196	95p
74LS197	125p
74LS267	89p
74LS280	99p
74LS273	199p
74LS323	59p
74LS378	159p

## BRIDGES

	2A	50V	100V	200V	400V	600V
	4A	45p	52p	60p	75p	100p
		52p	60p	68p	82p	105p
		60p	68p	75p	90p	112p

## DIL SOCKETS

8 pin	10p
14 pin	12p
16 pin	13p
20 pin	15p
24 pin	30p
40 pin	40p

## CMOS

4000	14p	4072	17p
4001	14p	4073	17p
4002	14p	4075	19p
4006	69p	4076	75p
4007	16p	4077	35p
4008	79p	4081	19p
4009	36p	4082	17p
4010	36p	4160	105p
4011	19p	4161	105p
4012	16p	4162	105p
4014	59p	4163	105p
4015	73p	4402	36p
4016	42p	4404	110p
4017	79p	4412	86p
4018	79p	4445	174p
4019	45p	4446	148p
4020	89p	4507	99p
4021	83p	4511	89p
4022	79p	4512	89p
4023	16p	4514	229p
4024	45p	4515	229p
4025	17p	4516	99p
4026	129p	4520	70p
4027	39p	4522	125p
4028	59p	4526	125p
4029	89p	4531	125p
4030	40p	4535	92p
4034	1250p	4556	69p
4035	750p	4581	269p
4042	750p	4582	115p
4043	69p	4584	59p
4044	109p	4585	99p
4049	45p		
4050	63p		

# Greenbank

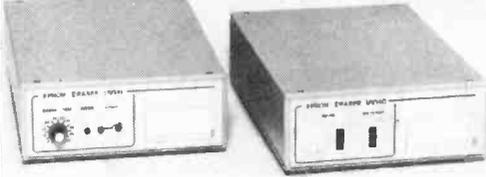
Greenbank Electronics  
(Dept TTE) 92 New Chester Road, New Ferry  
Wirral, Merseyside L62 5AG  
(Tel. 051-645 3391)



**TERMS, VAT, CWO.** Cheques etc payable to Greenbank Electronics and crossed. Add VAT to all prices at 15% except where stated otherwise. Post etc: UK 35p (+5p elsewhere = 40p) per order. Export: MO VAT but add 35p (Eire), 75p (Europe) and £2.50 elsewhere. Access: Barclaycard, Visa, telephoned orders accepted. (Polys, universities, gov depts, etc can telephone their orders for immediate delivery on account.)



## UV EPROM ERASERS



Two easy to use units designed for both the professional and amateur UV-prom user.

### Features:

- Can erase up to 14 proms.
- Special short wave ultraviolet tube.
- Erase time variable between 5 and 50 minutes in 5 minute steps (preventing over exposure which may shorten prom life).
- Sliding tray carries proms on conductive foam.
- Safety interlock switch prevents the timing circuit from operating and switching on the tube with the tray open.
- "Mains on" and "Tube On" indicators.
- Smart textured case.
- Complete instructions supplied.
- Supplied complete with mains plug and flex.

Model UV141. Price £77.70

Also available without timer as

Model UV140. Price £61.20

PROM WASHING SERVICE: 50p each prom

## COMPUTER BOARDS

The following is an extract from our leaflet ref. 'MP4', which is available free on request (a 9" x 6" SAE helps, but is not essential). See Microprocessor section to the right for board prices.

For many people the wide choice of microprocessors now available presents a difficult choice. To understand any particular microprocessor in depth a development system is almost essential, however in the past to understand more than one several separate development systems have had to be purchased.

The reason that separate systems, one for each processor, have been necessary is due to the fact that individual microprocessors have their own individual features in one case to access memory a separate read strobe and write strobe is required, in another a 'read/write' line is used in combination with a combined strobe called 'valid memory address and phi-2'. With some processors, the same address bus can be used for both memory and input/output ports, under the control of a 'memory request' or an 'input/output request' control line.

Naturally, if a development system takes advantage of any of the particular unique features of any particular microprocessor, this makes it more difficult to graft some other unrelated microprocessor onto the same bus at a later date. A Universal Micro System provides a basic bus structure on which any one micro-processor can be connected. The system uses a CPU (Central Processor Unit) card which is separate from the rest of the system, and this allows the same memory and interfaces to be retained when a different MPU is used.

The basic system bus consists of data and address buses together with read and write strobes. By locating the data input (Keyboard) and output (VDU) in the memory space then such chips as the 8080/8085 family, which normally use input/output ports, can now be used without any fundamental change to the bus (and as a bonus, users of these MPU's have all the ports entirely free for their own purposes).

The range of p.c.b.'s includes boards to implement a memory-mapped VDU, cassette interface, keyboard interface, PROM programmer, and a number of RAM and ROM cards. All the cards are of International Size 114 x 203 mm (4 1/2" x 8") except for the larger power PSU A power supply card. This latter card is sized so that it can be bolted to the side of a standard 4" chassis module which is then compatible with the other cards. The cards have a standard 43-way edge connector, with one position used for polarisation.

We do not propose to defend the (relatively small) number of bus connections (42), against such standards as the 'S100' bus. The S-100 bus, as it originated in America, is bigger and more expensive. In the same way, a Ford 'Granada' is bigger and more expensive than a 'Cortina', but it doesn't mean a 'Cortina' is a better value than a 'Granada'.

**NEW! 'ISBUS-1.1'**  
Low-cost commercial quality computer back board. 1.3" x 4 3/8" approx, for the International Standard (114x203mm) cards. Although intended for the 86-way double sided connector, it can be used with the 43-way connector specified for the computer boards we advertise. (Pin 37 is used for polarisation.)  
Takes up to 13 cards on 1" centres, and provides for 4 power rails, 58 parallel address/data etc. bus lines and 3 'daisy chains'.  
More details in our free leaflet 'ISB-1.1'.  
Existing enquirers Note Leaflets have been delayed, but will follow soon.

## CMOS

These cut prices for Amateur Users and Export. Note: industrial users - quantity prices available. Mostly Motorola, RCA

4000 18p	4042 80p	4096 95p	4451 £3.81	4549 £4.38
4001 25p	4043 90p	4097 £3.40	4461 £3.93	4552 £14.85
4002 25p	4044 90p	4098 £1.20	4462 £4.41	4553 £4.50
4006 95p	4045 £1.45	4099 £2.00	4490F £4.20	4554 £3.80
4007 18p	4046 £1.10	4100 £2.20	4490VP £3.14	4555 78p
4008 80p	4047 £1.00	4101 £1.32	4500 £6.95	4556 72p
4009 40p	4048 55p	4102 £1.80	4501 29p	4557 £3.86
4010 50p	4049 45p	4103 - £1.80	4502 £1.20	4558 £1.25
4011 25p	4050 49p	4104 99p	4503 70p	4559 £4.38
4012 18p	4051 80p	4105 99p	4505 £5.71	4560 £2.50
4013 50p	4052 80p	4106 90p	4506 50p	4561 81p
4014 84p	4053 80p	4107 60p	4507 55p	4562 £5.60
4015 84p	4054 £1.50	4108 £4.70	4508 £2.90	4566 £1.59
4016 45p	4055 £1.25	4109 £1.00	4510 99p	4568 £2.38
4017 80p	4056 £1.35	4110 £3.00	4511 £1.50	4569 £2.50
4018 89p	4059 £6.00	4114 £2.50	4512 90p	4572 40p
4019 45p	4057 £1.10	4182 £1.40	4514 £2.65	4580 £4.77
4020 99p	4052 £1.00	4192 £1.40	4515 £3.00	4581 £2.62
4021 £1.10	4063 £1.20	4193 £1.40	4516 £1.40	4582 £1.14
4022 £1.00	4066 55p	4194 £1.18	4518 £1.00	4584 90p
4023 27p	4067 £4.50	4195 £1.18	4519 80p	4585 £1.27
4024 50p	4068 27p	4257 £1.48	4520 £1.00	4587 £2.44
4025 £1.30	4069 27p	4161 99p	4521 £2.50	4588 £2.98
4026 27p	4071 25p	4162 99p	4522 £1.11	4599 £6.95
4027 50p	4072 25p	4163 99p	4526 £1.08	4700 £1.75
4028 84p	4073 25p	4174 90p	4527 £1.50	
4029 99p	4075 25p	4175 £1.15	4528 £1.11	
4030 55p	4076 £1.07	4176 £1.16	4529 £1.30	
4031 £2.00	4077 29p	4177 29p	4530 70p	
4032 £1.31	4078 29p	4469 £9.37	4531 £1.45	
4033 £1.80	4079 29p	4470 £9.37	4532 £1.30	
4034 £2.00	4081 27p	4471 £10.72	4534 £5.60	
4035 £1.10	4082 27p	4472 £10.72	4536 £3.69	
4036 £2.95	4085 74p	4473 £10.72	4537 £2.10	
4037 £1.15	4086 72p	4474 £10.72	4538 £1.20	
4038 £1.20	4089 £1.38	4475 £10.72	4539 97p	
4039 £2.95	4093 90p	4433 £12.30	4540 £1.19	
4040 £1.00	4094 £2.50	4434 £10.72	4541 £1.80	
4041 80p	4095 95p	4435 £3.81	4542 £1.80	

## 74C

74C00 33p	74C76 81p	74C163 £1.72	74C904 85p	74C926 £7.26
74C02 33p	74C77 81p	74C164 £1.62	74C905 £10.89	74C927 £7.26
74C04 33p	74C78 96p	74C165 £1.62	74C906 85p	74C928 £7.26
74C08 33p	74C79 £1.57	74C173 £1.35	74C907 85p	74C929 £17.90
74C10 33p	74C80 £2.28	74C174 £2.27	74C908 £1.44	80C95 85p
74C14 £2.12	74C81 £1.28	74C175 £1.27	74C909 £2.45	80C96 92p
74C16 £2.12	74C82 £1.28	74C182 £2.59	74C910 £1.10	80C97 92p
74C20 42p	74C83 £1.28	74C183 £1.72	74C911 £1.10	80C98 92p
74C22 42p	74C84 £1.28	74C184 £1.72	74C912 £1.69	80C99 92p
74C24 £1.38	74C85 £1.28	74C185 £1.72	74C913 £1.72	80C99 £2.90
74C28 £2.07	74C86 £1.72	74C186 £2.69	74C918 £1.59	80C99 £2.90
74C32 42p	74C87 £1.72	74C187 £2.69	74C921 £1.77	27.00 MHz £3.92
74C42 £1.38	74C88 £1.72	74C188 £2.69	74C922 £5.49	30.565 MHz £3.92
74C48 £2.07	74C89 £1.72	74C189 £2.69	74C923 £5.49	48.000 MHz £3.23
74C52 42p	74C90 81p	74C190 £1.72	74C924 85p	100.000 MHz £3.23
74C56 42p	74C91 72p	74C191 £1.72	74C925 85p	116.000 MHz £3.23

## MODULATORS

UM111, E36 UHF CA.36 Vision Modulator £2.50
UM1231 UHF CA.36 Vision Modulator wide bandwidth for computers etc. £4.70
UM1263 FM Sound Sub-carrier Modulator £2.50

## SWITCH MODE PSUs

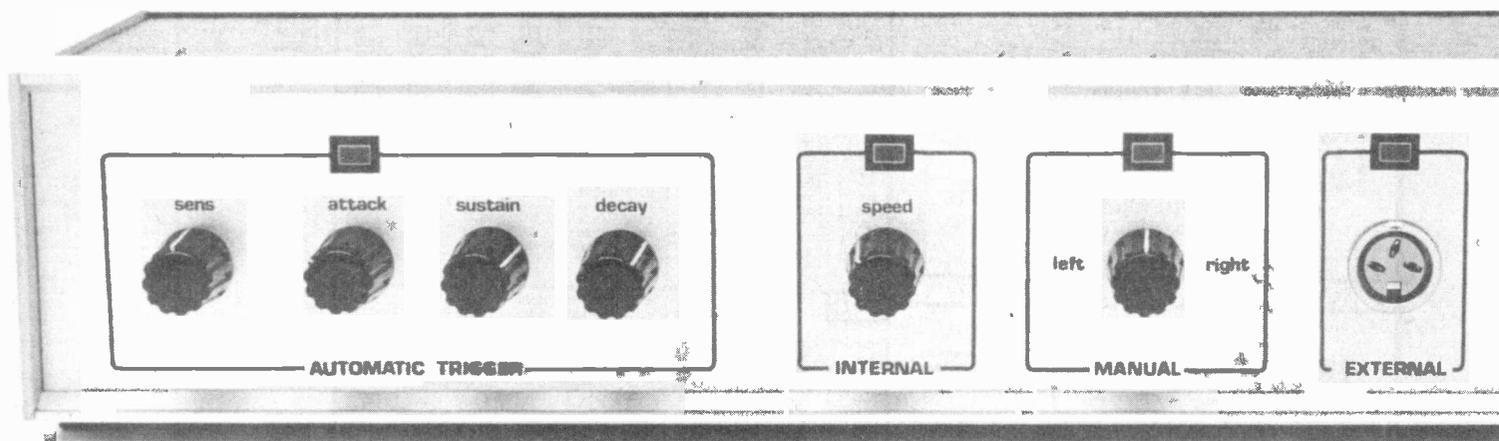
AC 220V 5V/10A £69.90
AC 220V 5V/5A, 12V/1A, -12V/1A, -5V/0.1A £86.80
AC 240V 5V/5A, 12V/1A, -12V/1A, -5V/0.1A £126.50



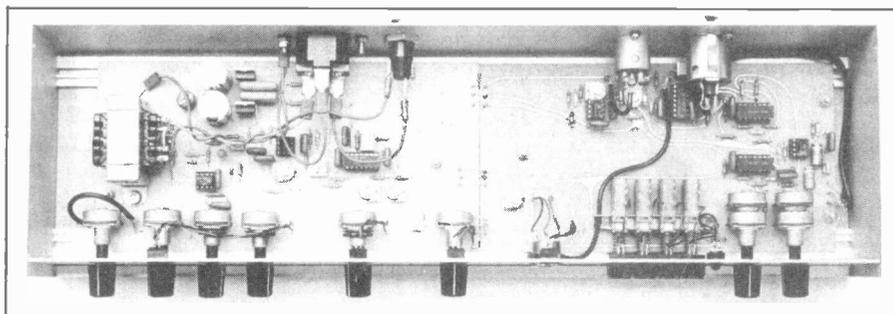
## MICROPROCESSORS

COMPUTER BOARDS	6800 MPU	6800	INTERFACE
114 x 203 mm fiberglass, with gold plated edge connector.	£6.95	£5.95	81LS95/6/7/8 £1.40
Buffed SC/MP CPU £9.40	£9.95	£7.75	75491 LED driver 50p
SC/MP Frontboard £9.40	£12.00	£3.96	75492 92p
280 CPU card £9.40	£12.00	£3.96	27425 85p
VDU 'A' set £8.90	£12.00	£3.96	8726 £2.64
VDU 'B' set £8.90	£12.00	£3.96	8727 £2.64
VDU 'G' three £9.40	£12.00	£3.96	8728 £2.64
EPROM Programmer £9.40	£12.00	£3.96	8729 £2.64
4K PROM board (£204s) £9.40	£12.00	£3.96	8730 £2.64
8K PROM board (£270s) £9.40	£12.00	£3.96	8731 £2.64
16K PROM board (£270s) £9.40	£12.00	£3.96	8732 £2.64
24K PROM board (£270s) £9.40	£12.00	£3.96	8733 £2.64
32K PROM board (£270s) £9.40	£12.00	£3.96	8734 £2.64
40K PROM board (£270s) £9.40	£12.00	£3.96	8735 £2.64
48K PROM board (£270s) £9.40	£12.00	£3.96	8736 £2.64
56K PROM board (£270s) £9.40	£12.00	£3.96	8737 £2.64
64K PROM board (£270s) £9.40	£12.00	£3.96	8738 £2.64
72K PROM board (£270s) £9.40	£12.00	£3.96	8739 £2.64
80K PROM board (£270s) £9.40	£12.00	£3.96	8740 £2.64
88K PROM board (£270s) £9.40	£12.00	£3.96	8741 £2.64
96K PROM board (£270s) £9.40	£12.00	£3.96	8742 £2.64
104K PROM board (£270s) £9.40	£12.00	£3.96	8743 £2.64
112K PROM board (£270s) £9.40	£12.00	£3.96	8744 £2.64
120K PROM board (£270s) £9.40	£12.00	£3.96	8745 £2.64
128K PROM board (£270s) £9.40	£12.00	£3.96	8746 £2.64
136K PROM board (£270s) £9.40	£12.00	£3.96	8747 £2.64
144K PROM board (£270s) £9.40	£12.00	£3.96	8748 £2.64
152K PROM board (£270s) £9.40	£12.00	£3.96	8749 £2.64
160K PROM board (£270s) £9.40	£12.00	£3.96	8750 £2.64
168K PROM board (£270s) £9.40	£12.00	£3.96	8751 £2.64
176K PROM board (£270s) £9.40	£12.00	£3.96	8752 £2.64
184K PROM board (£270s) £9.40	£12.00	£3.96	8753 £2.64
192K PROM board (£270s) £9.40	£12.00	£3.96	8754 £2.64
200K PROM board (£270s) £9.40	£12.00	£3.96	8755 £2.64
208K PROM board (£270s) £9.40	£12.00	£3.96	8756 £2.64
216K PROM board (£270s) £9.40	£12.00	£3.96	8757 £2.64
224K PROM board (£270s) £9.40	£12.00	£3.96	8758 £2.64
232K PROM board (£270s) £9.40	£12.00	£3.96	8759 £2.64
240K PROM board (£270s) £9.40	£12.00	£3.96	8760 £2.64
248K PROM board (£270s) £9.40	£12.00	£3.96	8761 £2.64
256K PROM board (£270s) £9.40	£12.00	£3.96	8762 £2.64
264K PROM board (£270s) £9.40	£12.00	£3.96	8763 £2.64
272K PROM board (£270s) £9.40	£12.00	£3.96	8764 £2.64
280K PROM board (£270s) £9.40	£12.00	£3.96	8765 £2.64
288K PROM board (£270s) £9.40	£12.00	£3.96	8766 £2.64
296K PROM board (£270s) £9.40	£12.00	£3.96	8767 £2.64
304K PROM board (£270s) £9.40	£12.00	£3.96	8768 £2.64
312K PROM board (£270s) £9.40	£12.00	£3.96	8769 £2.64
320K PROM board (£270s) £9.40	£12.00	£3.96	8770 £2.64
328K PROM board (£270s) £9.40	£12.00	£3.96	8771 £2.64
336K PROM board (£270s) £9.40	£12.00	£3.96	8772 £2.64
344K PROM board (£270s) £9.40	£12.00	£3.96	8773 £2.64
352K PROM board (£270s) £9.40	£12.00	£3.96	8774 £2.64
360K PROM board (£270s) £9.40	£12.00	£3.96	8775 £2.64
368K PROM board (£270s) £9.40	£12.00	£3.96	8776 £2.64
376K PROM board (£270s) £9.40	£12.00	£3.96	8777 £2.64
384K PROM board (£270s) £9.40	£12.00	£3.96	8778 £2.64
392K PROM board (£270s) £9.40	£12.00	£3.96	8779 £2.64
400K PROM board (£270s) £9.40	£12.00	£3.96	8780 £2.64
408K PROM board (£270s) £9.40	£12.00	£3.96	8781 £2.64
416K PROM board (£270s) £9.40	£12.00	£3.96	8782 £2.64
424K PROM board (£270s) £9.40	£12.00	£3.96	8783 £2.64
432K PROM board (£270s) £9.40	£12.00	£3.96	8784 £2.64
440K PROM board (£270s) £9.40	£12.00	£3.96	8785 £2.64
448K PROM board (£270s) £9.40	£12.00	£3.96	8786 £2.64
456K PROM board (£270s) £9.40	£12.00	£3.96	8787 £2.64
464K PROM board (£270s) £9.40	£12.00	£3.96	8788 £2.64
472K PROM board (£270s) £9.40	£12.00	£3.96	8789 £2.64
480K PROM board (£270s) £9.40	£12.00	£3.96	8790 £2.64
488K PROM board (£270s) £9.40	£12.00	£3.96	8791 £2.64
496K PROM board (£270s) £9.40	£12.00	£3.96	8792 £2.64
504K PROM board (£270s) £9.40	£12.00	£3.96	8793 £2.64
512K PROM board (£270s) £9.40	£12.00	£3.96	8794 £2.64
520K PROM board (£270s) £9.40	£12.00	£3.96	8795 £2.64
528K PROM board (£270s) £9.40	£12.00	£3.96	8796 £2.64
536K PROM board (£270s) £9.40	£12.00	£3.96	8797

# STEREO IMAGE CO-ORDINATOR



Following his article on the 1537A VAC, Keith Brindley comes up with a complete application using this most resourceful chip.



Perhaps an explanation is required! What, you may ask, is a Stereo Image Co-ordinator? Briefly it's a panning control — simple? — well, not so simple. Panning is an effect whereby you apply a single mono sound source and derive two independent adaptations of that original sound, which together form the inputs to a stereo (or 2 x mono) amplifier. By varying the amplitude of these two adaptations, the stereo image they produce can be altered providing an apparently moving sound source. It is an effect used quite often in recording studios usually with modern rock and pop music. Commercial units are now available (though not as effective or as good as the ETI Stereo Image Co-ordinator), which produce the effect live, for stage work, but in the past panning has been predominantly a studio technique.

## Not Only But Also

The ETI Stereo Image Co-ordinator produces the usual effect of panning using a manually turned pot, but added to this are the exclusive facilities of automatic control over the image produced. The use of these facilities obviously allows

the musician to concentrate on the music rather than the equipment.

Control over the stereo image is provided by four methods:

Manual — a single pot positions the image wherever required.

Sweep — the image is swept from one channel to the other at a variable rate, automatically.

Automatic Trigger — the instant a note is played or sung the image is swept from one side to the other at a completely variable rate.

External — control is accorded by an externally applied voltage eg from a foot pedal.

The unit utilises the 1537A Voltage Controlled Attenuator which as ETI readers will know is the high quality (good enough for studio applications), recently introduced, integrated circuit for VCA use. All other active components used in the audio section of the circuit are high quality, low noise types which coupled with the considerations of careful PCB design should allow the builder to construct a device which is at home in the studio as well as in live stage work.



This box of tricks gives you the opportunity to try out what has up to now been an effect used predominantly in the studio. The stereo sound image can be controlled automatically or manually. You can position the image in one place and keep it there or continually sweep the image between channels ..... and more.

Any input signal within the range 10 mV to 10 V AC should successfully operate the device, although obviously the best signal to noise ratios will be obtained with the larger values of input signal.

The overall signal gain of the Image Co-ordinator is approximately 6 dB, which allows for a unity gain output signal when the level pot is at approximately three-quarters of its rotation.

## Construction

The project consists of two printed circuit boards which together hold all components, switches, pots, etc apart from the nine LEDs. This makes construction a proverbial "doddle" and ensures high standards and a good chance of first time success.

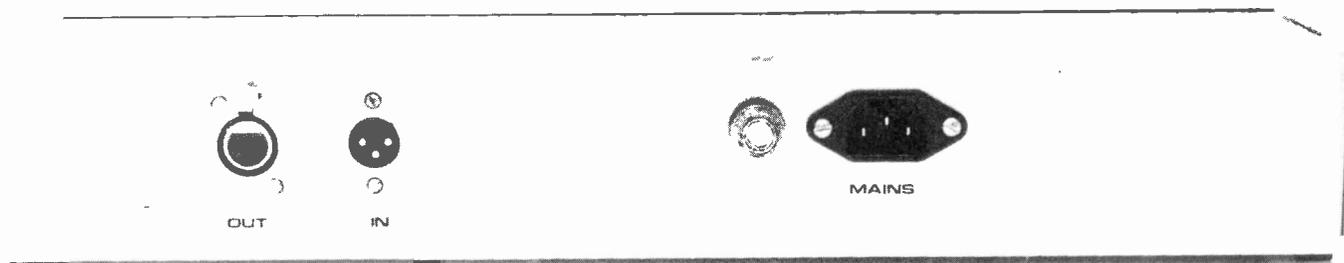
Roughly speaking, the right hand board includes all components to the right hand side of the circuit diagram and similarly the left hand board includes all left side components. The left hand board also contains the PSU.

PCB mounting pots and switches are used throughout eliminating the use of flying leads, therefore cutting down the

possibility of pickup in the audio section. Any jumpers or wires only carry DC control voltages or power and are, therefore, of no problem. There is one exception, however, and that is the connection between the Auto Trig output on the right hand board and the Auto Trig input on the left hand board. This should be screened lead taken neatly, either under or over the boards, keeping it away from the PSU section.

The right hand board is double sided whilst that of the left hand is single sided with jump leads. Neither are too difficult to construct, although it is worthwhile when building up the project to construct each stage separately, testing as you go along eg start with the PSU then the automatic trigger, then the sweep, etc, etc. In this way any faults which develop can be traced to one particular area very quickly. Actually this constructional method is highly recommendable with any project! Test procedures are described in the section on Setting Up.

IC sockets are advisable though not necessary, likewise cermet presets, although more expensive, present easier setting up and a high quality than their cheaper carbon colleagues.



The simple layout of the rear panel -- mains in, signal in, signal out.

## HOW IT WORKS

The main function of the unit is to create an impression of a stereo image from a single signal from a musical instrument. This is done by feeding the signal via IC4 (a quad op-amp) to 2 parallelled VCAs whose output amplitudes are controlled by an external control voltage. These VCAs form the output channels and are buffered by IC8a and b, providing drive for a stereo power amplifier. The stereo image is created simply by allowing the signal output from one channel to be greater than that from the other channel. The origin of the sound thus appears closer to the first side of the sound field than it does to the latter.

Interested readers who wish to know more about the VCA chips in question should refer to the March 1980 edition of ETI for a detailed discussion of the 1537A VCA.

IC5 provides phase split control voltages of 0 to -10 volts DC and -10 to 0 volts DC from a single input voltage of 0 to +10 volts DC. RV15 provides a depth control which simply limits the effect of the control voltages applied to the VCAs. IC5a inverts the DC control whilst IC5b inverts and also offsets it so that both outputs are in the range 0 and -10 volts, although 180° out of phase. IC5a also is a fairly high impedance buffer so as not to load the source.

SW1a gives selection of whichever source is required, there being three internal, sweep, manual and automatic trigger and one external method of controlling the stereo image. The corresponding LEDs are also switched in via SW1 allowing an indication of which function is in use at the switch and also at the function controls — see photographs. LED 1 is a special type of LED with an integral IC to provide an intermittent, flashing display. As this is in series with two other LEDs (2 and 6, 3 and 7, 4 and 8, or 5 and 9, dependent on SW1) then all three LEDs will flash on and off simultaneously.

External control of image is provided so that, for example a foot pedal can be used to control positioning of the applied signal within the stereo field. RV10 adjusts for various values of pots inside the pedal, although 100k lin is the nominal value.

RV12 acts as the manual pot in an identical fashion to an external control pedal pot but positioned on the front panel.

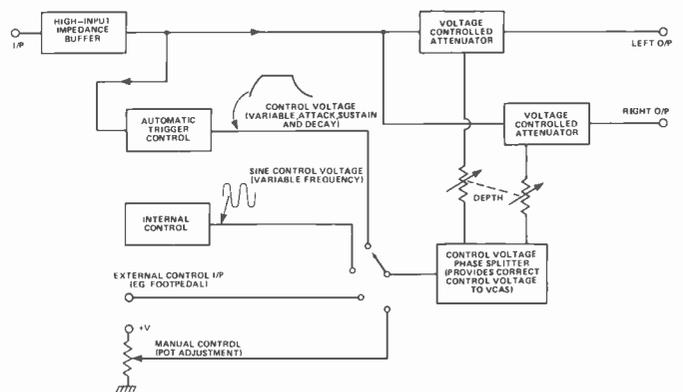
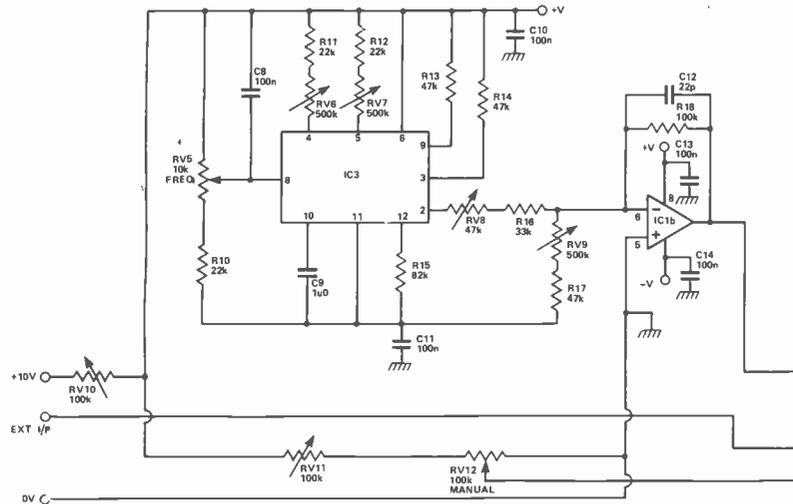
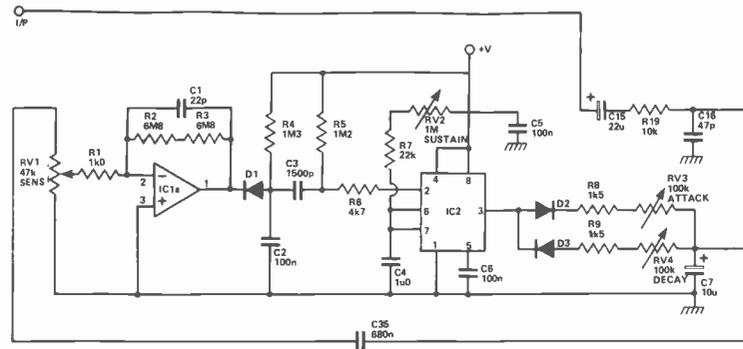


Fig.1. Block diagram of the Stereo Image Co-ordinator.

The signal switches which comprise SW1 a and b might be slightly difficult to get hold of so it is worthwhile taking your PCB along with you to make sure you get the right ones. Also see Buylines. Various other types are around but in our (dare we say it?) vast experience, these switches are by far the most superior for signal switches, which demand low resistance contacts and low noise levels. If you use the same push-fit knobs for the switches ie coloured transparent fronts you may like to do the same as us with the consecutive function marker LEDs and glue them into position inside the switch knobs so that the flashing indication is visible through the front of the switch. The square type of LEDs now available are ideally suited for this application. Alternatively the LEDs can be panel mounted vertically above the switch front. If LED 1, a flashing LED with integral IC, cannot be obtained an ordinary LED can be used in its place — but replace ZD1 with a suitable limiting resistor eg 560R.

The control marking LEDs should be positioned close to the corresponding controls in order that the user can clearly see which function is in use.

Finally use PCB pins for external connections so that when the two boards are fixed in their case side by side the nine links can be soldered into position along with input and output connections, without removing the boards.

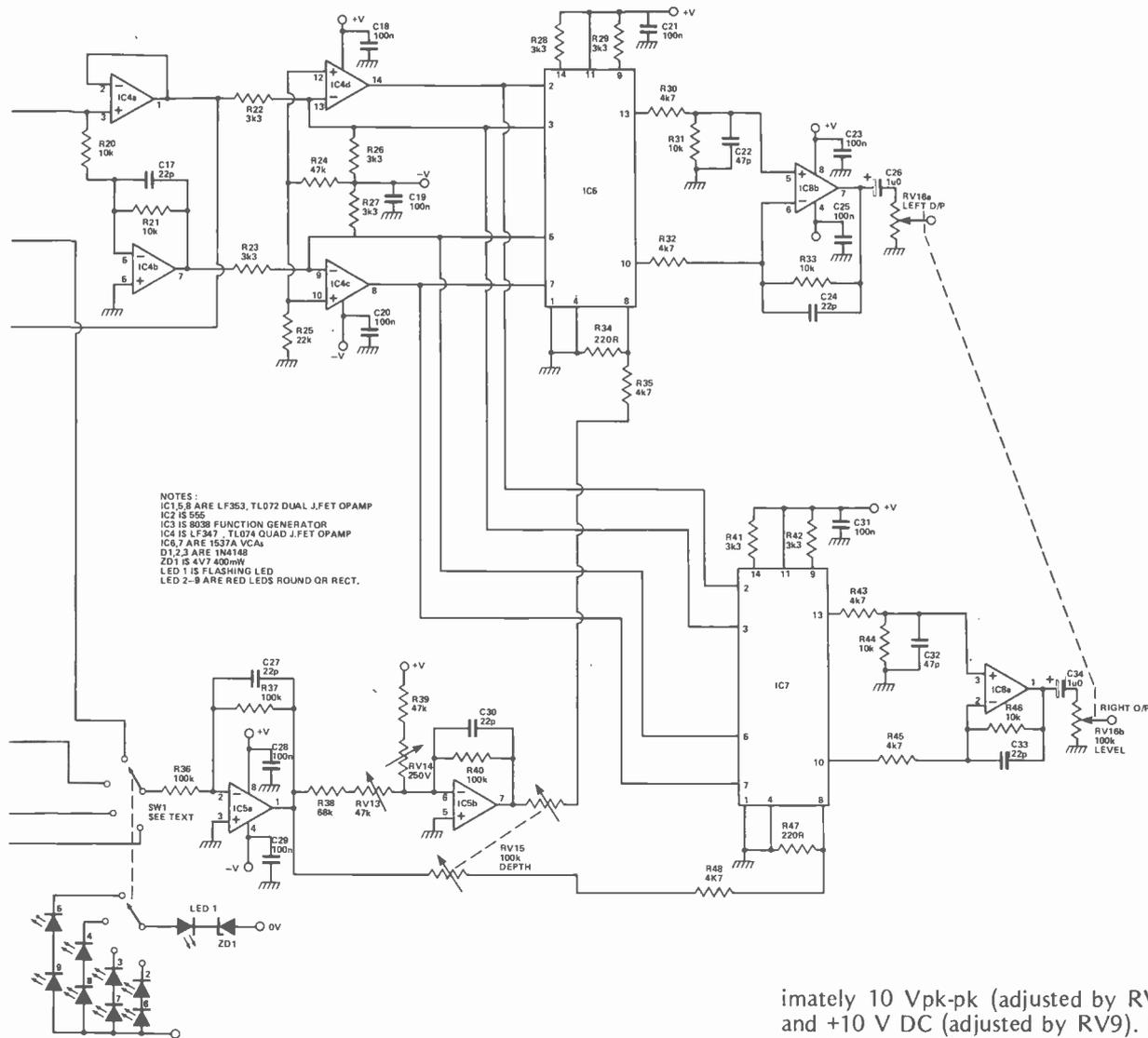
## Setting Up

After the PSU section is complete, it can be tested to make sure that the correct supply rails, +15 V, 0 V and -15 V are obtained.

The components around the automatic trigger should be

inserted next (R1-9, C1-7, IC1 and 2, RV1-4 and D1-3). This can be tested by applying an AC signal of about 500 mV at its input on the left hand board whilst watching the voltage across C7. (All four pots should be mid-position). This voltage should increase from 0 V to about +12 volts then after a short time decrease back down to 0 V DC.

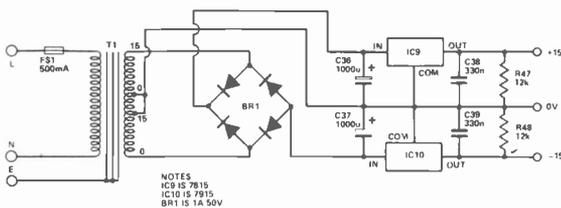
The sweep generator circuit can be built up next (R10-18, C8-14, IC3 and RV5-9) and tested. Set all pots and presets to mid-position. The DC output voltage at pin 7 of IC1 should be a low frequency near sine-wave oscillation approx-



NOTES:  
 IC1,5,8 ARE LF353, TL072 DUAL J-FET OPAMP  
 IC2 IS 855  
 IC3 IS 8038 FUNCTION GENERATOR  
 IC4 IS LF347, TL074 QUAD J-FET OPAMP  
 IC6,7 ARE 1537A VCA  
 D1,2,3 ARE 1N4148  
 ZD1 IS 4V7 400mW  
 LED 1 IS FLASHING LED  
 LED 2-9 ARE RED LEDs ROUND OR RECT.

Fig.2. (left) Circuit diagram. Note the orientation of LEDs connected to signal switch SW1.

Fig.3. (below) Power supply producing +15,0,-15 volts output.



NOTES:  
 IC9 IS 7815  
 IC10 IS 7815  
 BR1 IS 1A 50V

## BUYLINES

The dual and quad op amps are available from the better mail order companies, if you cannot obtain them from your local stockist. Electrovalue supply the printed circuit mounting pots.

The signal switches were RS Components stock and these may have to be ordered through a retail stockist. They are worth the bother of obtaining.

The case is a West Hyde Developments type CL2CDJ. Finally the 1537A VCA chips can be obtained from Aphex Audio Systems UK Ltd., 35 Britannia Row, London N1 8QH.

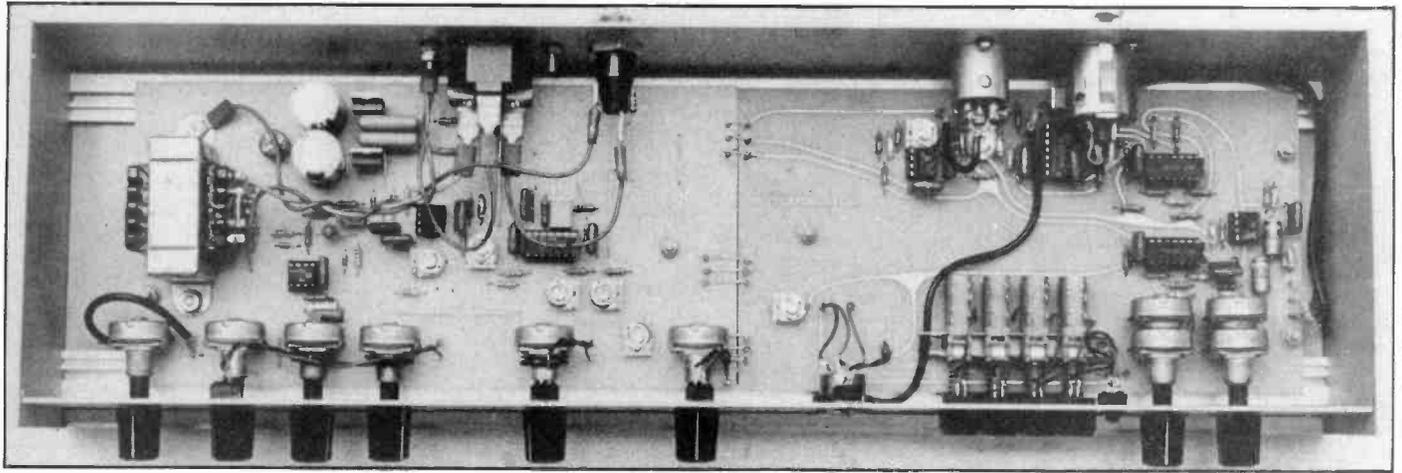
imately 10 Vpk-pk (adjusted by RV8 and varying between 0 and +10 V DC (adjusted by RV9). By altering RV6 and RV7 which control the charge and discharge rates of capacitor C9 (which in turn controls the overall frequency and shape) the best setting can be found whereby RV5 controls the frequency of the sine wave between approximately 0.1 Hz and 10 Hz. Fairly careful adjustment of these two presets is necessary and it is a distinct advantage if a scope is available with a slow time base so that the waveform can be studied for purest sine wave.

The manual control function circuitry is simple consisting of only two components RV11 and RV12. The DC voltage at the wiper of RV12 should vary between 0 and 10 V dependent on wiper position and is adjusted by RV11.

The external control circuit is equally as simple but an external pot is necessary in the shape of a foot pedal. RV10 adjusts for a wiper voltage of 0 to 10 V DC for different values of pot. Alternatively a control voltage of 0 to 10 V DC relative to chassis can be fed in from some external control circuit.

The control voltage phase splitter is next to be assembled and set up (R36-40, C27-30, IC5 and RV13,14). With a known input voltage of 0 to +10 V DC (derived best from the manual pot by pressing the manual switch and varying the pot) the voltage at pin 1 of IC5 should be 0 to -10 V DC the op amp being a simple unity gain inverter. The output at pin 7 should be the same size pk to pk (adjusted by RV13) but 180° out of phase ie -10 to 0 V DC (adjusted by RV14).

There is no further setting up to be undertaken so the rest of the circuit can be installed and testing of the whole job undertaken.



Construction should pose no problems. The two PCBs hold almost all of the components and controls.

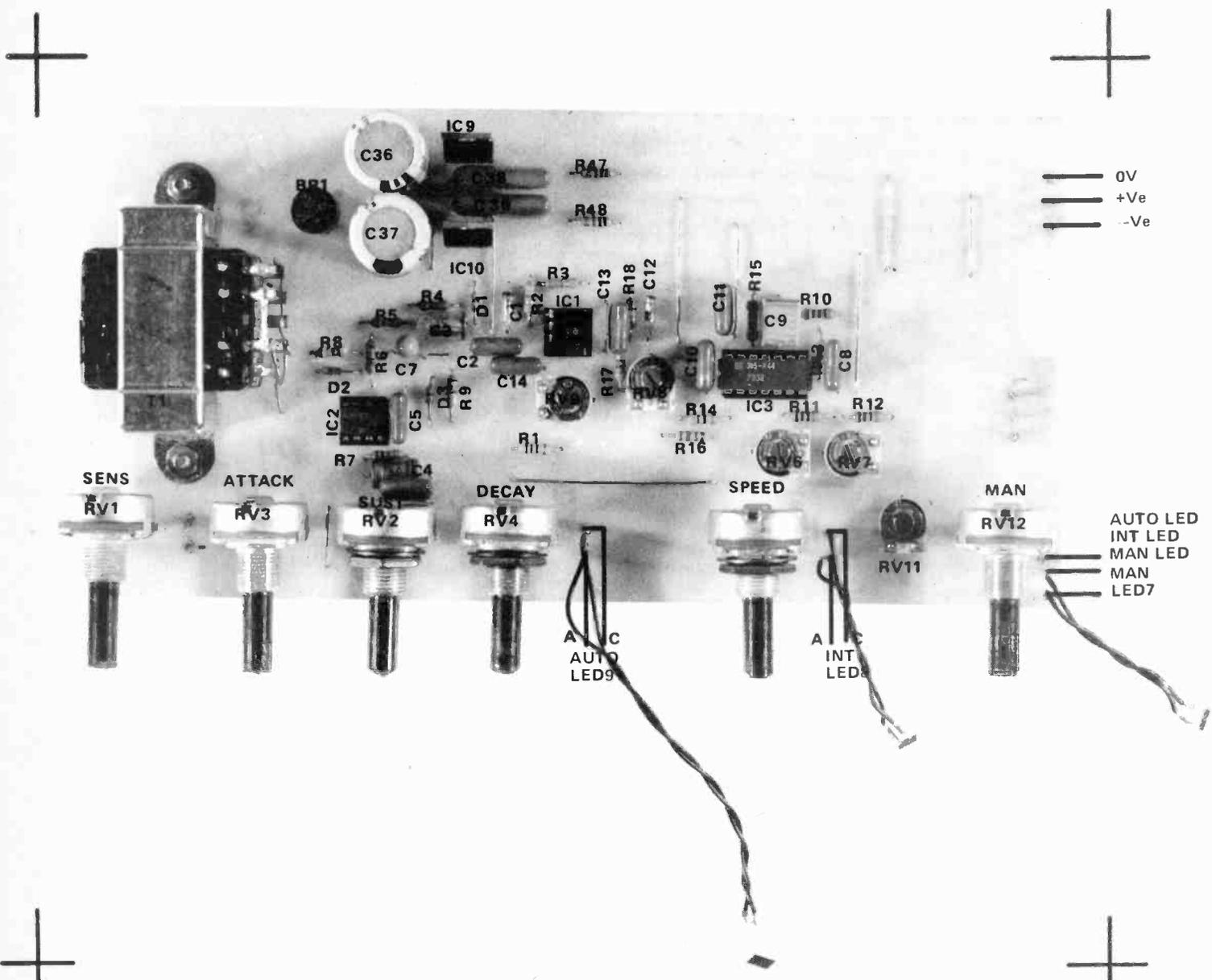


Fig.4. Component Overlay for the single sided board, which carries the power supply.

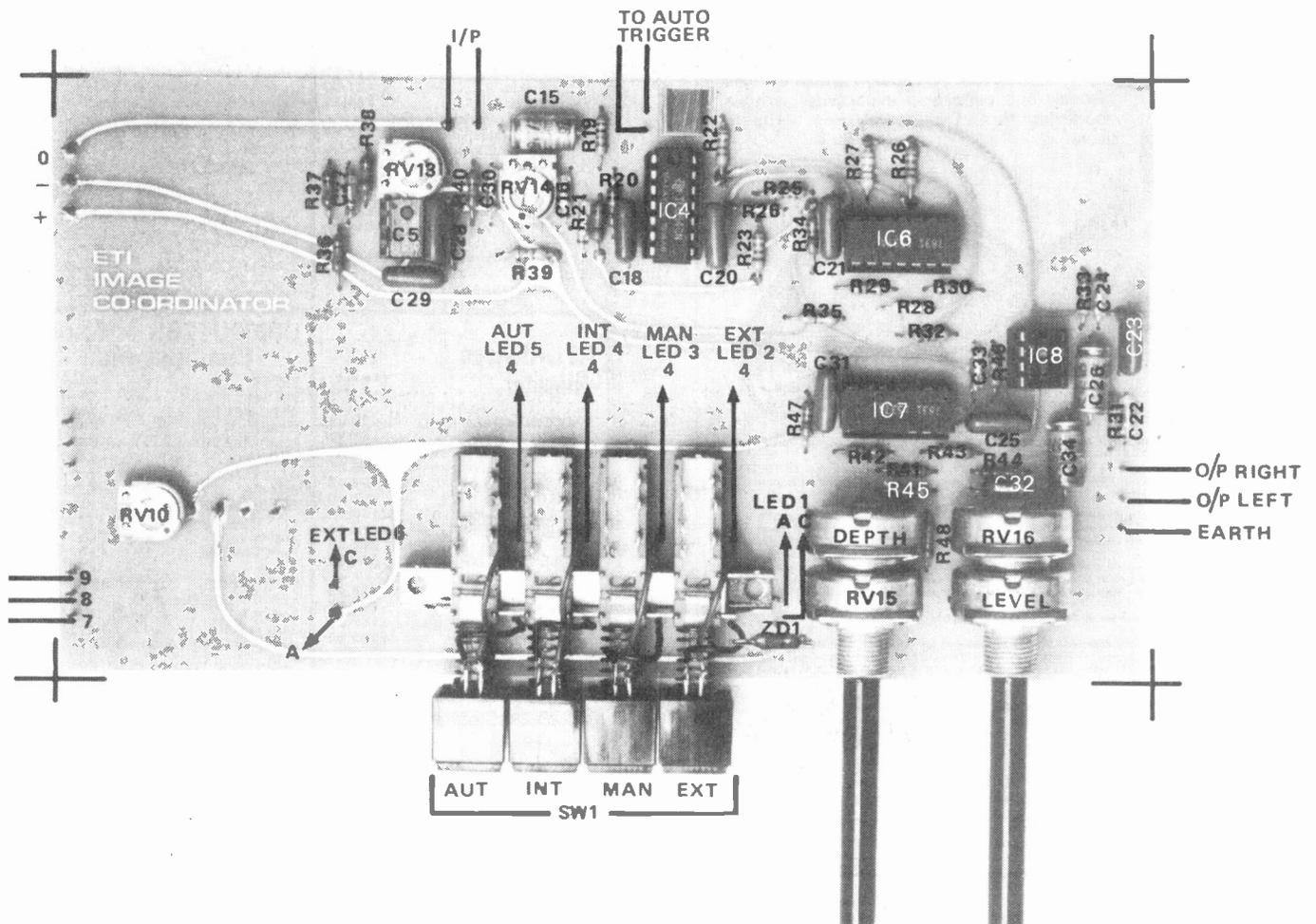


Fig.5. Component Overlay of the double sided board.

## PARTS LIST

### RESISTORS All 1/4W, 5%

R1	1k0
R2,3	6M8
R4,5	1M2
R6,20,32,35,43,45	4k7
R7,10,11,12,25	22k
R8,9	1k5
R13,14,17,24,39	47k
R15	82k
R16	33k
R18,36,37,40	100k
R19,20,21,31,33,44,46	10k
R22,23,26,27,28,29,41,42	3k3
R34	220R
R38	68k
R47,48	12k

### POTENTIOMETERS

RV1	47k log PCB mounting pot
RV2	1M0 lin PCB mounting pot
RV3,4,12	100k lin PCB mounting pot
RV5	10k lin PCB mounting pot
RV6,7,9	500k min horiz cermet preset
RV8,13	47k min horiz cermet preset
RV10,11	100k min horiz cermet preset
RV14	220k min horiz cermet preset
RV15	100k lin dual PCB mounting pot
RV16	47k log dual PCB mounting pot

### CAPACITORS

C1,12,17,24,27,30,33	22p polystyrene
C2,5,6,8,10,11,13,14,18,19,20,21,23,25,28,29,31	100n polyester
C3	1500p polystyrene
C4,9,26,34	1u0 25V electrolytic
C7	10u 16V electrolytic
C15	22u 25V electrolytic
C16,22,32	47p polystyrene
C35	680n polycarbonate
C36,37	1000u 25V PCB electrolytic
C38,39	330n polyester

### SEMICONDUCTORS

IC1,5,8	LF353, TL072 etc dual op amp
IC2	555
IC3	8038
IC4	LF347, TL074 etc quad op amp
IC6,7	1537A
ZD1	5V1 zener 400mW
LED 1	Flashing red LED
LED 2-9	Red LED
D1-3	1N4148

### MISCELLANEOUS

SW1a and b	4 off push button signal switches 2 pole
	C/O + appropriate hardware (see text)
T1	15-0-15 6VA mains transformer
FS1	500mA fuse + panel mounting holder
	Mains connector, input and output sockets case (see Buylines).

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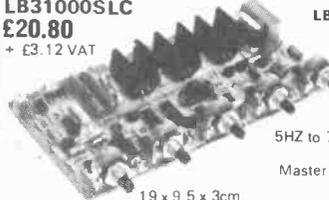
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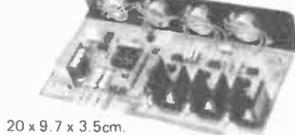
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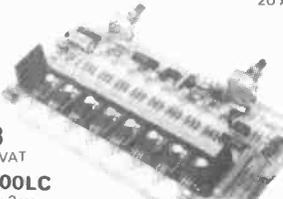
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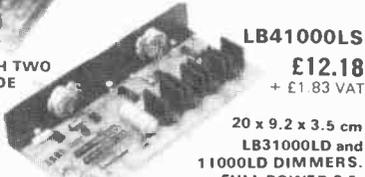


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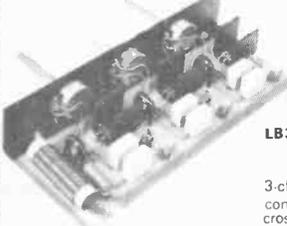
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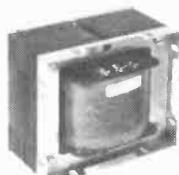


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## Construction

Fit all the components except C3, which is fitted after testing. The board is designed to fit into a MK type 2140 surface mounting wall box. The LDR may be mounted into the blanking plate MK type 3827, as shown in Fig.2, or remote from the unit.

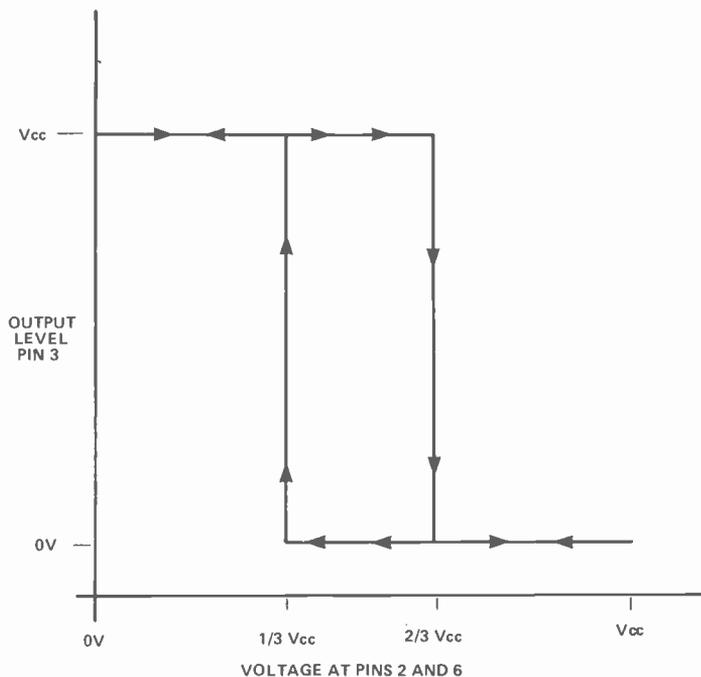


Fig.1. IC1 is used as a level detector with hysteresis.

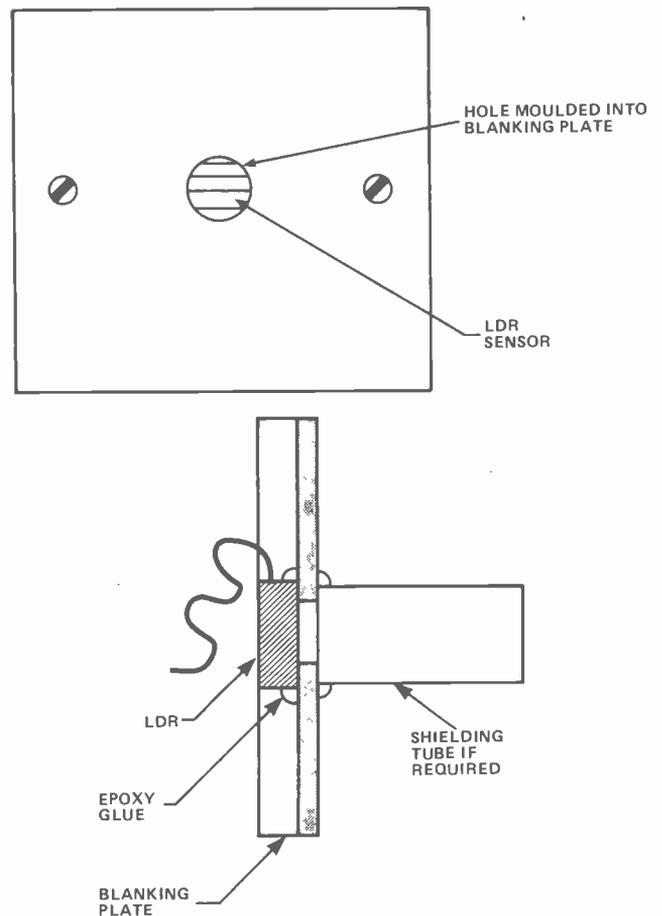


Fig.2. The LDR is mounted in the blanking plate (top). A shielding tube may be fitted if necessary (above).

## Setting Up and Testing

Having built the board, check for solder splashes and dry joints. Set RV1 to mid-position, connect a lamp, the LDR and the mains. A WORD OF CAUTION, there is mains and rectified mains on the board, also the tab of the thyristor is connected to its anode. Be careful where you put fingers and voltmeter.

Now switch on. If the LDR is in a light area, nothing will happen. Darken the LDR and the lamp will light. Increase the light around the LDR and the lamp will extinguish. The exact setting of RV1 will depend on the

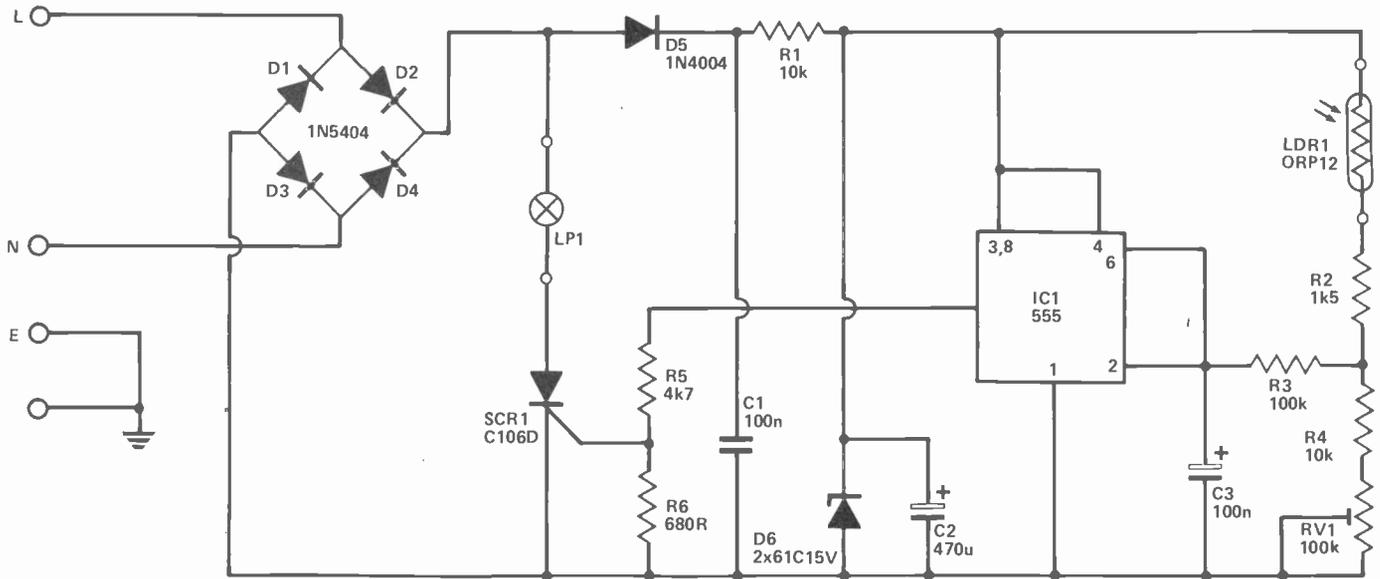


Fig.3. Circuit diagram. A common or garden 555 is at the heart of the unit.

## HOW IT WORKS

Figure 3 shows the full circuit diagram of the unit. Light Dependent Resistor LDR1 is the sensor for the system. Its resistance depends upon the amount of light falling on it, the more light the lower its resistance. IC1 is used as a level detector with hysteresis. The 555 has inbuilt resistance levels of  $\frac{1}{3}V_{cc}$  and  $\frac{2}{3}V_{cc}$ . When the voltage on pins 2 and 6 rises above  $\frac{1}{3}V_{cc}$  the output, pin 3, swings low, and as the voltage falls below  $\frac{1}{3}V_{cc}$  the output goes high as shown in Fig.1.

RV1 is adjusted so that the unit switches on at the required light level. R3 and C3 form a 10 S time constant. This is the time it takes for the voltage on pins 2 and 6 to rise to  $\frac{1}{3}V_{cc}$ , assuming C3 charges from 0 V, and is included to reduce the possibility of false triggering, eg passing car headlamps, or children with torches! The supply for the circuit is via D1-D5, R1, and regulated by D6. C2 is supply smoothing.

The external lamp is switched by the thyristor SCR1. A thyristor was chosen because it is easier to trigger than a triac, and does not have a radio frequency interference problem in this configuration. The disadvantage of this method is that a diode bridge, D1-D4, is required, and the bridge must be capable of handling the lamp current.

It was found with early prototypes that mains transients could cause the lamp to flicker when nearing the lower (switch on) threshold level. A comprehensive filter circuit has been included, comprising D5, R1, C1 and C2.

Any high frequency spikes on the mains supply will pass via D1-D5 and be decoupled to the negative side of the supply by C1. The impedance of C1 being smaller than the value of R1. Should the mains voltage fail or fall for a few cycles, C2 would try to discharge through R1 and the lamp circuit. D5 and C2 hold the supply high for this short period, D5 being reversed biased.

The thyristor used is the C106D sensitive gate type. This requires 0V8 cathode to gate, and 200 V gate current. It is triggered from the output of the 555. R5 and R6 form a potential divider to give approximately 2 V cathode to gate, sufficient to ensure reliable triggering. R5 also ensures the gate returns to the same potential as the cathode when the output of the 555 goes low, thus ensuring the thyristor remains untriggered.

The circuit may be modified for 115 V operation by reducing the value of R1 to 4k7 (2 W). The other components remain the same. However, because of the reduction in the supply voltage, the maximum wattage that can be switched is reduced to 250 W the current through the diode bridge D1-D4 and thyristor SCR1 being 2 A maximum.

## BUYLINES

All components used are standard and should be readily available from most mail order stockists.

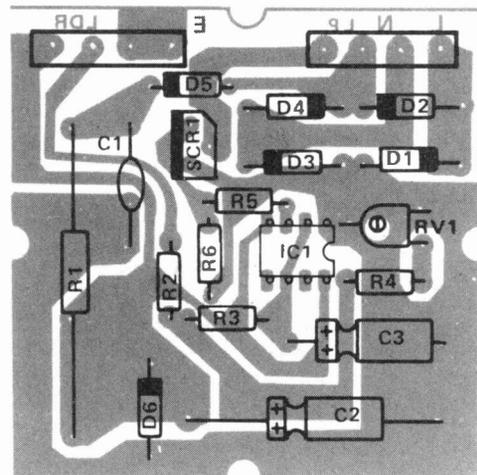


Fig.4. Component overlay. THERE IS MAINS AND RECTIFIED MAINS ON THIS BOARD.

## PARTS LIST

Resistors All $\frac{1}{4}W$ except where stated	
R1,4	4k7 4W (2W for 115V)
R2	1k5
R3	100k
R5	4k7
R6	680R
Potentiometers	
RV1	100k
Capacitors	
C1	100n 400V polyester
C2	470u 25V electrolytic
C3	100u 25V electrolytic
Semiconductors	
D1-D4	1N5404 or similar
D5	1N4004 or similar
D6	BZX61 C15V
SCR1	C106D or similar
IC1	NE555
LDR1	ORP 12

Miscellaneous  
PCB, PCB mounting terminal block RS No. 423-762, Surface mounting box MK list No. 2140, Blanking plate for box MK list No. 3827, 2 screws M3.5 Pan Head, Small heat sink (aluminium 1mm x 25mm x 10mm).

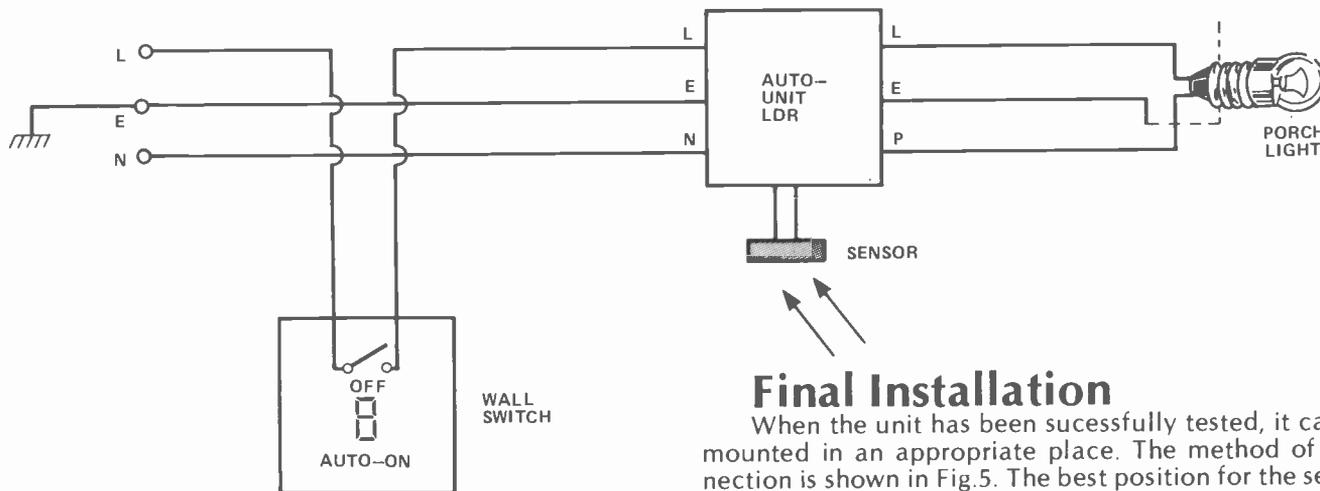


Fig.5. Method of connection of the unit to the house mains wiring.

location of the sensor, and is best set when the unit is finally installed. RV1 and R4 values give ample adjustment for most situations. If however, the adjustment of RV1 is insufficient in the clockwise direction, the value of R4 can be increased to 47k. When all is satisfactory, fit C3. Recheck that the unit does not respond to short dark or light periods.

## Final Installation

When the unit has been successfully tested, it can be mounted in an appropriate place. The method of connection is shown in Fig.5. The best position for the sensor is an outside location away from the influence of traffic, street lamps and neighbours' lights. If a suitable location cannot be found, a small tube to shade the sensor can be fitted which will increase its directivity, as shown in Fig.2. This completes the construction of the unit.

If the completed unit is mounted externally, some form of weather proof seal must be made between the box and the blanking plate. The best type of sealer to use is silicone bath sealer. Spread a small amount on the mating surfaces of the box and tighten down the plate. The sealer will harden and prevent water entering. **ETI**

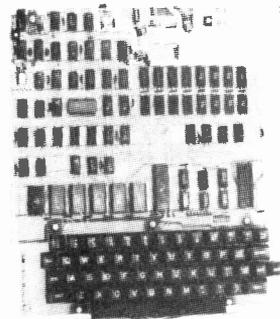
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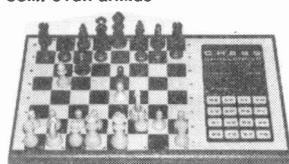


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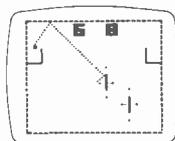
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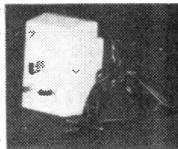


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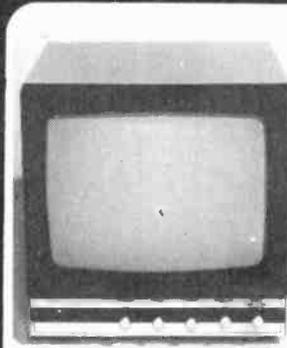
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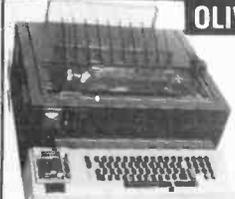
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# STATE VARIABLE FILTER

Choose one of seven filter responses with this voltage controlled state variable filter design by R.C. Blakey for your Project 80 modular synthesiser.



The Voltage Controlled State Variable Filter has low pass, high pass, band pass and notch filtering capabilities. The first three responses are available as both two pole (12 dB/octave) and four pole (24 dB/octave) filters. Manual and external control of resonance is included.

## Design Features

The state variable filter using three operational amplifiers, as shown in Fig.1, is probably familiar to most readers.

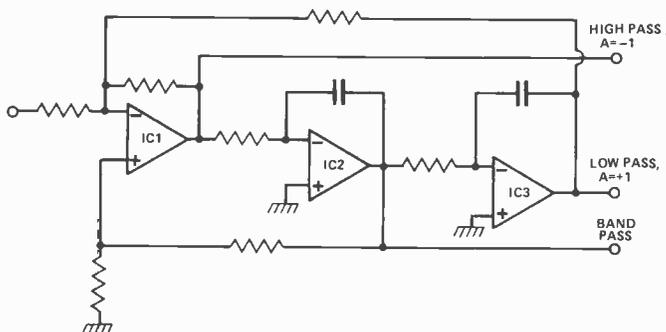


Fig.1. Circuit diagram of a state variable filter using three op amps.

A simple way to convert this into a voltage controlled filter is to interpose operational transconductance amplifiers (eg CA3080) prior to the two integrators around IC2 and IC3. Voltage control of Q (or resonance) can also be obtained by using an OTA in the feedback to the non-inverting input of IC1. This is the basis of the present design. Such a filter gives 12 dB/octave low and high pass responses and second order band pass response. By placing two such filters in series it is possible to increase the roll-off characteristics by a factor of two. In practice, however, this is often difficult due to component mismatching which results in uneven roll-off characteristics. The problem has been minimised in this design by using a customised integrated circuit from

Solid State Micro Technology for Music, namely, the SSM2040. This device contains four closely matched transconductance amplifiers and an exponential generator which is common to the four cells. For resonance control the relatively new LM13600, dual transconductance amplifier, is used in the feedback of the two stages of state variable filters. Both manual and external voltage control of resonance is provided and while these controls are additive the maximum useful range is our standard 0 to 10 volts into 100k.

Seven filter responses are available, one at a time, via a selector switch — low pass (12 and 24 dB/octave); high pass (12 and 24 dB/octave); band pass (2nd and 4th orders); and notch. The low pass and high pass outputs are 180° out of phase and so combining these outputs results in a notch. A notch filter is of limited use in synthesis since the ear only responds to frequencies present and not to frequencies which are absent. The latter may sound rather obvious but since the notch filter allows most frequencies to pass the ear cannot detect the difference between the original and filtered signals, except in some exceptional circumstances or unless the notch is fairly wide.

The filter has three signal inputs and the combined signal should not exceed 10 volts peak to peak. An attenuating potentiometer has been provided on one of the inputs and if mixing of signals is required then external attenuating controls can be used. The filter has approximately unity gain at maximum resonance feedback.

Frequency response control is obtained using the exponential converter within the SSM2040 and an attenuating network, with adjustment, allows the 1 V/octave characteristic to be obtained. Initial frequency (zero control voltage) is set to approximately 20 Hz and the filter has a 1,000:1 control range. Control Input 1 is used for keyboard input; Control Input 2 has an attenuating potentiometer for use in conjunction with an envelope shaper, etc; a Coarse control provides manual sweep over 10 octaves and a Fine control is included for more accurate initial setting and has an adjustment range of one octave. Temperature stability should not be

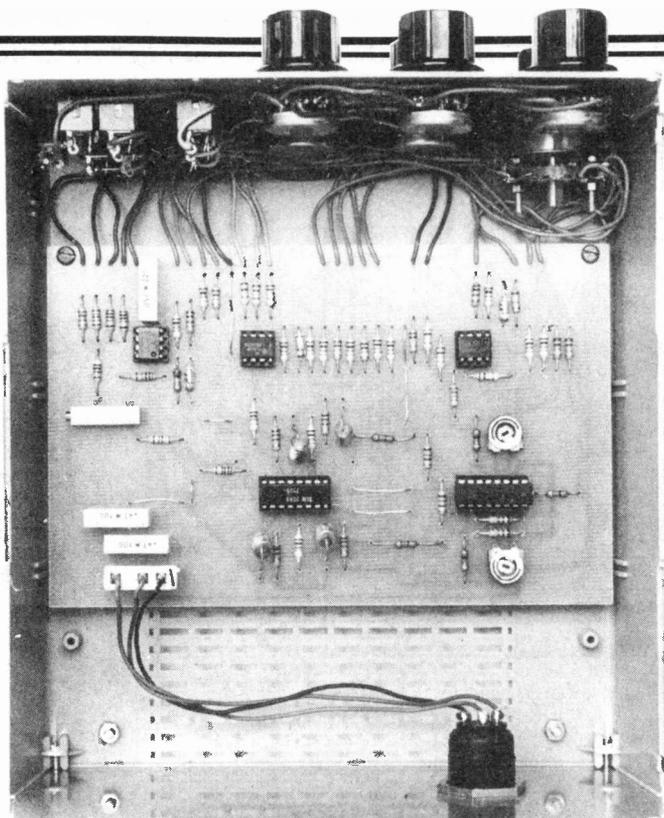


Fig.2. The voltage controlled state variable filter can be built into this Teko Alba case (see Buylines) as a 'stand alone' project.

a problem under normal circumstances. If required, however, R47 may be replaced by a Q81, 1k $\Omega$ , 1% temperature compensating resistor.

## Construction

The first point to note is that the SSM2040 outputs (OUT, CAPACITOR and IN) are not short circuit protected and shorting any of these to either supply will generally blow the circuit, although connections to ground can be tolerated for several seconds. Some additional resistors have been used to provide additional safeguard in the latter circumstances. Take particular care on both the orientation of this IC and when any probes are connected to components on the PCB, for whatever reason.

Identify and solder the seven wire links before installing components. The capacitors around the SSM2040 will accept both preformed (as illustrated) and normal polystyrene capacitors. When all components have been installed, the two holes remaining around IC1 are for installing a Q81 temperature compensating resistor, when required. The manual resonance control (RV2) may be wired via the jack socket used for the external resonance control such that the former is disabled when external control is in use. The manual and external controls may also be wired up independently but no increase in gain will be achieved when their combined voltages exceeds the equivalent of about 10 volts into 100k, eg manual control half way and five volts external input. In fact the resonance will begin to decrease somewhere above 10 volts.

The most complicated task is wiring up the switch

but this should not pose any problems if reference is made to both the circuit diagram and the PCB layout.

## Setting Up And Calibration

First adjust the module to achieve the seven filter responses. These can be readily observed on an oscilloscope by using the VCLFO and VCO as a sweep frequency generator, as described for the 80-6 filters. There are, however, only two adjustments to make in order to ensure that the seven responses are present (assuming no wiring errors) and these can be made by ear with the aid of an amplifier, as shown below.

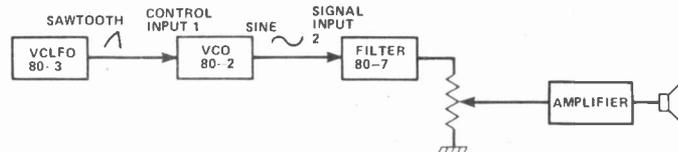


Fig.2. The seven filter responses can be inspected with the circuit shown above.

Set Coarse frequency controls on VCLFO and filter 80-7 to mid position and to zero on the VCO. With the edge connections of the filter facing you and the components uppermost set the wipers of both PR1 and PR2 to about the 9 o'clock position. Put selector switch on BP2 output and slowly turn PR1 anti-clockwise. Initially there may be no output but then a low pass output will be heard. Further rotation of PR1 will result in a fairly abrupt change from low pass to band pass and this is audibly obvious. PR1 should be left at this setting. Now switch to LP4 output and turn PR2 slowly clockwise. Initially nothing will be heard and then a low pass response. PR2



If you wish to build all of the Project 80 modules and install them in a single case with keyboard, mount the PCB on this front panel. At the end of the series you'll have a matching set.

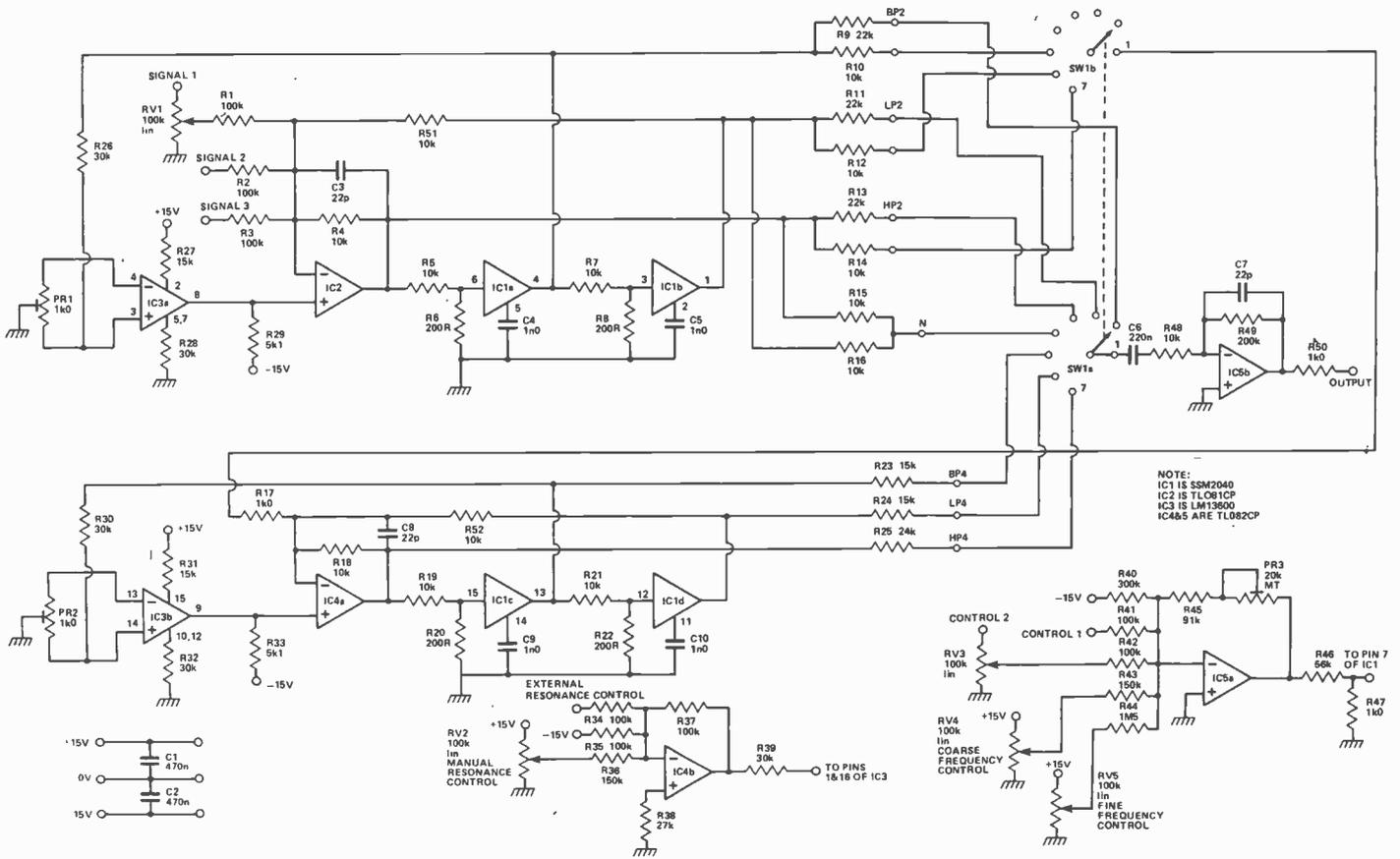


Fig.2. Circuit diagram of the state variable filter.

## HOW IT WORKS

The SSM2040, VCF produced by Solid State Micro Technology for Music, contains four independent filter sections which may be interconnected to provide a wide variety of filter responses. Each section contains a transconductance amplifier followed by a buffer and by using two of these sections with an external op amp a state variable filter may be realised as shown below.

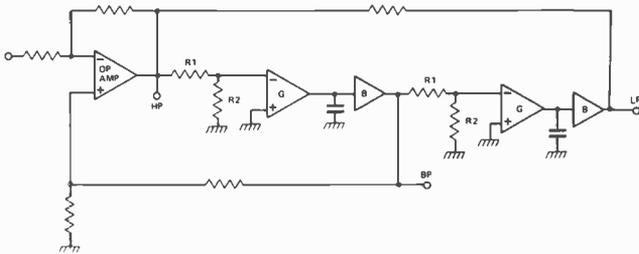


Fig.3. Using the sections of the SSM 2040 and an op amp to form a state variable filter.

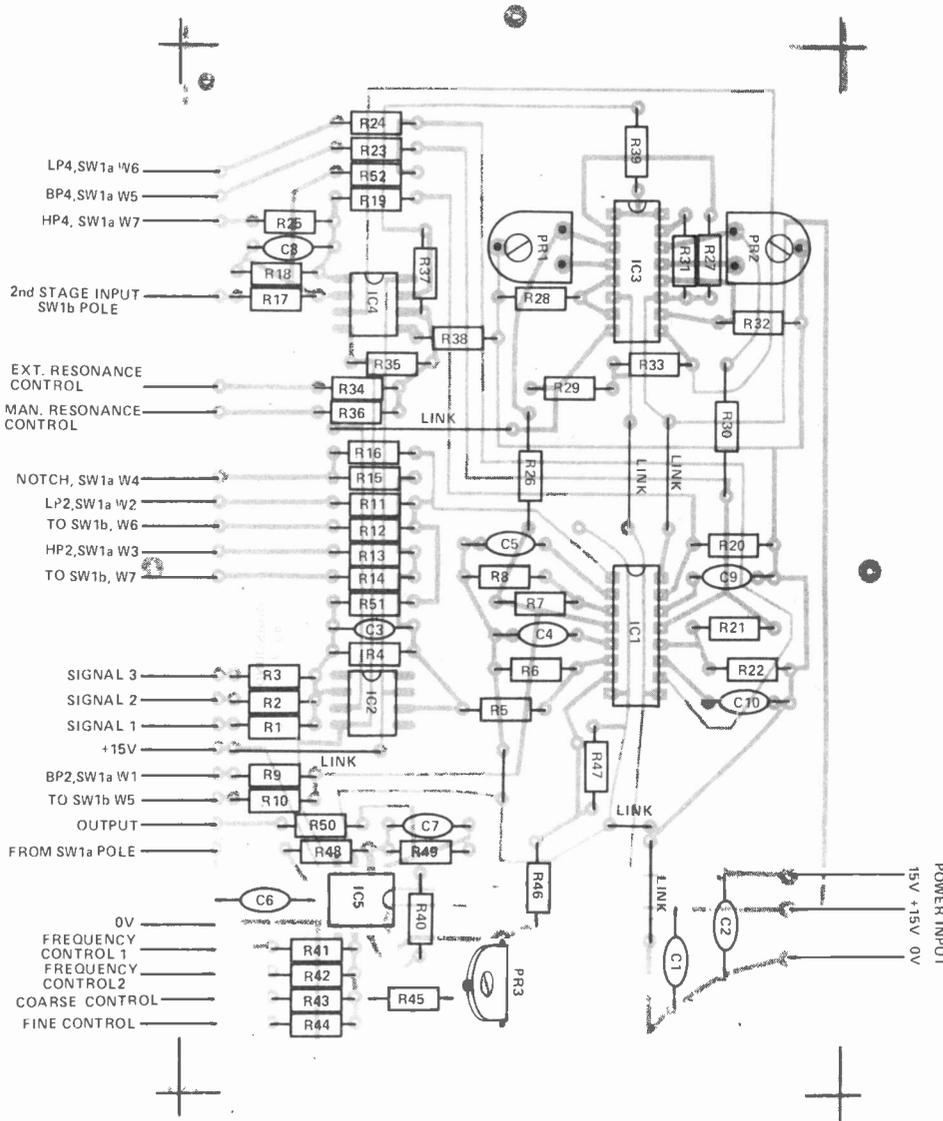
The signal levels into the gain cells should be limited to 2mV RMS and since R2 should be 200 R for optimum control rejection then R1 is 10k with a 1 V signal at the op amp output. The equivalent input noise for the SSM2040 is 0.5 uV RMS at 20 Hz to 20 kHz so a signal to noise ratio of about 90 dB is achieved. In the first state variable filter section around IC3a, IC2, IC1a and IC1b a 10 V signal into R1, 2 or 3 is reduced by IC2 and R4 to produce the 1 V into attenuating resistor network R5, 6. The two pole low pass, high pass and band pass filter responses are derived and a notch produced by combining the low and high

pass outputs which are 180° out of phase. These four outputs are connected to the rotary switch, SW1a and the signal restored to its original level by R49, R50 and IC5b. The signals are AC coupled into IC5b to remove any DC offsets.

The low pass, high pass and band pass outputs from the first stage are also separately connected to rotary switch, SW1b and fed into the second stage formed around IC3b, IC4a, IC1c and IC1d. The four pole outputs derived in this section return to switch SW1a and are available via IC5b, as before.

Resonance control is provided by an LM13600 (IC3), dual transconductance amplifier, interposed between the band pass output and the non-inverting input of the filters external op amps (IC2 and IC4a). The amount of feedback is controlled by the current developed across R39 and this has been commoned for both halves of the LM13600. Manual control is obtained via RV2 and R36 into IC4b and external voltage control via R34 into the same input summing node. The control voltage should be limited to an equivalent of 10 V into 100k.

Frequency control is common to all four amplifiers in the SSM2040 and best results for a 1,000 to 1 sweep in the range 20 Hz to 20 kHz is obtained with +90 V at pin 7. Resistor R40 connected to -15 V provides approximately +90 mV and a lower frequency limit of about 20 Hz. A 0 to +10 V control voltage into Control Inputs 1 or 2 will then allow frequency adjustment over a range of ten octaves. Manual adjustment over a ten octave range is provided by the Coarse Frequency Control (RV4 into R43) and Fine Frequency Control over a range of one octave by RV5 into R44. Precise adjustment of the 1 V per octave response is achieved by adjusting the gain of IC5a using PR3.



## PARTS LIST

Resistors 1/4W, 5% carbon film except where stated

R1,2,3,34,35,37	100k
R4,5,7,10,12,14,15,16,18,19,21,48,51,52	10k
R6,8,20,22	200R
R9,11,13	22k
R17,50	1k
R23,24,27,31	15k
R25	24k
R26,28,30,32,39	30k
R29,33	5k1
R36	150k
R38	27k
R40	300k, 1% metal film
R41,42	100k, 1% metal film
R43	150k, 1% metal film
R44	1M5
R45	91k, 1% metal film
R46	56k, 1% metal film
R47	1k0, 1% metal film
R49	200k

### Potentiometers

RV1,2,3,4,5	100k linear
PR1 2	1k0 carbon
PR3	20k cermet multiturn

### Capacitors

C1,2	470n polyester
C3,7,8	22p polystyrene
C4,5,9,10	1n0 polystyrene
C6	220n polyester

### Semiconductors

IC1	SSM2040
IC2	TL081CP, or equivalent
IC3	LM13600
IC4,5	TL082CP, or equivalent

### Miscellaneous

SW1	2 Pole 7 (or more) Way Rotary Switch
-----	--------------------------------------

should be left at the setting where the low pass output commences. The selector switch can then be turned through its seven outputs to check that the appropriate response is present and these can be clearly identified by ear. If an oscilloscope is available then switching to BP2, LP4 and HP4 outputs and making minor adjustments to both PR1 and PR2 may result in some improvement to the filter responses.

The final step is to calibrate the filter for 1 V/octave frequency control. The 80-7 filter will not oscillate at maximum resonance feedback and so the best approach is to observe the maximum signal amplitude using an oscilloscope. Connect the sinewave output from a VCO to Signal Input 2. Connect the LP4 output to an oscilloscope, set VCO frequency to about 250 Hz and adjust RV4 (Coarse Control) and RV5 (Fine Control) to obtain maximum signal amplitude. Increase voltage on Control Inputs 1 of both VCO and VCF by exactly 1 V and adjust PR3 until maximum amplitude is restored. Repeat the above steps until calibration is achieved. If an oscilloscope is not available then an alternative ap-

proach is to set all VCF controls to zero and apply about 4 V to Control Input 1 and measure the voltage at the junction of R46 and R47, using a high input impedance voltmeter. Increase the control voltage by exactly 1 V and then adjust PR3 to obtain an 18.0 mV change at the junction of R46 and R47. Again repeat the procedure until an 18.0 mV change is obtained for a 1.000 V change in control voltage.

## BUYLINES

An 80-7 State Variable Filter module kit (PCB plus components) is available for the inclusive price of £20.10 from Digisound Ltd, 13 The Brooklands, Wrea Green, Preston, Lancs PR4 2NQ.

The modules are cased in Teko Alba A23G cases (order code TEK A23G), available from West Hyde Developments Ltd, Unit 9, Park Street Industrial Estate, Aylesbury, Bucks HP20 1ET at £4.43 each all inclusive.

# ENVELOPE SHAPER

**Tamper with your time constants. This Project 80 design by R.C. Blakey gives full control of Attack, Decay, Sustain and Release.**

The envelope generator is based on the SSM2050, a voltage controlled transient generator produced by Solid State Micro Technology. Using this IC all that is necessary to vary the time constants for the Attack (A), Initial Decay (D) and Final Decay or Release (R) is a voltage applied to the appropriate pin via a scaling resistor. A minimum range of 2 mS to 20 S is available for each of the three timing functions. The voltage response is exponential which means that the most useful time range utilises the highest proportion of the associated control potentiometer. The attack output is nominally 0 to 10 V and the Sustain level (S) is simply a voltage applied to Pin 12.

It has separate gate and trigger inputs whereby a combined gate and trigger pulse will initiate a full ADSR response; a trigger applied after the first one and while the gate pulse is still present will restart the attack response and a gate pulse on its own will generate an AD contour. When the gate pulse is released the final decay commences, as is usual with ADSR and AD envelope shapers.



Fig.1. Wave forms associated with envelope processing.

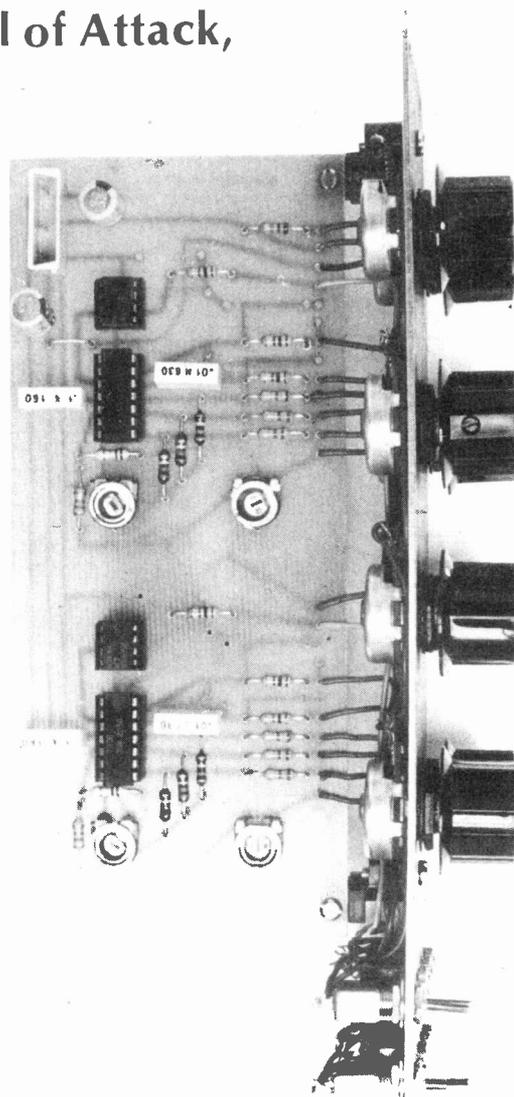
The time constants may be trimmed so that any number of ADSR's can be adjusted to exactly the same scale. Also an adjustment to ensure that the sustain voltage accurately matches the peak attack voltage is provided. The output buffer in the SSM2040 is adequate for most practical purposes but to retain our 'plug in anything to anywhere' philosophy an external buffer has been added. Other features included are external initiation of the ADSR or AD contours, for example, from a manual push button, as well as provision to use gate and trigger pulses derived from TTL logic.

## Construction

The PCB is designed to take two envelope generators and as usual will fit either a panel or the TEKA ALBA A23G case. If the latter is used then there is only sufficient panel space to sensibly install a single envelope generator.

Construction is very straightforward and the only points to note are the single wire link and the opposed orientation of the SSM2050 and the 741 buffer.

An on-off switch, SW1, is connected across the inputs marked 'TRIGGER (CMOS)' and 'GATE (CMOS)' so



that when only single pulses are available, eg, manual gating, then both the ADSR (SW1 closed) and AD (SW1 open) responses can be obtained. The manual gating can be added by connecting a push to make switch between the PCB connections marked 'OUTPUT FOR MANUAL GATE' and 'MANUAL GATE'. The push button may be panel mounted but the preferred approach is to take the former connection to a jack socket and to use an external hand, or foot, switch connected to two jack plugs. These jack plugs go to the Gate (G) input and the Manual input (from R11). The option and type of switch is left to the constructor.

Resistors R12, R13 and R14 are not part of the basic kit but are to be installed by constructors who are using TTL logic to derive gate and trigger pulses. Also in this case the switch, SW1, is connected across the PCB con-

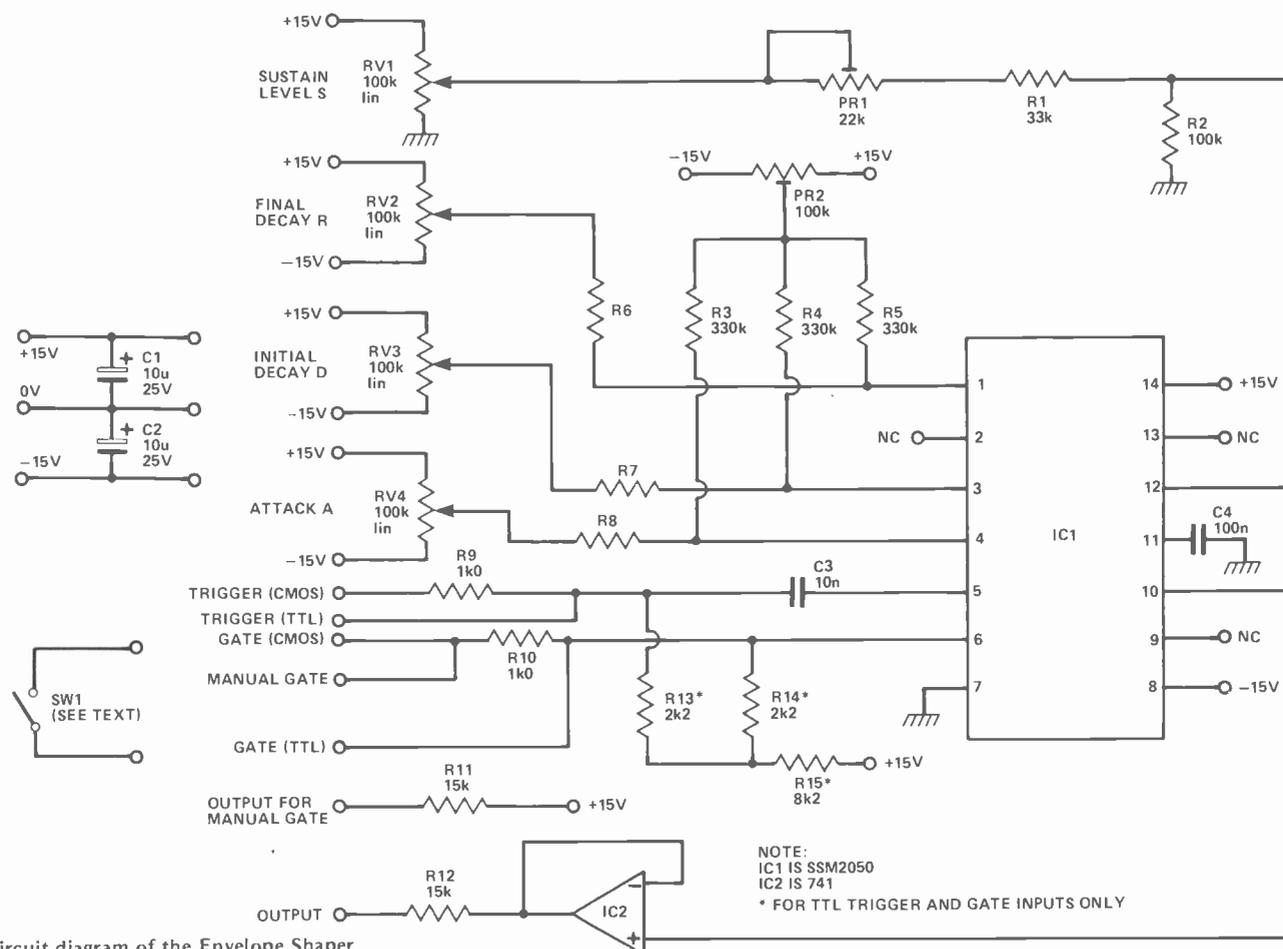


Fig.2. Circuit diagram of the Envelope Shaper.

## HOW IT WORKS

The SSM2050 Voltage Controlled Transient Generator contains a voltage controlled resistor to generate the nominally exponential slopes and various logic devices to define the states. An attack flip-flop (AF/F) is set by the trigger pulse and reset by either NOT GATE or the attack comparator determining that the output has reached +10 V. Thus ATTACK = GATE and AF/F; INITIAL DECAY = GATE and NOT AF/F; FINAL DECAY = NOT GATE. Each state is characterised by a nominally exponential approach to a characteristic voltage; these being +13 V, sustain voltage and 0 V for attack, initial decay and final decay respectively.

The input stages of the SSM2050 logic inputs have a lateral PNP structure which protects them from excess voltages. Their sensitivity is 750  $\mu$ A or 1V5 max., these being the minimum current and voltage required to trigger the SSM2050. For 5 V, 10 V and 15 V CMOS gate and trigger inputs these requirements are met using 1k, 10k and 15k resistors respectively to these inputs.

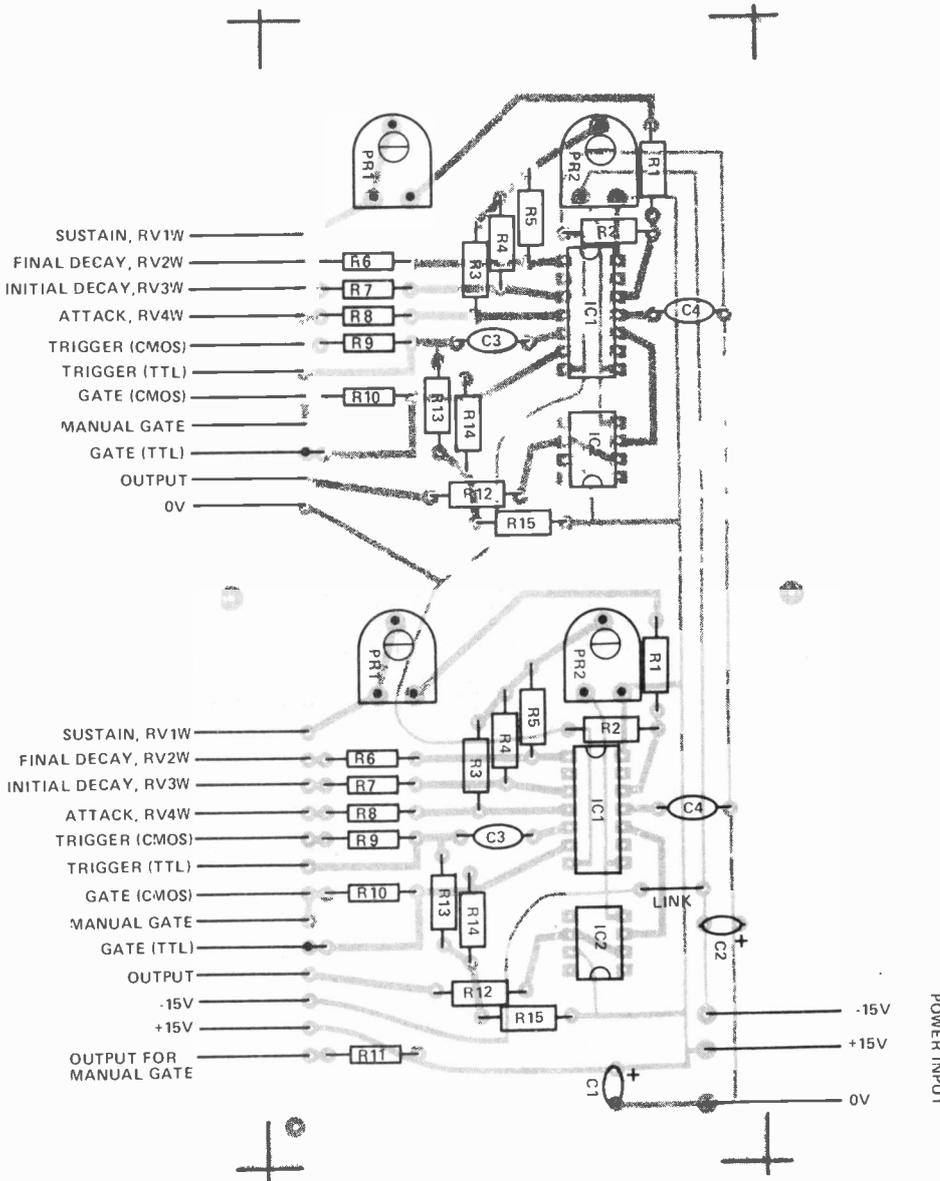
The attack, initial decay and final decay inputs have a nominal impedance of 3k1 and a time constant sensitivity of 18 mV/octave with a 100n timing capacitor (C4). An increasing positive voltage increases the time constant. Thus R6, 7 and 8, connected to +15 V via the rotary controls RV2, 3 and 4, will have nominal values of about 300k to achieve a five decade timing range from 2 mS to 20 S. The input impedance, however, varies by up to +25% between devices. Fortunately the impedance may be measured with a high input impedance ohmmeter as the resistance between pins 1 and 7 and so the appropriate scaling resistor may be selected by multiplying this resistance by 100 and adding 10k. The nearest E24 resistor is chosen and more precise adjustment of timing is achieved by injecting a small offset voltage via PR2 and R3, 4 and 5. The attack voltage may vary between 10 and 11 volts and PR1, R1 and R2 provide a means of matching the maximum sustain voltage to the peak attack voltage. The sustain level can then be varied from 0 to 100% of attack voltage using RV1.

As an additional safeguard the output of the SSM2050 has been buffered by IC2 configured as a voltage follower.

nections marked 'TRIGGER(TTL)' and 'GATE(TTL)' to provide the same function as before. For manual gating with TTL a push to break switch should be connected between 'GATE(TTL)' and 0V, since the gate and trigger pulses are held high by the additional resistors.

## Setting Up And Calibration

Provide a means of manually gating the envelope generator as described in the previous section and the switch may be constructed from two strips of metal, if necessary. Connect the output to a voltmeter set to a DC range of 15V and turn Attack control (RV4) to about 3 o'clock position and all other external controls to zero. Put SW1 in the ADSR position (gate and trigger commoned), turn PR1 fully anti-clockwise and PR2 about mid position. Apply power to the module, depress the manual button and keep held down while observing the voltmeter. The voltage should steadily rise and will probably take between 5 and 20 seconds to reach about 10V. Since the module is not calibrated the time taken may be outside of the range stated. The important point is that the voltage increases to a maximum of about 10V and then drops sharply to zero. If this response is observed then set Sustain control (RV1) to mid position and RV2, 3 and 4 to about the 3 o'clock position (a little less if the time to reach 10V was greater than 10 seconds in the previous step or a little more if the time was less than 5 seconds). Press button and hold down as before. The voltage should now rise to about 10V and then decay at the same rate to a voltage of approximately 5V and remain steady. On releasing the button there will be a final decay to about 0V. Finally, open switch SW1 to check



## PARTS LIST

### Resistors 1/4W, 5% Carbon film

R1	33k
R2	100k
R3,4,5	330k
R6,7,8	see text
R9,10,11	1k0
R11	15k

### Potentiometers

RV1,2,3,4	100k linear
PR1	22k carbon
PR2	100k carbon

### Capacitors

C1,2	10u 25V electrolytic
C3	10n polyester
C4	100n polyester

### Semiconductors

IC1	SSM2050
IC2	LM741CN, or equivalent

### Miscellaneous

SW1	Sub Min SPST (or SPDT) switch
-----	----------------------------------

Fig.3. Component overlay.

the AD response and repeat the last step. This time the voltage should rise to about 5V and maintain this value until the button is released which will initiate the decay to about zero. Note that in the AD mode the Initial Decay control (RV3) determines the attack time and the Sustain level controls the amplitude of the AD contour. The above demonstrates that all functions are operational.

The next step is to adjust the sustain voltage to match the peak attack voltage. Close SW1; set RV4 to about 3 o'clock; RV1 fully clockwise; RV2 and RV3 to the zero. Depress the manual button, observe the voltmeter and note whether there is a discernible drop in voltage after the attack has reached its peak. If so, turn PR1 clockwise and repeat the last step. Repeat until peak attack voltage and sustain level are matched. The adjustment to PR1 must be made in small increments so as to avoid having a higher sustain voltage than the attack voltage, otherwise malfunction of the SSM2050 can occur. It is therefore better to err on the safe side and wait until the envelope shaper is connected to the VCA at which time any mismatch between the two voltages can be checked by ear and a minor adjustment made to PR1 to correct it, if necessary.

The final step is to adjust the time constants and this calibration is only required for the Attack time control (RV4). The module should be in the ADSR mode (SW1 closed) and all other control pots set to zero. If an oscilloscope with a triggered sweep is available then the gate and the oscilloscope can be simultaneously triggered and PR2 adjusted to give an attack time of 2 mS when RV4 is at zero. An alternative method is to time the attack period, for example, by observing a voltmeter connected to the output and measuring the time between pressing the manual push button and the voltage dropping sharply. With the latter method adjust RV4 so that there is 10V0 at its wiper, trigger the module and adjust PR2 until the time taken is 9 S (slightly more than less). When this time is obtained turn RV4 to zero and check that a fast response time is obtained.

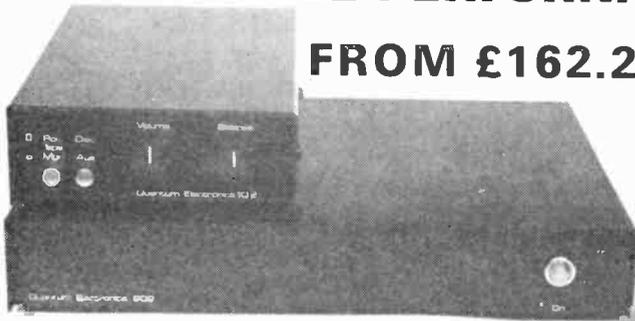
## BUYLINES

A single 80-8 module with PCB and all components shown on the circuit diagram for CMOS inputs is available from Digisound Limited for £9.83 and a dual unit for £17.02, both inclusive of postage and VAT.

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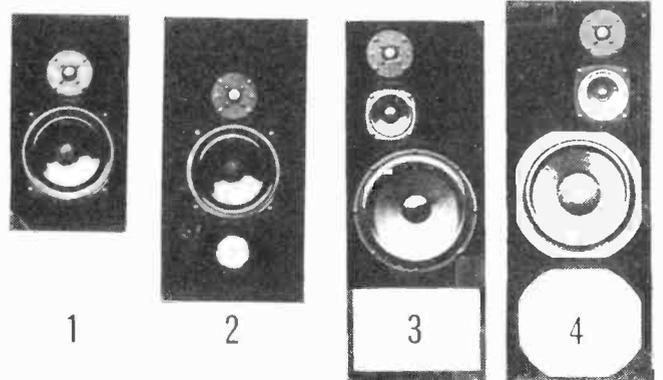
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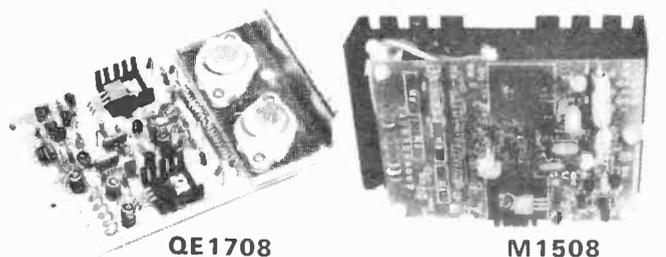
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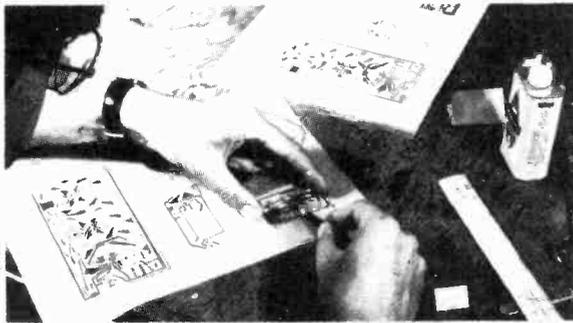
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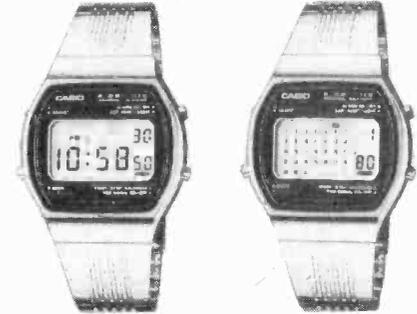
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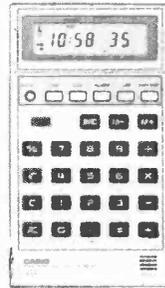
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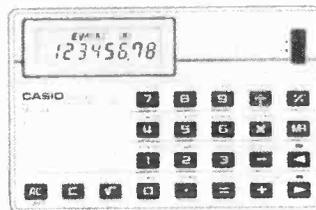
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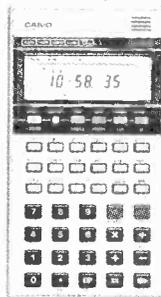
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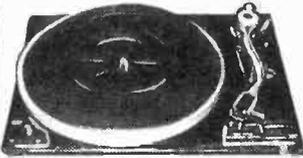
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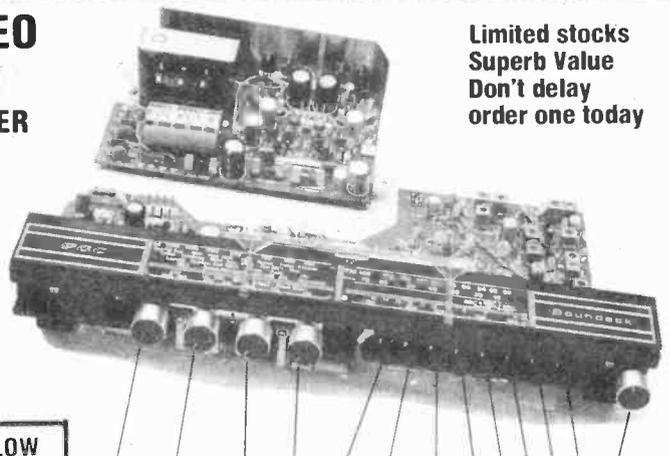
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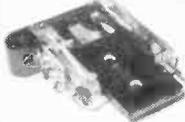
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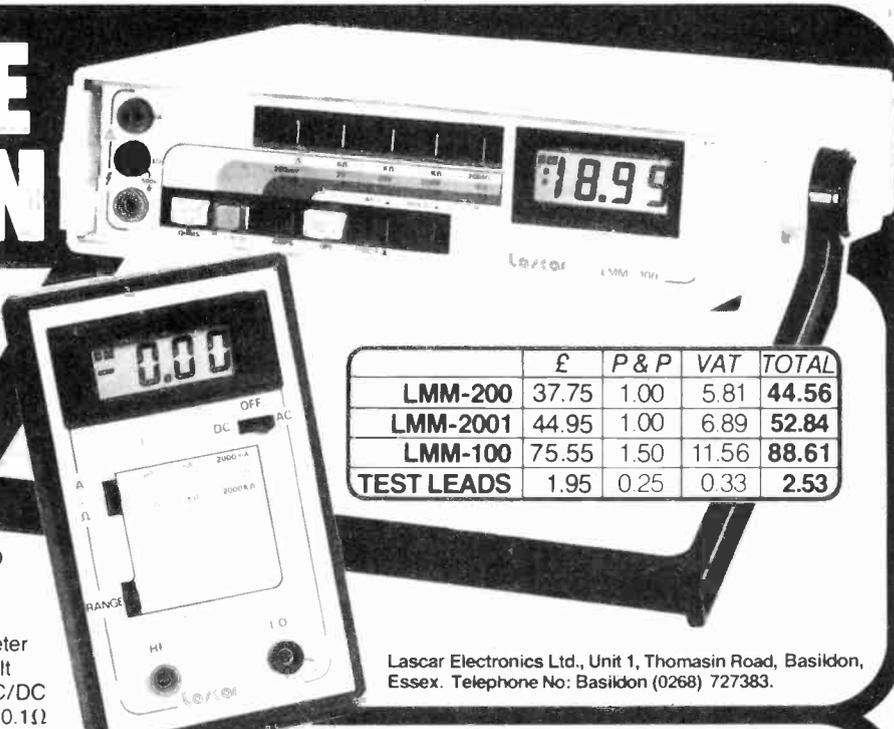
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# LOUDSPEAKER PROTECTION MODULE

**M**odern transistor power amplifiers use the technique of DC coupling between the low level amplifier stages and between the output stages and the loudspeaker. This has the advantage of removing coupling capacitors from the signal path, decreasing parts count and improving performance at low frequencies.

Older transistor amplifiers used a single supply rail so the transistors operated between the supply voltage and ground. Since an AC signal has both negative and positive excursions the power amp was designed so that a DC voltage was present on the output stage. Positive excursions would cause an increase of this DC voltage while negative excursions decrease the voltage. Since DC cannot be applied directly to a loudspeaker it was necessary to insert a capacitor, called a blocking or output capacitor, between the output stage and the loudspeaker. The load impedance of the loudspeaker is around  $8R$  so the capacitor has to be 5000  $\mu F$  to 10,000  $\mu F$  before an acceptable low end performance can be obtained.

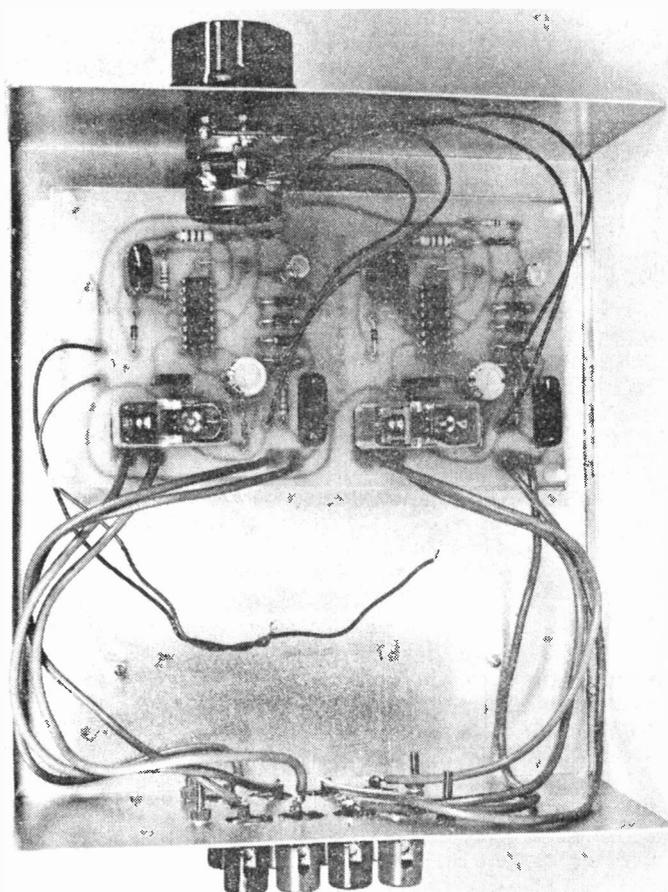
The solution to these problems was DC coupling. The power amp is run from a 'split supply' so that the output transistors are supplied from a positive and negative supply voltage. The average of these supply rails is zero volts, so the output can be connected directly to the loudspeaker. Both positive and negative excursions are possible due to the split power supply.

## Coupling Fault

Unfortunately, DC coupling also has its disadvantages. The biggest of these is the possibility of damage to the loudspeakers in the case of power amp failure. Since all the stages are DC coupled, a fault anywhere in the power amp can cause the output stage to swing hard against one of the supply rails. The most common power amp fault is a condition in which one or several of the output or driver transistors is destroyed, and this almost always causes the full DC voltage from one of the supply rails to be applied directly to the loudspeaker. The loudspeaker cone is slammed against the suspension and the power dissipation in the voice coil causes a rapid increase of voice coil temperature. In this condition most woofers will survive for only a few seconds.

This type of fault is all too common and is the most expensive fault likely to occur in a modern hi-fi system. Some top line amplifiers have built in protection circuits with relays that disconnect the loudspeakers should this condition occur, but these are the minority.

**Make your loudspeakers immune to everything except music and the End of The World with our comprehensive protection circuit.**



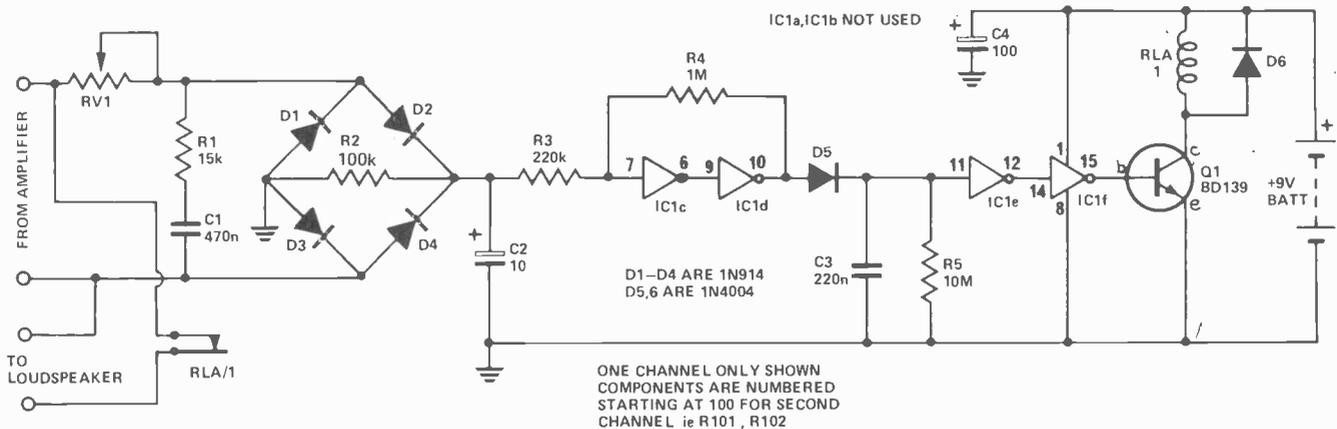


Fig.1 (above) The circuit diagram for the loudspeaker protection unit. Note that one channel only is shown and that on the PCB components for the second channel are numbered from 100 to avoid confusion. Relay RLA1 should be a 12 V type with the facility for one, at least, pair of changeover contacts. This project has been designed such that it does

not place a significant load upon the amplifier itself during usage, such that the damping to the speaker is unaffected. Secondly the high input impedance of the protector ensures that a load-sensitive amplifier is unlikely to be pushed into colouration by your decision to save your loudspeakers from destruction if it cracks up.

## Remedy

This circuit 'looks' at the loudspeaker wires and protects the loudspeakers in two ways. The presence of any DC automatically trips the relay and disconnects the loudspeaker. The protector also looks at the amount of power applied to the loudspeaker. It allows high power transients but will disconnect the loudspeaker if the applied power exceeds the loudspeaker rating for more than about 50 milliseconds. In this way the advantage of the improved high power amplifiers is not lost but the loudspeaker is still protected. The circuit includes a two-second monostable delay circuit so that the loudspeaker is automatically reconnected approximately two seconds after the 'fault condition' has been removed.

The project is designed around two standard CMOS ICs. This ensures a very low current consumption and obviates the need for a power switch. This is important since a fault with an amplifier could well occur at the moment of turn-on and it is essential that the loudspeaker protector is already on. When the relay trips, the circuit pulls around 50 mA for each relay so it is important that battery is capable of supplying 100 mA during relay operation. There should be no problem with the battery lasting for its shelf life, providing the relays are not tripped more than very occasionally.

## Construction

Solder the resistors, capacitors, diodes and relay first. The diodes and electrolytic capacitors must be inserted the right way round as shown on the pc board overlay. Lastly, solder the transistors and ICs on the board. Again, these devices must be oriented correctly.

The prototype was constructed in a general purpose steel box but this is not critical. The front panel is fitted with a stereo 100k potentiometer. This sets the trip point of the protector so that it can be adjusted for your particular loudspeakers. The rear panel holds the terminals for the wires from the amplifier and loudspeakers. The wiring to the rear panel and to the front potentiometer is shown in the wiring diagram.

Finally, make the connection to the battery.

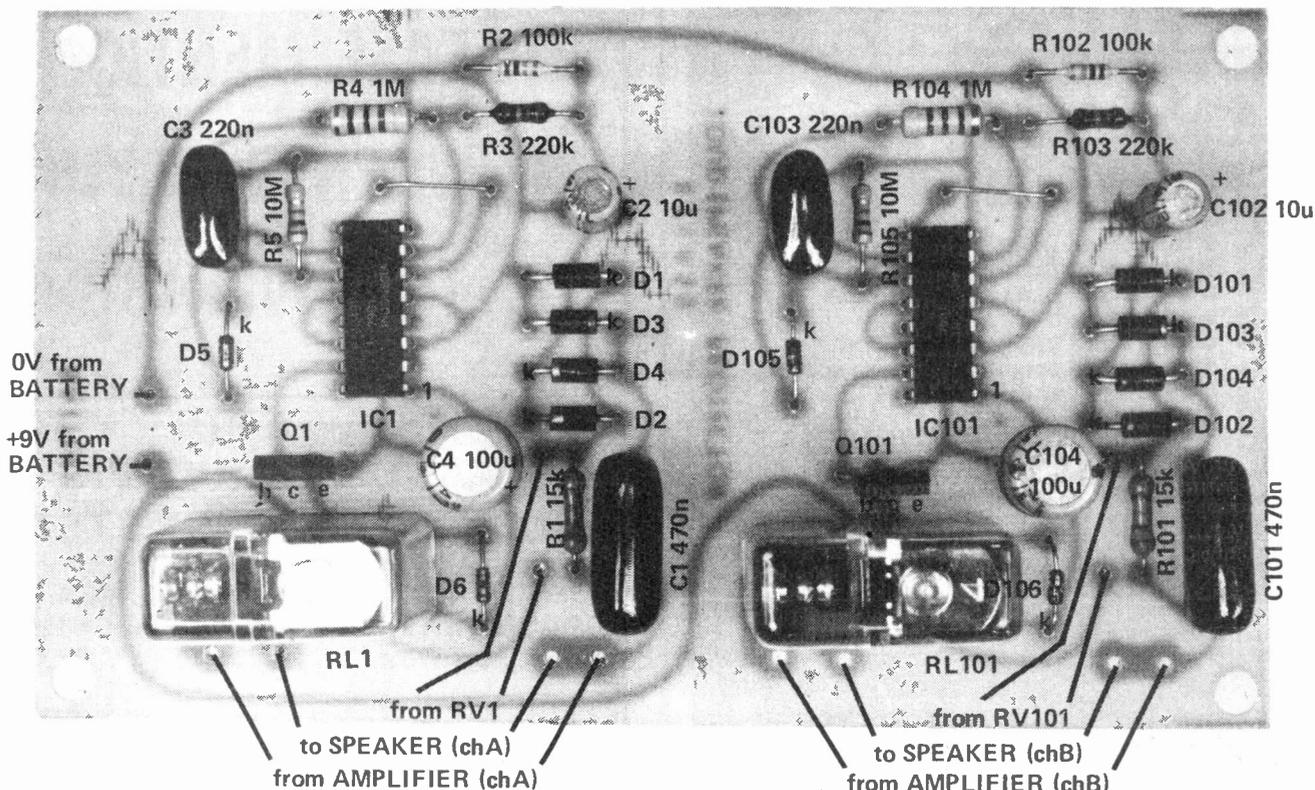
## HOW IT WORKS

The signal voltage from the amplifier is rectified by a full-wave bridge consisting of diodes D1, D2, D3 and D4. The potentiometer RV1 and the resistor R1 and capacitor C1 form a potential divider that determines the sensitivity of the circuit. At normal signal frequencies C1 has a relatively low impedance and the resistance across the diode bridge becomes that of resistor R1, i.e.: 15 k. As the frequency approaches DC however, the impedance of this capacitor increases, increasing the sensitivity of the circuit. If a DC voltage is presented to the input C1 acts as an open circuit and the protector is therefore at its most sensitive.

Signal voltages from the full wave rectifier are averaged by the capacitor C2 and R2, and then applied to a Schmitt trigger. The Schmitt trigger is formed from the resistors R3, R4, IC1c and IC1d. This circuit will only respond to a voltage level greater than a preset amount. When this voltage is exceeded (around 6V5 in this case) the output goes positive charging C3 through diode D5. This diode prevents C3 from being discharged by the Schmitt trigger when its output goes low again so the capacitor can only be discharged by the 10 M resistor R5. This takes about two seconds to this circuit is in reality a simple and effective monostable. Another two stages of the IC drive the transistor which is in series with the relay coil. Diode D6 protects the transistor from large back-EMF voltage spikes produced when the relay is turned off.

## Testing

Check the orientation of all polarised components including the transistors and ICs. If all is well cut two short lengths of speaker cable and connect the output of the amplifier to the input of the loudspeaker protector. Connect the speaker cables to the output of the protector. Now switch on the hi-fi system. Choose music with reasonably even amplitude for this test. Turn the front panel level control on the loudspeaker protector for the lowest power and slowly increase the amplifier volume.



## PARTS LIST

Two of each of the following is required for stereo.

Resistors all  $\frac{1}{2}W$ , 5%

R1 15k  
R2 100k  
R3 220k  
R4 1M  
R5 10M

Potentiometers

RV1 100k lin. (dual)

Capacitors

C1 470n polyester  
C2 10u 25V electrolytic  
C3 220n polyester  
C4 100u 25V electrolytic

Semiconductors

Q1 BD139  
D1-D4 1N4002, or similar  
D5, D6 1N914 or similar  
IC1 4049B

Fig.2. (above) The component overlay for a stereo version of the loudspeaker protection module. Note the '100 upwards' component numbering of the second channel. Apart from the battery connections, the PCB is, in fact, symmetrical. Mains power was not employed because it is important that the module is operating at amplifier power up and the best way to ensure this is to use battery power! In normal use the battery (PP6) will last well-nigh its normal shelf-life as it draws virtually zero power until tripped. If you run the circuit so that it continually operates something is amiss — so stop it!

## BUYLINES

Nothing unusual used in this circuit, so your local neighbourhood component emporium should be able to supply with no problems.

One thing we have heard in the past is that high value 5% resistors are not easy to obtain. In this design lower values of R4 and R5 must not be substituted.

When the power to the loudspeakers exceeds that set by the potentiometer the protector should trip in and disconnect the loudspeakers.

Turn the amplifier down, and the loudspeakers should be reconnected after about two seconds. Since loudspeaker power figures are a rather dubious quantity, it is probably best to establish the correct setting for the loudspeaker protector experimentally rather than just setting it to the rated power handling of your loudspeakers. Your ears are the best indication that the

system is being strained. Set the loudspeaker protector so that it trips just below that volume where distortion starts to occur.

We have done extended tests on the protector, even to the point of connecting expensive loudspeakers and inducing power amp faults that would otherwise destroy a loudspeaker in seconds. In all of these tests the loudspeaker protector has performed well and it is a comforting thought that should a power amp fault occur, it will not take your loudspeakers with it.

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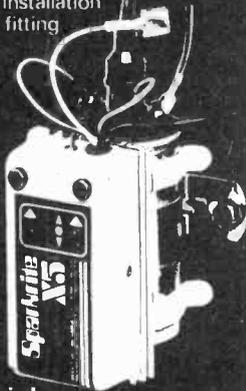
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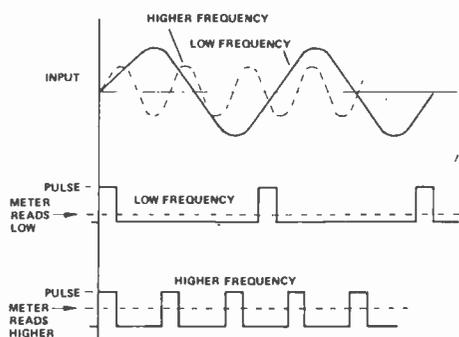
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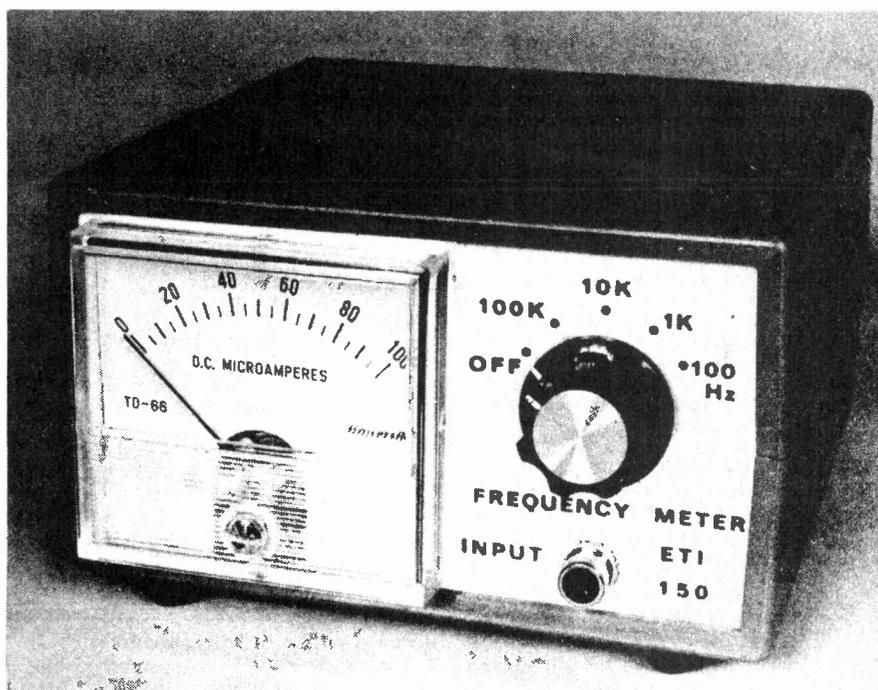
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# LINEAR FREQUENCY METER

A project dedicated to all those hundreds of times you've needed to know one cycle from another and been frequently left wanting.



Above: waveform diagrams which indicate two possible sources of incorrect reading using a DFM. The drawings are self-explanatory on the whole.



There are many applications in the home workshop where simple audio frequency measurements are required. When experimenting with oscillators, building or repairing function generators etc, it is often handy to have some means of measuring frequency — accuracy to the last Hertz is not always required and thus a full-blown digital counter is not warranted.

This project will enable you to measure frequency from around 100 Hz right up to 100 kHz with an accuracy of a few percent. It is inexpensive to build but performance is quite adequate to meet a large number of needs in any hobbyist's workshop. Accuracy is unaffected by the waveshape of the signal being measured and the unit will accept signal levels as low as 200 mV. The input is fully protected against high signal levels and against DC voltages up to the rating of the input capacitor, C1. The input is also fully floating above earth — a useful feature.

The frequency meter may be powered from an internal 9 V battery or from a battery eliminator. A suitable socket may be installed on the rear of the cabinet.

## Circuit Features

The circuit generates a series of short pulses at the same frequency as the input. These pulses drive a moving-coil meter the current through which will be the average amplitude of the pulse waveform; that is, it will integrate the pulses. This average will be proportional to the ratio of time the pulse is on to the time it is off. The time the pulse is on, that is — the pulse width, is fixed. At low frequencies, the time the pulse is off will be much, much longer than the time the pulse is on. Thus, the average current through the meter will be quite low. At higher frequencies, the time between pulses will be quite short and the average current through the meter will be quite a bit higher (as shown in the diagram). Thus, as the frequency of the pulses is proportional to the input frequency, the pulse on/off ratio, and therefore the meter current, will be proportional to the input frequency. The meter can be calibrated directly in frequency as the relationship is a linear one. We have used a 100  $\mu$ A movement for convenience as it does not have to be rescaled.

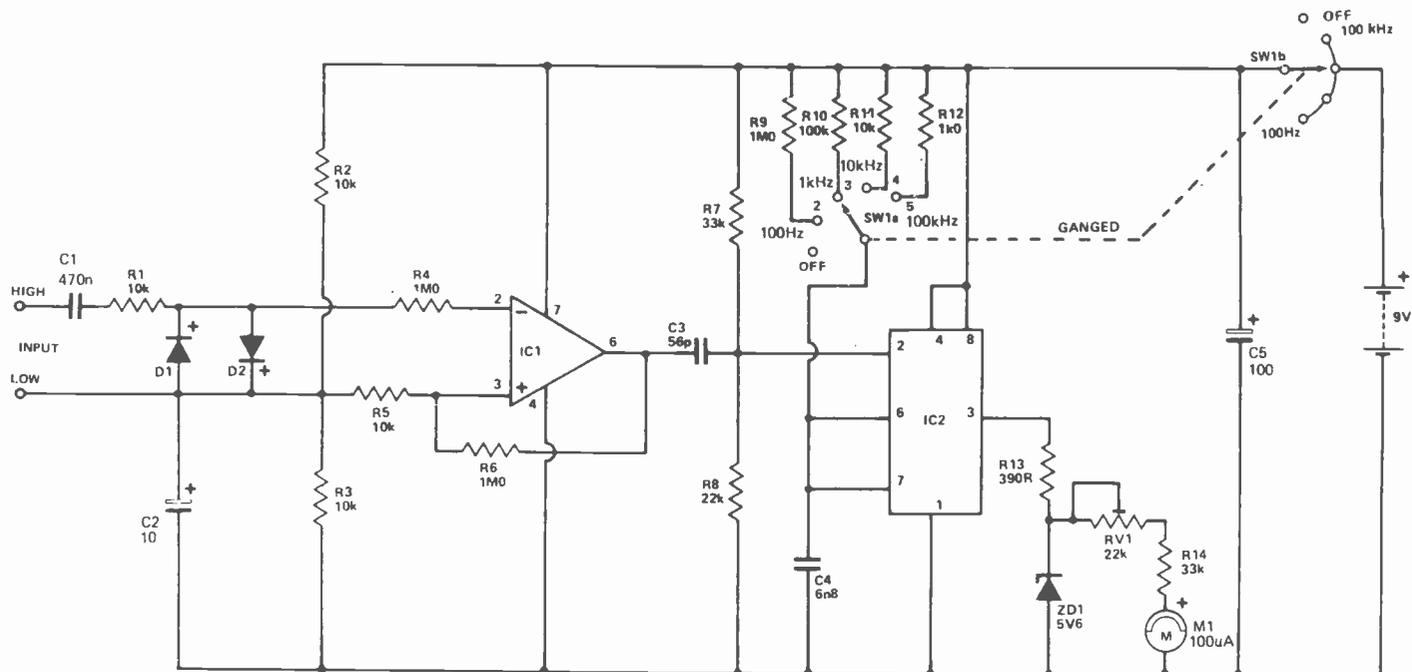


Fig.1. A full circuit diagram for the linear frequency meter.

## HOW IT WORKS

The circuit consists of an op-amp operated as a Schmitt trigger to amplify and square the input signal, followed by a 555 timer wired as a monostable, giving a short output pulse of fixed width for each cycle of input signal. This pulse drives a moving-coil meter, the reading being an average of the pulse amplitude, which is proportional to the pulse frequency. As the pulse frequency is directly related to the input frequency, the meter reading is directly proportional to the input frequency.

The input signal is coupled into IC1 via C1, which provides DC blocking. Protection from overload caused by high amplitude input signals is provided by a diode clipper consisting of D1, D2 and R1. The diodes are connected in an inverse-parallel arrangement so that both positive and negative peaks, above the diode forward conduction voltage, are clipped.

IC1 is a fast op-amp connected as a Schmitt trigger with amplification, as mentioned above. Resistors R5 and R6 provide hysteresis, a 'dead band' in the action of the Schmitt, centred on zero input level. This dead band ensures that the Schmitt ignores noise pulses.

As the unit is required to operate from a single supply, for convenience, R2 and R3 bias the input of IC1 at half the supply voltage.

The output of IC1 is a train of square waves at the same frequency as the input. The output of IC1 is differentiated to provide short trigger pulses for the 555 timer, IC2. The differentiating network consists of C3, R7 and R8. This network is arranged to provide a trigger pulse that is always shorter than the output pulse of the 555. Capacitor C3 is selected to give the shortest possible pulse to the 555 consistent with reliable triggering.

The output of the 555 monostable will be a pulse of fixed width, determined by the range resistors, R9 to R12, and capacitor C4. The ranges are arranged to give a 75% output duty cycle at frequencies of 100 Hz, 1 kHz, 10 kHz and 100 kHz on the input.

The output pulse from the 555 is clipped at 5V6 by a zener diode, ZD1, to avoid inaccuracies caused by falling battery voltage (as the battery ages). The meter responds to the average value of the clipped pulses. As the frequency increases, the duty cycle (on/off ratio) of the pulse train increases, increasing the average voltage and thus the meter current in direct proportion. Thus the reading on the meter will be linearly related to frequency.

The lowest range is 100 Hz full-scale deflection, the highest, 100 kHz.

Only two cheap IC's are used in the whole design, a 3140 op-amp and a 555 timer. The 3140 amplifies and squares the input signal and was selected for its high slew rate, wide frequency response and high input impedance. The output of this stage will be a square wave of the same level for all input signal levels and waveforms.

The pulses are generated by a 555 timer connected as a one-shot monostable giving a single pulse output for each input cycle. The monostable has four ranges giving decade scales on the meter. A fifth position on the switch is used as a power switch.

Regulation of the output pulses by a zener diode preserves the accuracy of the unit with falling battery voltage.

## Construction

As mentioned previously, we constructed our prototype in a plastic box. This has the advantage that the unit can be operated fully floating from earth — handy in some situations. Check placement of components on the front panel and the positioning of the PCB inside before commencing major assembly. It's probably best to assemble the components on the board first. Take care with the orientation of the ICs, diodes and tantalum capacitor.

The input capacitor, C1, can be obtained in several voltage ratings. Polyesters are available in ratings of 100 V, 250 V and 630 V. If all your work is with solid-state circuitry, a 100 V type will be more than adequate. If you anticipate using your unit with say, valve equipment, the highest rating type for C1 is recommended. The rating applies to the combined voltage that may be present on the input, plus the possible peak value of the input signal.

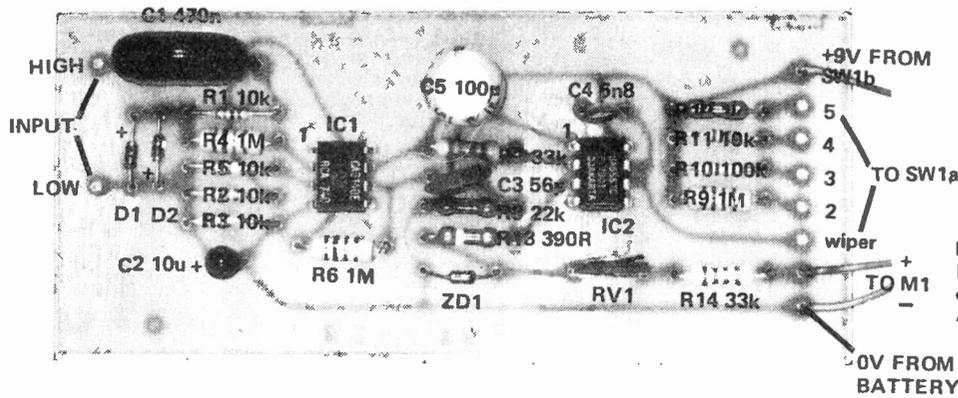


Fig.2. Component overlay for the ETI Linear Frequency Meter. Note the input and output connections from the PCB carefully. A couple of crossed wires here and ...

## PARTS LIST

Resistors All 1/2W, 5%	
R13,5,11	10k
R4,6,9	1M
R7,14	33k
R8	22k
R10	100k
R12	1k
R13	390R
Potentiometer	
PR1	22k Trimmer
Capacitors	
C1	470n polyester
C2	10u tantalum
C3	56p ceramic
C4	6n8 polyester
C5	100u 25V electrolytic
Semiconductors	
D1,2	1N914 or similar
ZD1	5V6, 400mW zener diode
IC1	3140 op amp
IC2	555 timer
Miscellaneous	
M1	100uA meter, SW1 two pole five position wafer switch.

## BUYLINES

As one of the criteria in designing the project was that it would be assembled from easy to obtain bits and pieces, it is (or should be) unlikely that any problems will be encountered in that area! Boxing is not critical at all and the ever-present Vero range would serve as well as the one we employed here.

## SPECIFICATION

Frequency	10Hz to 100kHz in four decade ranges
Minimum input	200 mV RMS
Maximum input	250 V peak AC or DC (dependent on voltage rating of C1)
Supply voltage	9 V

A 630 V rated capacitor will be physically larger than a 100 V type and the leads may have to be shaped to fit the capacitor on the board.

Once the board is assembled, the major components can be assembled onto the front panel of the case. We made up an overlay for the front panel.

The board may be mounted anywhere convenient in the case and wires run to the front panel for the input and switch connections. Make sure the board does not get in the way of the meter when the front panel is in place.

The unit may be powered from an internal battery, which makes it a handy portable unit. If you wish to operate the unit from a plugpack battery eliminator, then we recommend you purchase a unit giving a nominal 6 V DC output. The current requirement for the project is quite modest and the output of these small battery eliminators is dependent on the load. A 6 V unit will typically deliver 9 V or so under a light load.

If you do decide to use one of these units, a socket matching the unit's plug will have to be mounted on the rear panel and leads run to the supply rail pads on the board. If you wish to have the option of both battery and mains operation, then a small SPDT toggle switch should be mounted on the rear panel also and wired into the circuit.

## Calibrating It

Calibration of the frequency meter is very easy, aided by the fact that it has a very high input impedance.

With the unit switched to the 100 Hz range, touch your finger to the input. There will usually be enough 50 Hz field from the electrical wiring in a building to drive the input. This will cause a deflection on the meter and RV1 should then be adjusted to give a meter reading of 50 (half scale). Move the unit near house wiring to increase the amount of signal to the input if a reading cannot be obtained.

If a signal generator of known accuracy is available the instrument can be calibrated on any range. Only one range need be calibrated as the others will automatically fall into line.

If it is impossible to obtain any reading on the meter, the coupling capacitor (C3) may have to be increased in value to say 100pF or 150pF. This component has been selected to give a very short trigger pulse into the 555 and has been found to work correctly, using the value shown in the circuit, with several different ICs.

Selecting the 100 kHz range will connect power to the unit and the unknown signal can then be applied to the input. Set the reading and switch to a lower range if required.

1

**GENTS QUARTZ LCD, 5-function.** Hours, minutes, secs, month, date, backlight.  
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2

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3

**QUARTZ LCD Slim Chronograph, 11-function.** Hours, mins, secs, 6 digit-month, date, day of week, 1/100 sec stopwatch, split and lap modes, backlight.  
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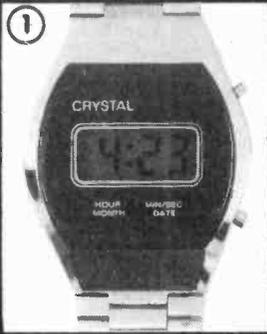
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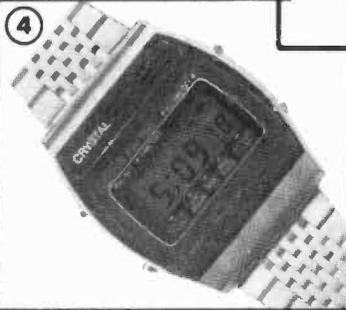


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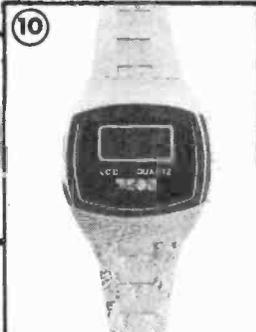
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9

**LADIES QUARTZ LCD, SAME FUNCTIONS AS 8.** - Alternative style. Available with black or white face.  
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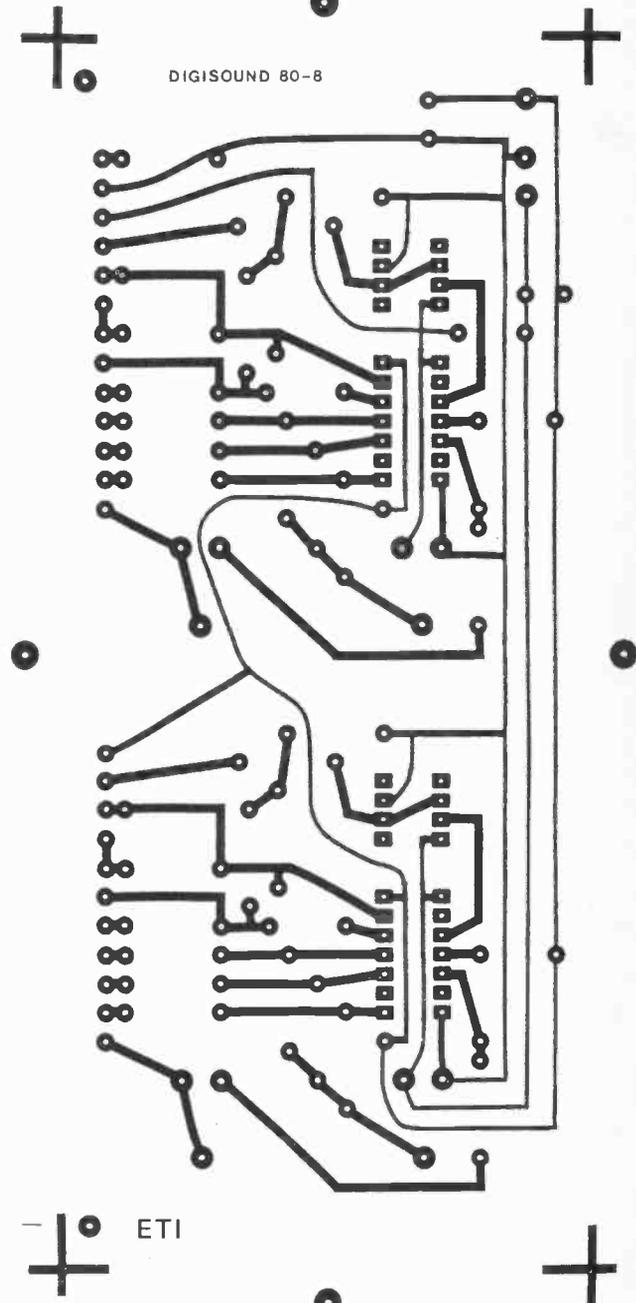
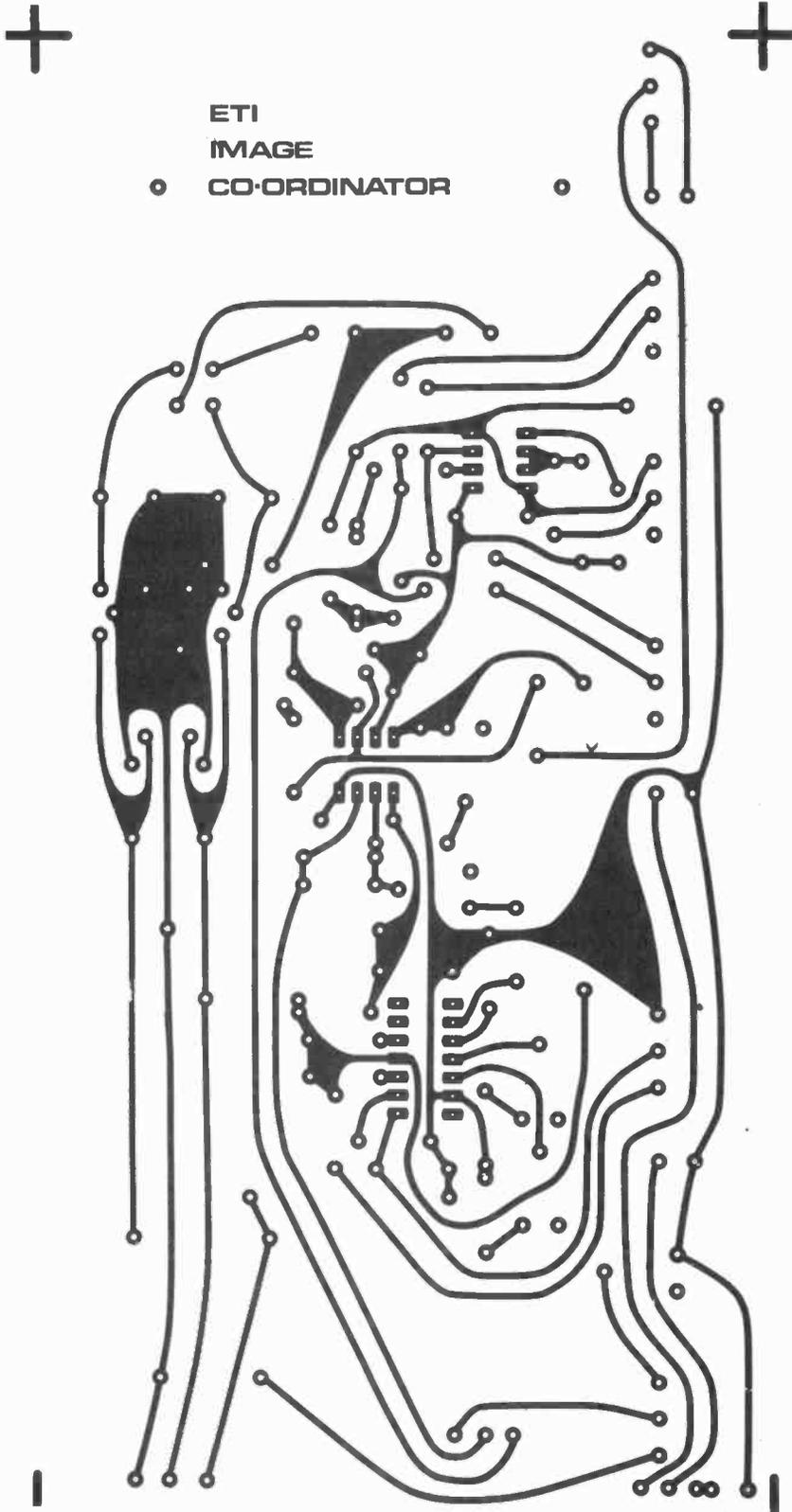
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ET12

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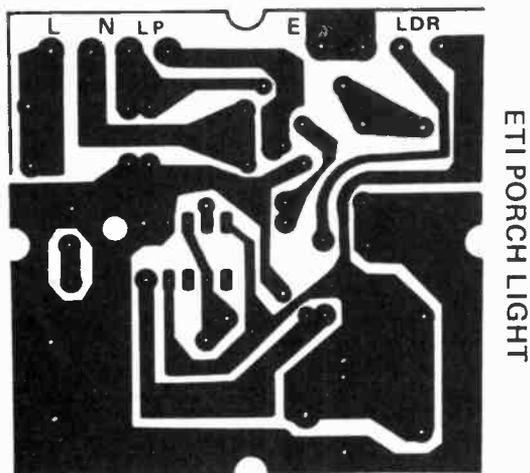
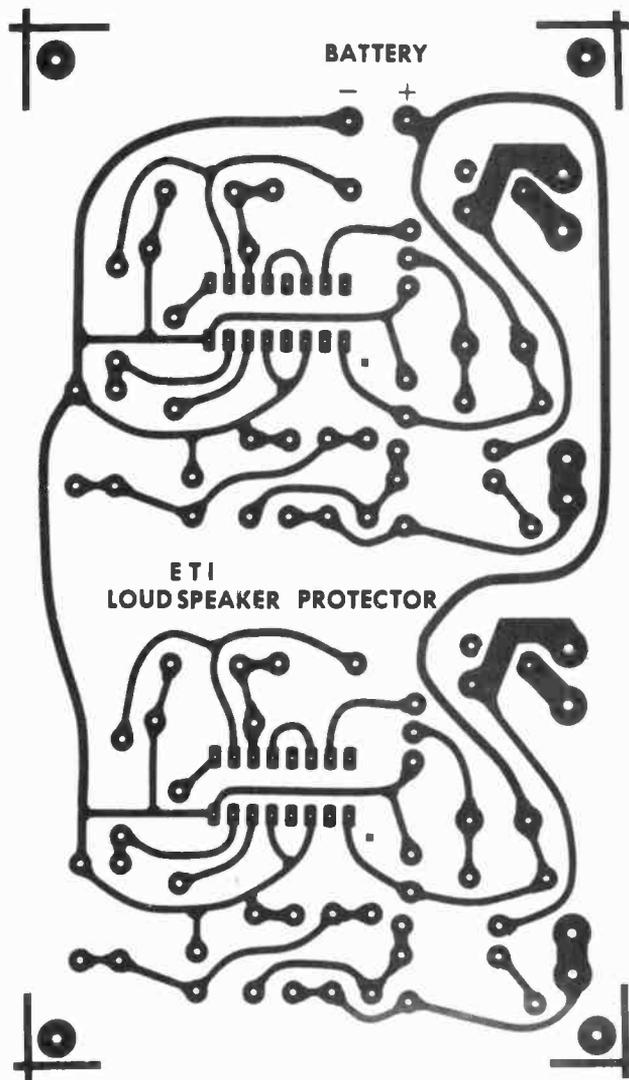
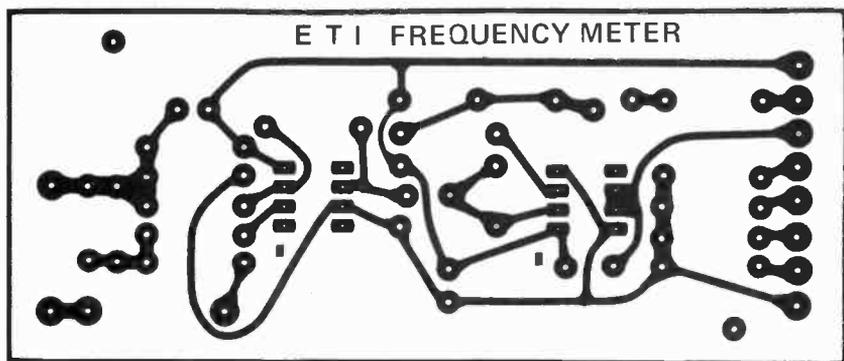
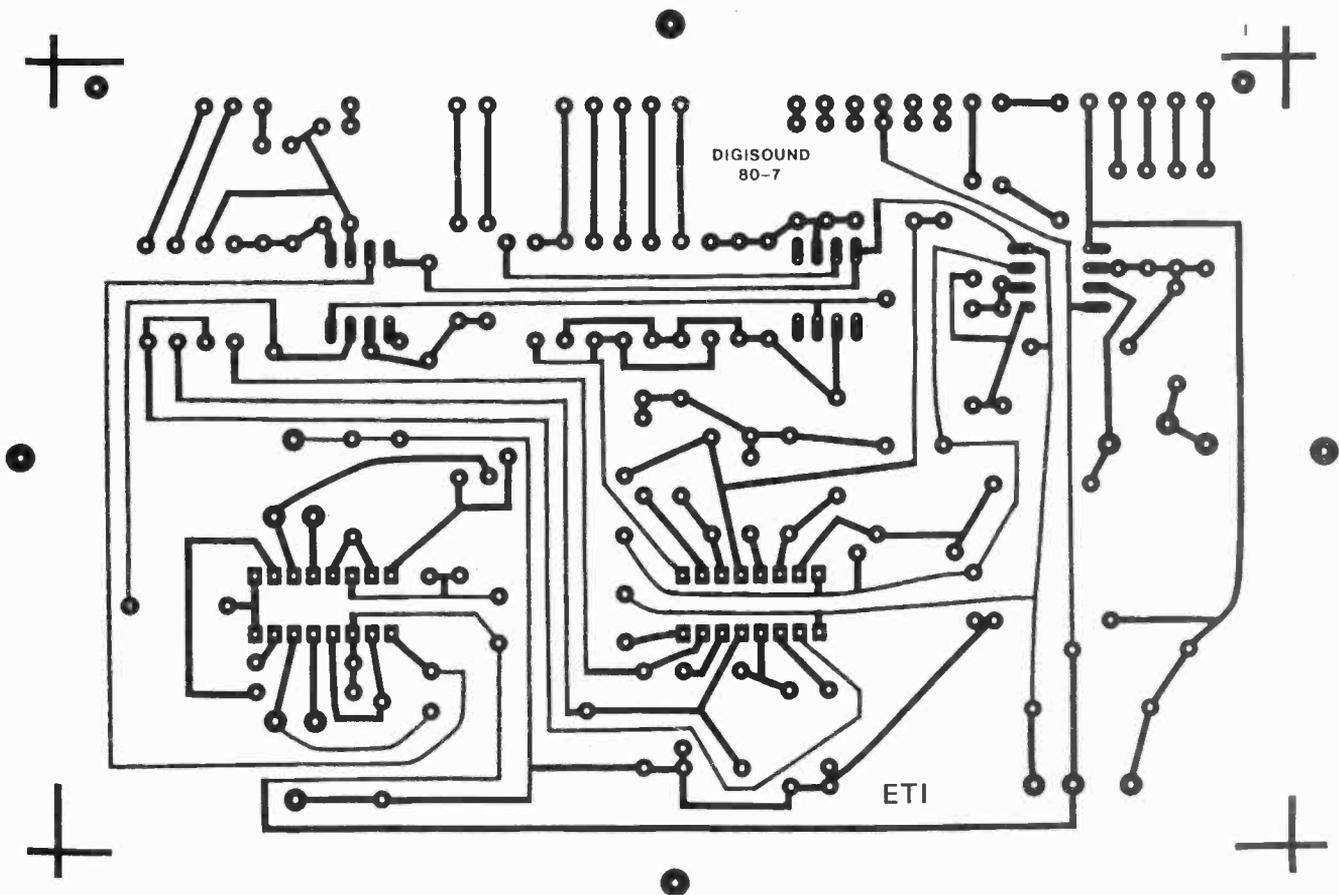


ETI  
IMAGE  
CO-ORDINATOR

Topside

ETI  
IMAGE  
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Bottom



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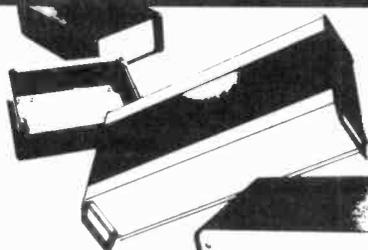
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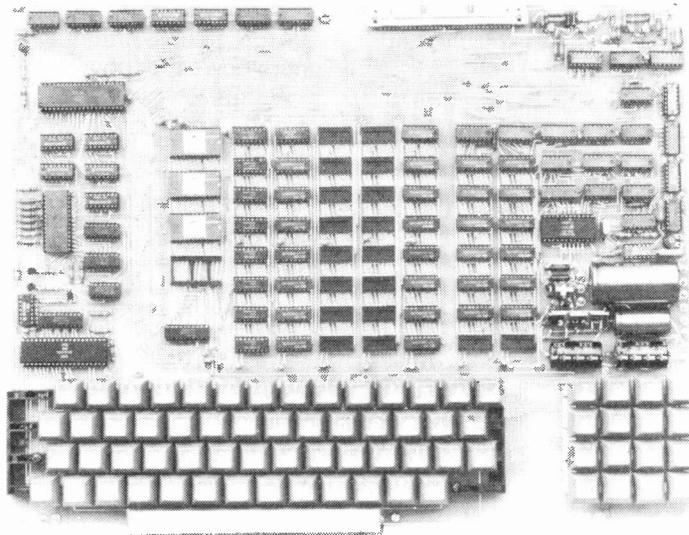
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The unique Sinclair BASIC interpreter offers remarkable programming advantages:

- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability—takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The ZX80 also has string input-to request a line of text when necessary. Strings do not need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up to 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications.
- Timer under program control.
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- High-resolution graphics with 22 standard graphic symbols
- All characters printable in reverse under program control.
- Lines of unlimited length



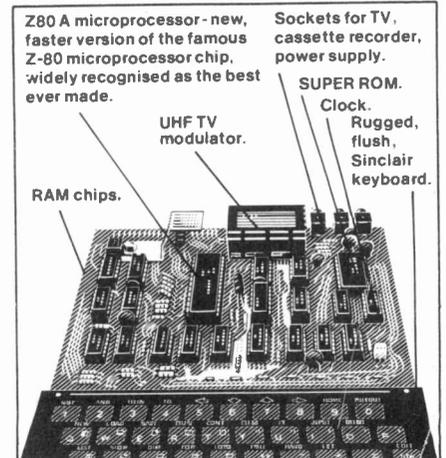
### Fewer chips, compact design, volume production—more power per pound!

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer—typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines.

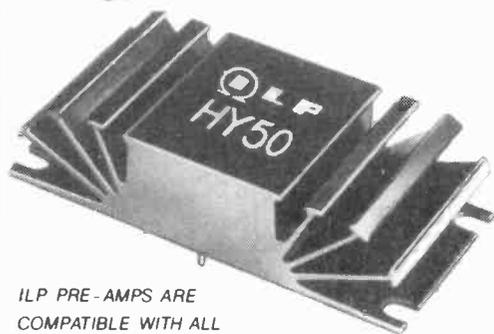
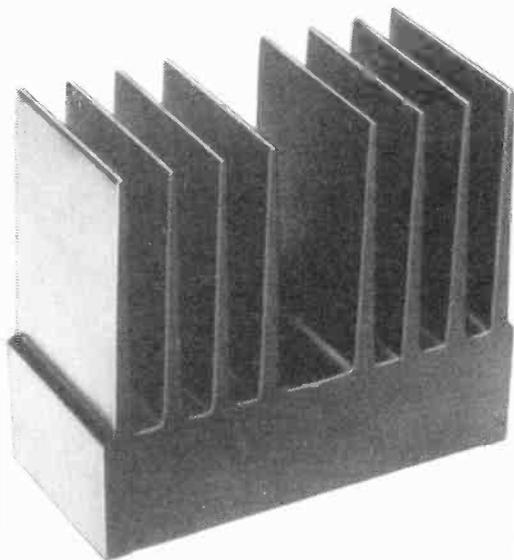
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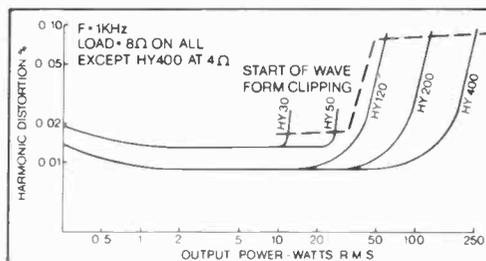
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HY50	30 W into 8 Ω	0.02%	100 dB	-25 0 +25	105x50x25	155	£7.24 + £1.09
HY120	60 W into 8 Ω	0.01%	100 dB	-35 0 +35	114x50x85	575	£15.20 + £2.28
HY200	120 W into 8 Ω	0.01%	100 dB	-45 0 +45	114x50x85	575	£18.44 + £2.77
HY400	240 W into 4 Ω	0.01%	100 dB	-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  
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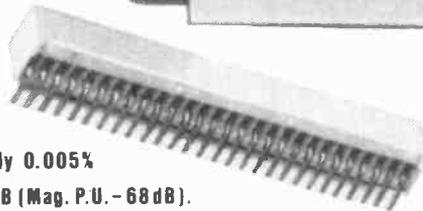
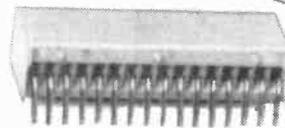
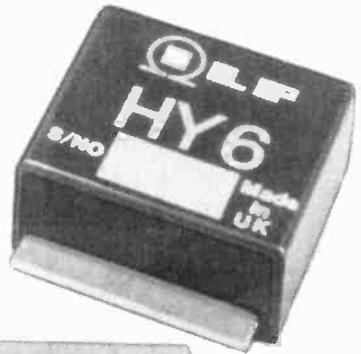
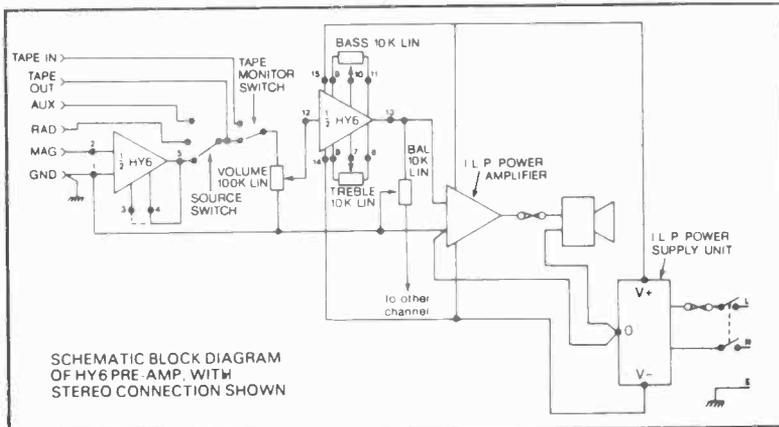
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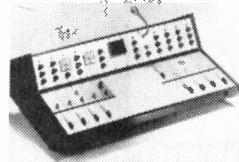
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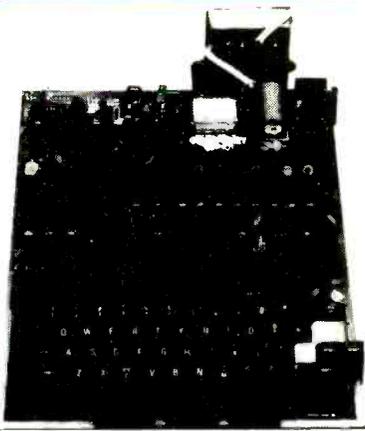
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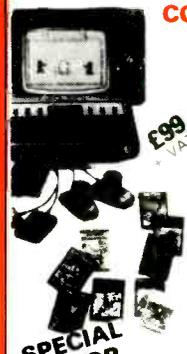


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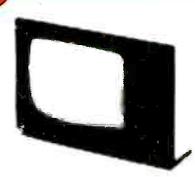
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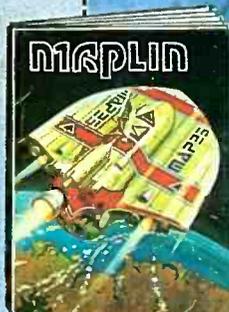


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