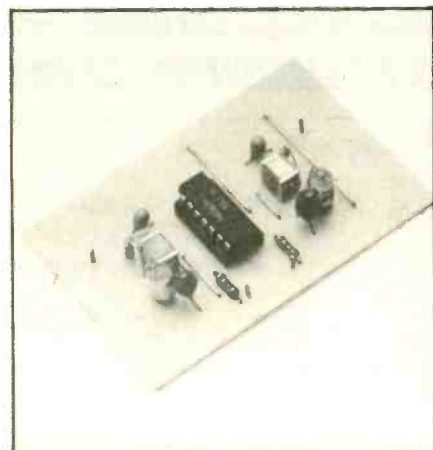




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# electronics today

NOVEMBER 1980 VOL.9 NO.11 INTERNATIONAL

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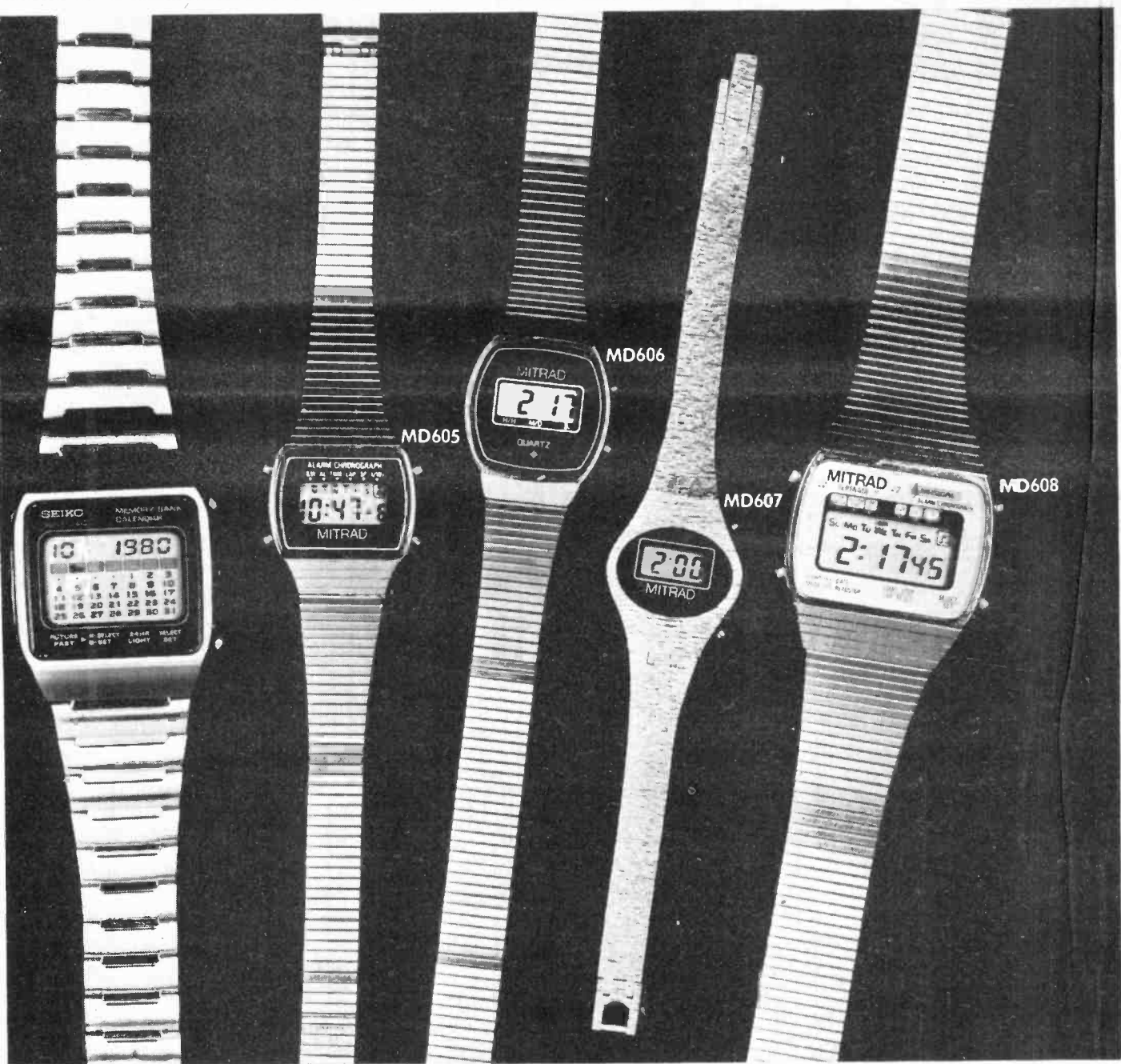
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ETI

ETI NOVEMBER 1980





**MD609** Gentleman's **super slim** flag date alarm. Only 4mm case thickness. Continuous display of hours, minutes, seconds and day; optional display of date, month, year. 24 hour alarm, alarm mode indication. Back light. Infinitely adjustable stainless steel strap. Very latest technology.  
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**MD610** Gentleman's dual time melody alarm chrono. Only 5mm case thickness. Continuous display of hours, minutes, seconds plus date and mode indications. 'Running horse' chrono to 1/10 sec, 12 hour alarm plays 30 seconds of 'Yellow Rose of Texas'. Infinitely adjustable stainless steel strap.  
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**MD605** Ladies musical alarm chrono. Continuous display of hours, minutes, seconds; optional display of day, date, month. Auto calendar. Chronograph with lap timing facilities, to 1/10 sec. 24 hour alarm plays 30 seconds of Beethoven's 'Für Elise'. Back light. Infinitely adjustable stainless steel strap.  
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**MD606** Ladies five function fashion LCD watch with 3 year battery. Continuous display of hours and minutes, with month/date and date/seconds available. Auto calendar. Only 6mm case thickness. Back light. Infinitely adjustable stainless steel strap.  
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**MD607** Ladies slim 'sugar coated' dress watch. Continuous display of hours and minutes; optional display of month and date. Auto calendar. Back light. Integral watch and strap. In gold or silver finish.  
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**MD608** Gentleman's musical alarm chrono. Continuous display of hours, minutes, seconds, plus day indication. Also month and date. Chronograph with lap timing facilities, to 1/10 sec. 24 hour alarm plays 30 seconds of Beethoven's 'Für Elise' or can be set to awaken to a single note. Back light. Infinitely adjustable stainless steel strap.  
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(P&P is extra on all items) Call in at our shop for Demo or write in for leaflets.

<b>SWITCHES</b> TOGGLE: 2A, 250V. 32p SPST 34p DPST 44p DPDT 54p 4 pole on/off	<b>SLIDE 250V:</b> 1A DPDT 14p 1A DPDT c/over 15p 1/2A DPDT 13p 4 pole 2-way 24p <b>PUSH BUTTON</b> DPDT Black Body Red, Blue, Grn., Yell. SRL Latching 125p SRM Momentary 125p <b>MINI. Non Locking</b> Push to Make 15p Push Break 25p <b>DIL SWITCHES</b> (SPST) 4 way 85p, 6 way 95p, 8 way 115p	<b>ROTARY:</b> Make your own multiway Switch. Adjustable Stop Shafting Assembly. Accommodate up to 6 Wafers 90p Mains Switch DPST to fit 40p Break Before Make Wafers. 1 pole/12 way. 2p/6 way. 3p/4 way. 4p/3 way. 6p/2 way 56p Spacer and Screen 6p <b>ROTARY: (Adjustable Stop)</b> 1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way 43p <b>ROTARY:</b> Mains 250V AC. 4 Amp 52p
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<b>CRYSTALS</b> 100KHz 323 455KHz 383 1MHz 323 1.008M 395 1.28MHz 392 1.6MHz 323 1.9MHz 323 1.8432MHz 362 2.4576MHz 362 3.2768M 323 3.57954M 195 4.000MHz 323 4.032MHz 323 4.433619M 195 5.0MHz 355 5.185M 323 5.24288M 425 6.0MHz 323 6.5536M 200 7.680M 323 8.0MHz 392 8.08333M 362 8.867237M 362 9.375M 323 10.0MHz 323 10.7MHz 323 12MHz 392 14.31818M 362 18MHz 323 18.432M 323 20.0MHz 323 27.648M 323 38.6667M 350 48.0MHz 323 100.00MHz 323	<b>TRANSFORMERS</b> (Mains Prim. 220-240V) 6.0-6V: 9.0-9V: 12.0-12V 100mA 85p 3VA: 0.6V 0.6V (PCB mounting) 150p 6VA: 6V: 5A 6V: 5A 9V: 3A 12V: 3A 150p 12V: 3A: 15V: 25A 15V: 25A 215p 12V: 4.5V: 1.3A 4.5V: 1.3A: 6V: 1.2A 6V: 1.2A: 235p (30p p&p) 12V: 1A 12V: 1A: 15V: 8A 15V: 8A: 20V: 3A 235p (30p p&p) 24VA: 6V: 1.5A 6V: 1.5A: 9V: 1.3A 9V: 1.3A: 20V: 6A 320p (55p p&p) 12V: 1A 12V: 1A: 15V: 8A 15V: 8A: 20V: 3A 235p (30p p&p) 50VA: 6V: 4A 6V: 4A: 9V: 2.5A 9V: 2.5A: 12V: 2A 20V: 2A: 15V: 1.5A 15V: 1.5A: 20V: 1.2A 20V: 1.2A: 25V: 1A 25V: 1A: 30V: 8A 30V: 8A: 365p (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 695p (74p p&p). (NB: p&p charge to be added above our normal postal charge.)	<b>ALUM. BOXES WITH LID</b> 3x2x1" 55 2 1/2x5 1/2x1 1/2" 75 4x4x1 1/2" 75 4x2 1/2x1 1/2" 100 4x5 1/2x2" 80 5x4x2" 107 5x4x2" 110 7 1/2x2 1/2" 185 8x6x3" 185 10x7x3" 240 10x4 1/2x3" 228 12x5x3" 230 12x8x3" 275	<b>PANEL METERS</b> FSD 60x46x 35mm 0-50µA 40p 0-100µA 40p 0-500µA 40p 0-1mA 40p 0-5mA 40p 0-10mA 40p 0-50mA 40p 0-100mA 40p 0-500mA 40p 0-1A 40p 0-2A 40p 0-25V 40p 0-50V AC 40p 0-300V AC 40p "VU" 445p each 4 1/2x3 1/2x1 1/2" 0-50µA 40p 0-100µA 40p 0-500µA 40p 1 1/2x3 1/2x1 1/2" 0-50µA 40p 0-100µA 40p 0-500µA 40p
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<b>ETI Projects:</b> Parts available for: <b>Digital Test Meter, DM900, 60W Amplifier System.</b> Send SAE plus 5p for list.	<b>VOLTAGE REGULATORS</b> 1A TO3 +ve -ve 7905 220p 5V 7805 145p 7912 220p 12V 7812 145p 7912 220p 15V 7815 145p 7912 220p 10.7MHz 323 12MHz 392 14.31818M 362 18MHz 323 18.432M 323 20.0MHz 323 27.648M 323 38.6667M 350 48.0MHz 323 100.00MHz 323	<b>OPTO</b> LEDs with Clips TIL209 Red 13 TIL211 Grn 17 TIL212 Yel 18 TIL220 2" Red 14 2" Green, Yellow or Amber 18 Square LEDs, Red, Green, Yellow 30 LD271 Infra Red 40 SFH205 Detector 90 TIL32 Infra Red 65 TIL32 Detector 75 BARGRAPHY Red 225 LS400 255 OC71 120 ORP12 63 ORP61 85 2N5777 45 3" Green CA 150 3" Red CA 150 3" Green CA 150	<b>ISOLATORS</b> IL74 55 TIL111/2 85 TIL114 85 TIL117 110 4521 250 4522 150 4526 150 4527 160 4528 120 4529 175 4530 89 4531 165 4532 140 4534 575 4536 395 4538 160 4539 135 4541 150 4543 175 4549 296 4553 440 4554 175 4555 85 4556 75 4557 425 4558 290 4560 235 4561 95 4562 595 4566 190 4568 299 4569 250 4572 48 4580 595 4581 350 4582 150 4583 125 4584 66 4585 140 40106 95
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LS245 450 LS247 135 LS248 135 LS249 135 LS251 130 LS253 130 LS257 115 LS258 120 LS259 160 LS261 150 LS266 75 LS273 180 LS276 320 LS278 88 LS280 250 LS283 190 LS290 130 LS293 130 LS295 215 LS298 215 LS299 420 LS300 175 LS302 175 LS320 270 LS323 450 LS324 200 LS325 320 LS326 330 LS327 315 LS346 185 LS347 150 LS348 190 LS352 185 LS353 185 LS355 65 LS366 65 LS367 65 LS368 65	LS373 180 LS374 180 LS375 150 LS377 199 LS378 185 LS379 215 LS384 50 LS385 420 LS386 85 LS390 140 LS393 140 LS395 210 LS396 199 LS398 235 LS399 230 LS445 140 LS447 195 LS490 150 LS495 215 LS498 215 LS499 420 LS500 175 LS502 175 LS520 270 LS523 450 LS524 200 LS525 320 LS526 330 LS527 315 LS546 185 LS547 150 LS548 190 LS552 185 LS553 185 LS555 65 LS566 65 LS567 65 LS568 65	4015 85 4016 42 4017 82 4018 28 4019 48 4020 99 4021 105 4022 95 4023 25 4024 75 4025 25 4026 180 4027 48 4028 82 4029 105 4030 60 4031 225 4032 125 4033 175 4034 210 4035 125 4036 365 4037 115 4038 118 4039 360 4040 105 4041 80 4042 80 4043 95 4044 95 4045 175 4046 110 4047 98 4048 65 4049 45 4050 48 4051 80 4052 80	4053 80 4054 130 4055 135 4056 135 4057 2650 4059 575 4060 130 4061 1225 4062 995 4063 120 4066 58 4067 430 4068 26 4069 26 4070 30 4071 25 4072 25 4073 25 4075 25 4076 99 4077 48 4078 30 4081 28 4082 28 4085 90 4086 90 4089 150 4093 89 4094 240 4095 105 4096 105 4097 350 4098 115 4099 190 4100 125 4101 125 4102 125 4103 125 4104 125 4105 125 4106 125	4174 130 4175 120 4194 125 4408 790 4409 790 4410 790 4411 1020 4412F 1520 4412V 1520 4415F 850 4415V 850 4419 320 4422 570 4432 1050 4435 1050 4440 999 4450 350 4451 350 4452 350 4490F 750 4490V 750 4501 28 4502 125 4503 75 4506 75 4507 60 4508 325 4510 99 4511 150 4512 99 4513 225 4514 265 4515 299 4516 120 4517 450 4518 105 4519 70 4520 115	4521 250 4522 150 4526 150 4527 160 4528 120 4529 175 4530 89 4531 165 4532 140 4534 575 4536 395 4538 160 4539 135 4541 150 4543 175 4549 296 4553 440 4554 175 4555 85 4556 75 4557 425 4558 290 4560 235 4561 95 4562 595 4566 190 4568 299 4569 250 4572 48 4580 595 4581 350 4582 150 4583 125 4584 66 4585 140 40106 95
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### CMOS

# All these advantages...

- Instant all-weather starting
- Smoother running
- Continual peak performance
- Longer battery & plug life
- Improved fuel consumption
- Improved acceleration/top speed
- Extended energy storage

## ..in kit form

SPARKRITE X5 is a high performance, too quality inductive discharge electronic ignition system designed for the electronics D.I.Y. world. It has been tried, tested and proven to be utterly reliable. Assembly only takes 1 1/2 hours and installation even less due to the patented clip on ease fitting.

The superb technical design of the Sparkrite circuit eliminates problems of the contact breaker. There is no misfire due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current by 95% of the normal.

There is also a unique extended dwell circuit which allows the coil a longer period of time to store its energy before discharging to the plugs. The unit includes built in static timing light systems function light, and security changeover switch. Will work all rev counters.

**Fits all 12v negative-earth vehicles with coil/distributor ignition up to 8 cylinders.**

THE KIT COMPRISES EVERYTHING NEEDED. Die pressed case. Ready drilled aluminium extruded base and heat sink, coil mounting clips and accessories. All kit components are guaranteed for a period of 2 years from date of purchase. Fully illustrated assembly and installation instructions are included.



Roger Clark the world famous rally driver says "Sparkrite electronic ignition systems are the best you can buy."

# Sparkrite

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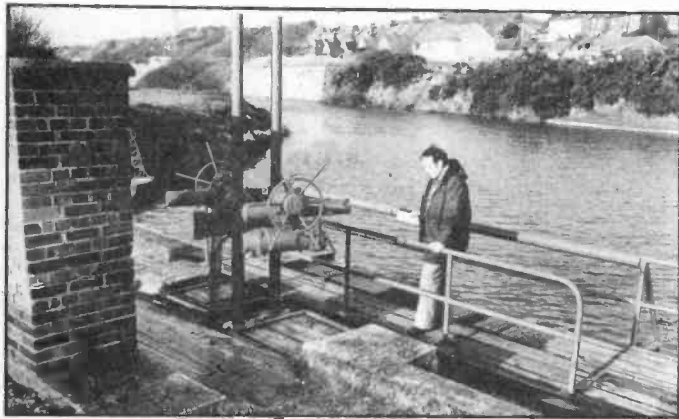


# DIGEST

## High Level Control

A system for regulating the level of the Royal Military Canal in Kent has been installed by Shepway District Council. The fully automatic system was devised and commissioned by Rotork Retrofit of Bath and utilises a pressure transducer which senses a predetermined water level and initiates the raising of the water gates to allow water to flow beneath and so maintain a safe level. The electronic control system is housed in a weatherproof cabinet on the site and is programmed to provide four stages of control in winter

and three in summer. In summer a high level is maintained to cater for the needs of pleasure boats and anglers. The automatic control ensures that this high level is maintained even in times of heavy rainfall to prevent fish being lost out at sea, which occurred before. During the winter the canal is tidelocked during high tide conditions and this has led in the past to incidents of flooding. Previously the gates had to be left in a partly open position and this necessitated having staff 'on call' day and night to adjust them manually whenever tide or weather caused problems. The new system saves time, money and staff inconvenience.



## Cassette Interface PCB

We omitted to include a Buy-lines section in the Cassette Interface project published last

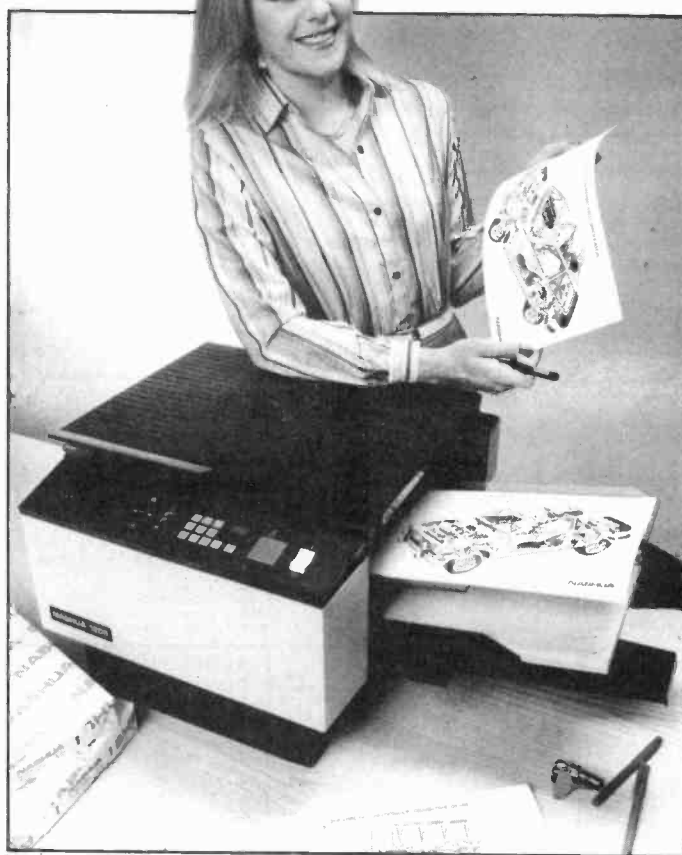
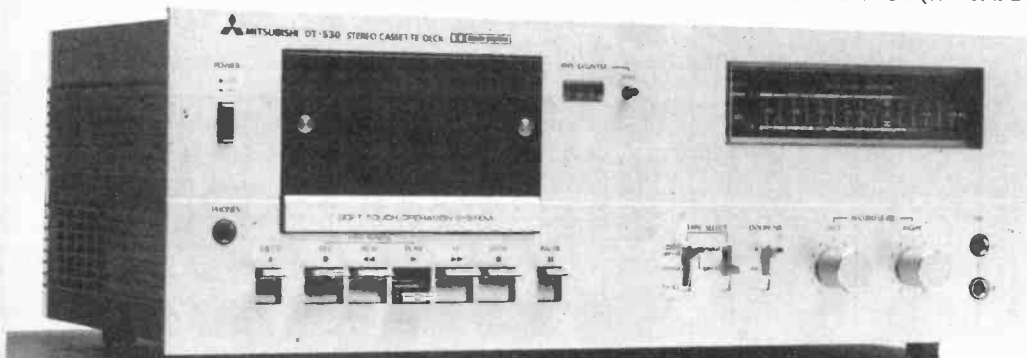
month. Jayman Electro Devices, 15 Ash Grove, Springhead, Oldham, Lancs OL4 4RP will supply a PCB for £4 all inclusive or a complete kit (including PCB) for £13.50 including post and VAT.

## Getting It Taped

Mitsubishi Electric have launched their new metal tape cassette deck, the DT-530. For £122.00 you can enjoy such features as soft touch operation

and one-touch recording, together with Dolby noise reduction and peak level indicators for accurate reading. Fifteen LEDs per channel provide an easy-to-read scale from -20 dB to +5 dB and at 0 dB the scale colour changes from green to red. The cassette housing on the front loading deck is air-damped and

features background cassette illumination and a smoked glass front which detaches simply to facilitate head cleaning. Wow and flutter is 0.07% W RMS, S/N ratio (at 400 Hz) weighted, Dolby NR in, is 64 dB and frequency response (metal, special Fe-Cr) is 30 Hz to 16 kHz. Dimensions are 42.4 x 15.4 x 24.4 cm (W x H x D).



## Copycat

Nashua have introduced what they consider to be the smallest plain paper copier in the world. Measuring only 18" x 18" x 13", the Nashua 1205 will make its UK exhibition debut at the London Business Show on September 23-26. It is designed for the small business where inexpensive decentralised copying is required. The 1205 utilises fibre optics combined with a miniaturised development of Nashua's micro-processor controlled Liquid Toner Transfer system to achieve its

small size. The first copy is ready in 7 S, subsequent copies at 12 per minute and the single paper tray can hold a range of paper from A5 to 8.5" x 14.0". There is an automatic shut-off 60 S after the last copy is produced and the toner/developer is held in self-contained cartridges. The machine also has improved copy (especially blue response), adjustable exposure control and a touch-tone keyboard with a digital readout to keep track of copy countdown. For further information contact Nashua Copycat Ltd, Cory House, Bracknell, Berkshire, RG12 1ET.

## 24 Hour Fone Machine

Most telephone answering machines lie redundant in the office all day, only bursting into action when everyone has gone home. The Ansafone 6A has been designed to be useful 24 hours a day.

In addition to providing telephone answering and simple announcement facilities, the 6A doubles as a simple-to-use dictation machine. It can also be used as a music cassette player for background music.

Ansafone 6A is available on rental from £2.35 per week from Ansafone, Lyon May, Frimley Road, Camberley, Surrey GU16 5EY.



# TRANSCENDENT DPX

**DIGITALLY CONTROLLED, TOUCH SENSITIVE, POLYPHONIC, MULTI-VOICE SYNTHESIZER**

Another superb design by synthesizer expert Tim Orr — published in Electronics Today International

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 strong sounds.



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

**COMPLETE KIT ONLY £299 + 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!

## POWERTRAN

**MANY MORE KITS ON PAGE 116. MORE KITS AND ORDERING INFORMATION ON INSIDE FRONT COVER**

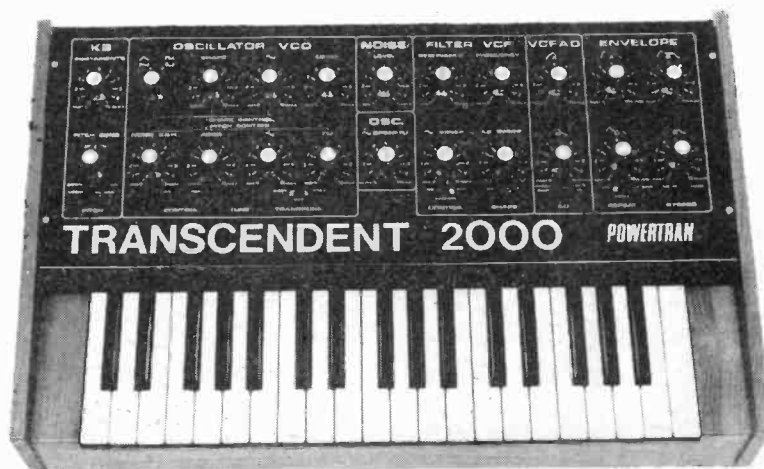
## TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

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

The TRANSCENDENT 2000 is a 3 octave instrument transposable 2 octaves up or down giving an effective 7 octave range. There is portamento, pitch bending, a VCO with shape and pitch modulation, a VCF with both low and high pass outputs and a separate dynamic sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features. The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or 1/2% metal film) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality 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!



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## Keep Your Pecker Up

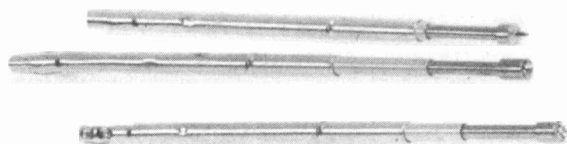
Chiptech have just introduced a new portable EPROM programmer based on the Z80 microprocessor. The PKW5000 is capable of programming devices up to 32K bits, including the 2708, 2716, 2732, 2516 and 2532 EPROMs. Keyboard function commands such as load, write, erase, check, compare and buffer clear as well as data entry and various editing functions through the RAM buffer are available.

A 16 digit hex display shows address and data information and also the EPROM type selected. An audible warning confirms the key-

in operation, programming completion and error occurrence.

In addition to its programming capability, the PKW5000 may be used to run and debug Z80 programs with readout of all registers and insertion of up to two breakpoints. An optional I/O card will allow the unit to be interfaced with a 150 CPS tape reader, a 20 mA current loop or RS232C serial interface. The option also contains sockets which can accept preprogrammed EPROMs containing an assembler, debug program or BASIC.

For further information on the PKW5000 get in touch with Chiptech Ltd, Unit One, Tewin Court, Welwyn Garden City, Hertfordshire AL7 1AU.



## Test Points

Vero Electronics can now supply a range of high quality, low cost probe pins for testing bare or component-loaded boards, wire-wrap boards or backplanes.

The pins come in two parts — the receptacle, which is available in either minwrap or solder termination, and the spring contact, which can have any one of three tips. The serrated tip will cut into flat pads to enable readings to be taken; the conetip can be used to probe plated-

through holes; the cup can be used for wire wrap boards or backplanes.

The pin constituents are a veritable tour of the periodic table. The spring contact probes have heat treated beryllium copper plungers plated with rhodium over nickel and the phosphor bronze receptacles and nickel silver contact shells are plated with gold over nickel.

For further details of these low cost probe pins contact Vero Electronics Ltd, Industrial Estate, Chandlers Ford, Eastleigh, Hampshire SO5 3ZR.

## APOLOGY

On page 84 of the September issue of Electronics Today International we published an advertisement placed by Tempus which stated that Zeon had gone into voluntary liquidation. This statement referred to Zeon Products Limited and was not intended to reflect in any way on Zeon Limited.

The advertisement was phrased in such a way that it may have been detrimental to Zeon watches. No criticism of the watches sold by Zeon Limited under the "Zeon" trade mark was intended. Furthermore, we are informed that Zeon Limited have taken over the service obligations entered into by Zeon Products Limited, thereby providing continuing service.

We wish to apologise to Zeon Limited for any embarrassment which the advertisement may have caused.

## Microbasics

We've had a few inquiries about the subject of the photo we used to start off Microbasics in September. It was one of the first all-transistor computers, built at Harwell between 1952 and 1954. In the 1950s, CADET (the reversed initials of Transistor Electronic Digital Automatic Computer) was thought of as a mini compared to the vast valve complexes of the day.

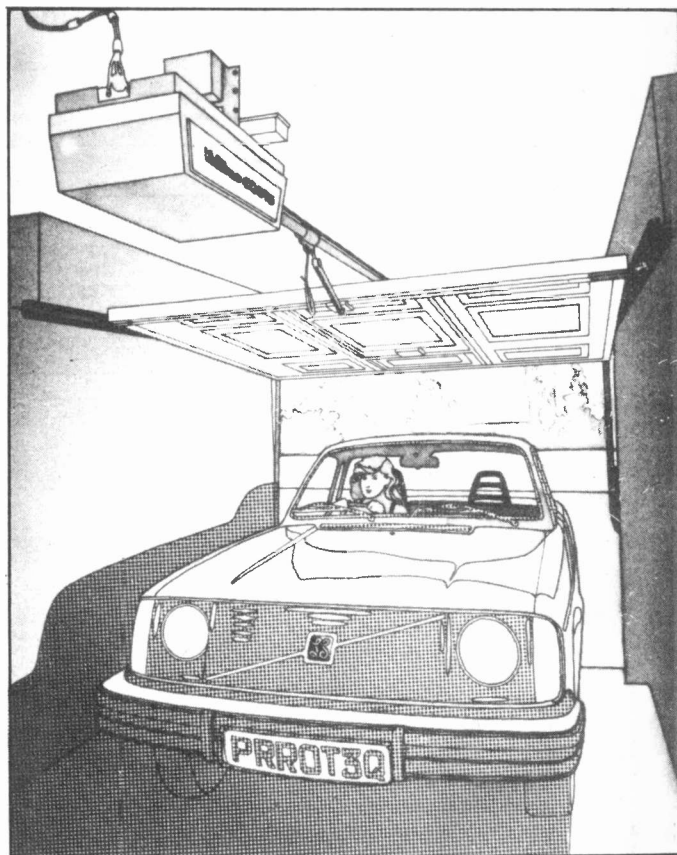
CADET was used for several years at Harwell. The UK nuclear programme and Harwell's involvement generally in electronics and instrumentation benefitted from the experience gained from the design, construction and use of CADET. You may have seen some of its original circuit panels at the 'Challenge of the Chip' exhibition at the Science Museum in London.

## Home Computing

A new computerised garage door which has achieved great success in the States, is now being sold in the UK. It is being introduced to builders' merchants, hardware, electrical DIY and car accessory retailers. The NuTone garage door operates from the greater than normal distance of 400 yards, has a computer that makes its own adjustments and is simple to instal. Whilst it is a convenience to the ordinary motorist it is also useful for elderly or handicapped drivers. The hand-held radio control unit is fitted with British-made electronics and is Home Office approved. Additional units can be purchased as well as an alternative key-operated opening

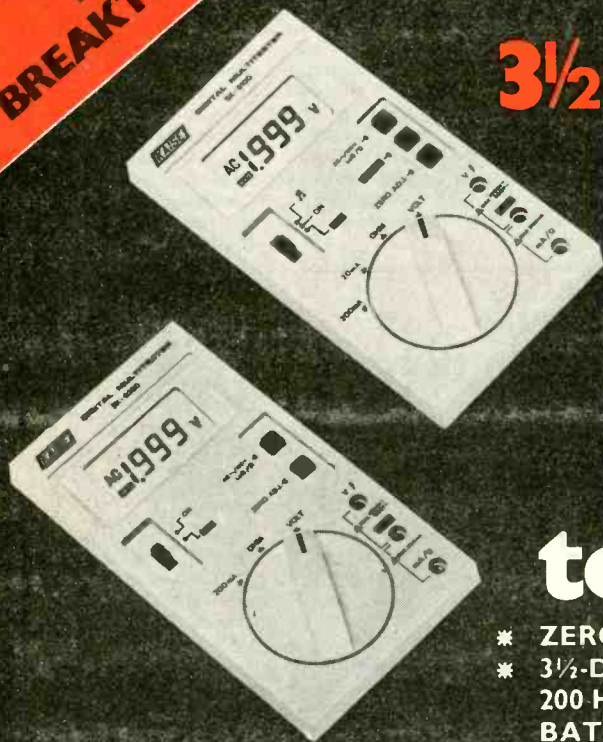
device which can be fitted to the gatepost or a site convenient to the garage entrance. Inside the home a push button switch (this is included) can be installed to operate the NuTone door.

A built-in light is also included to switch on once the door is opened. Should the door be obstructed as it tries to close, the motor will automatically reverse until the door is fully open. In the event of an obstruction as it opens, the motor will stop. The garage door operator costs £229 including VAT. The radio receiver, transmitter and aerial costs £75; the key switch system £9.25; a manual release button £14.85; additional transmitters £28.25 and pushbuttons 85p. A Haos service agent will confirm whether or not a garage door can accommodate the unit. The Haos Company Ltd are at The Built-In Centre, 32 Letchworth Drive, Bromley, Kent.





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2ETI





## New Records

Digital recording techniques are taking off in a big way at EMI's Abbey Road studios in London. The result of a four year R&D programme is EMI's first digitally recorded classical album — Debussy's 'Images' played by the London Symphony Orchestra conducted by André Previn. This has won three major awards since its release in December 1979.

EMI has been using five SE7000M units for its experimental recordings, which were primarily designed for laboratory standard scientific and engineering instrumentation and data recording applications. They were selected for use by EMI for their high quality performance and ability to withstand rigorous use. The advantages of digital recording are that it provides audio engineers with the ability to eliminate all extraneous background noise and distortion problems associated with conventional recording techniques.

Analogue recording is

susceptible to equipment noise and non-linear recording characteristics as well as many other factors. Digital recording gives the ability to store and subsequently edit signals so that the sound remains distortion-free throughout the various production processes. The resultant sound has far greater clarity and freshness.

Each of the recording systems being used at Abbey Road comprises a single encoder and decoding unit interfaced to an SE7000M recorder. The complete system is trolley mounted to facilitate movement around the studios and for location work. At Abbey Road they can be moved to various locations within the building, although they will mainly be used in the larger Studio One for orchestral productions. However, they are also required for location work in Europe and America and have been shipped for recording sessions as far apart as Berlin, Philadelphia, Vienna and Amsterdam.

All material is recorded on standard 10½" reels of 1" magnetic tape running at 30

inches per second. Currently only two channels of sound can be processed digitally, using two tracks per channel to store data at the very high density level of 25 k/bits per inch. The outstanding quality of recordings is achieved due to this and an extremely sophisticated error-correction system to counteract drop-out or blemishes on the tape. For recording sessions, two digital systems are normally used together to provide a back-up facility. At Abbey Road they can interface with the mixing consoles in any of the three studios.

At present, editing of the digital material is carried out on the computer-controlled prototype equipment at the Central Research Laboratories. This function will soon be undertaken at Abbey Road itself.

By the end of 1980 virtually every classical record produced at Abbey Road will be digitally recorded. 'Middle of the road' and 'pop' discs generally rely on multi-track facilities, but even these can be produced using a mixture of analogue and digital recording processes. The final product will still offer improved reproduction quality.

## Sound and Vision

Thorn Television Rentals and Magnetic Video, a subsidiary of 20th Century Fox, have reached an agreement in which Thorn will market through its TV rental outlets VHS video cassettes of 43 film titles. The range includes 'Butch Cassidy and the Sundance Kid', 'The Poseidon Adventure', 'Cleopatra', 'M.A.S.H.', 'Patton', 'The Sound of Music', 'The French Connection', 'Hello Dolly', 'Gentlemen Prefer Blondes', 'Soldier Blue' and 'Von Ryan's Express'. Initially they will be available on a test market basis through rental showrooms and later in the year through all 1,200 outlets of the Thorn Rental Group. This will be the first time that major film titles will be available on a rental basis to the general public. Rates will be £5 for hire over three days.

## EMPerative

If you wish to protect your telecommunications equipment or other information transmission system from the effects of EMP, the M-O Valve Co. has something for you. They have introduced a fast acting gas-filled surge arrester, type E3465. Conventional gas-filled surge arresters designed for lightning protection do not give adequate protection against EMP. The E3465 is a sub-miniature metal ceramic device which, when used in conjunction with a suitable holder can provide protection on a nanosecond time scale. It has a maximum surge strike voltage of 1 kV at 1 kV/nS rate of rise and a maximum capacitance of 4 pF, whilst retaining the normal advantages of gas-filled arresters of high current capability and low discharge voltage. For further information contact the M-O Valve Co, Brook Green Works, London W6.

For further news of ETI's pursuit of the EMP phenomenon turn to page 15!

## Sounding Board

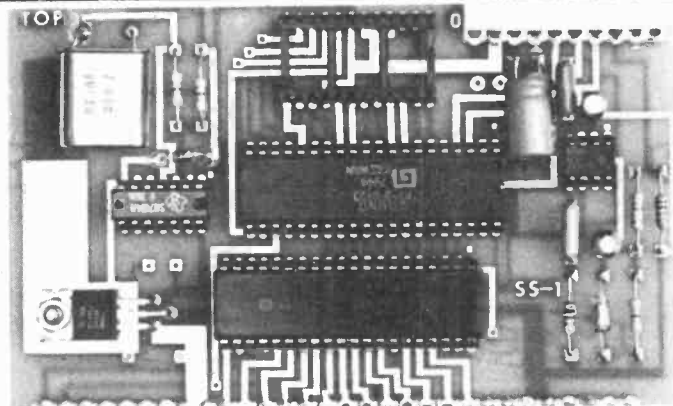
Sirius Cybernetics can now supply a programmable sound synthesiser board for the SWTPC S50 bus 6800 and 6809 computers. For £60 (including post, but excluding VAT) you get an assembled and tested slot printed circuit board and driving software.

The package enables the 16 internal registers of the sound synthesiser chip to be programmed either from assembly language or BASIC.

Three independently controlled sound channels producing a tone and white noise can generate a variety of sound effects or music.

Two bi-directional 8-bit ports are also provided on the board for, amongst other things, the connection of keyboard or games paddles to the host computer. The board even has its own on-board power amplifier. Just connect a loudspeaker.

The 6800/6809 S50 bus Sound Synthesiser board is available from Sirius Cybernetics Ltd, 7 Euston Place, Leamington Spa, Warwickshire CV32 4LN.



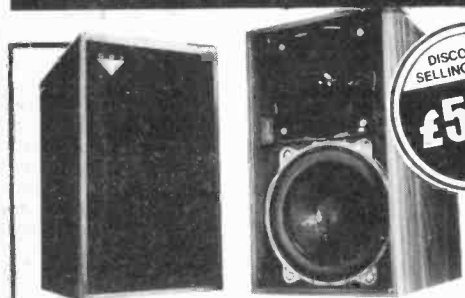


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E.T.I. 11/80



# EMP

**Following ETI's article on EMP, Tina Boylan has been finding out what's going on in the country to protect us in a nuclear war.**

**I**n the event of war our protection will depend mainly on local councils and this is the area that we have explored to find out exactly what is going on. Local councils will be in charge of re-organising the survivors in their area in the aftermath of a nuclear strike. This will basically mean local groups providing food, medical help and checking damage. As far as their radio communications are concerned, equipment at this local level has no special, built-in protection against EMP other than those in the Home Office's standard specification. How effective this will be is something no-one really seems to know.

The only other protection this equipment will have is either that at the 'four minute warning' the radios will be switched off at the mains and have their aerials removed, or that a back-up system will remain 'frozen' until the danger of EMP has passed. Standard procedure will then be followed. After 24 hours the equipment will be switched on again and broadcasts will be tried on frequencies 1-10 (is there anybody out there?); after 36 hours frequencies 10-20 will be tried, etc, until either something is located or until someone realises that the equipment is useless. In the meantime, according to one man "there'll be a lot of telephoning around". Perhaps someone forgot to tell him that EMP will almost certainly destroy all telephone communications!

This method of 'protection' of equipment relies heavily on the assumption that 1) there will be a four minute warning and, 2) that the enemy hasn't made a nuclear detonation over somewhere like the North Sea, which will knock out these communications anyway.

## Us and Them

Strangely enough, local as well as national Government has known about the EMP effect for between four and six years, since its discovery during nuclear tests in the Pacific, but they have not considered it to be of interest to the general public. With this long-standing knowledge perhaps something more tangible should have been done, but again, it's the same old story; finance — or rather lack of it — has prevented much action being taken.

Until recently, civil defence in general has not appeared on the local council list of priorities. But since the Afghanistan crisis reared its ugly head, a more careful study of the country's state of readiness for war has been made. The results of this investigation prompted Mr. Whitelaw, the Home Secretary to make a statement in the House of Commons on August 7th this year. There is a firm belief that any war is likely to start conventionally and escalate into nuclear exchange.

The main points of Mr Whitelaw's speech were that the UK monitoring and warning organisations would modernise their equipment and that the associated communications network responsible for wartime broadcasting would be improved, so that it can continue public broadcasting even after a large scale attack.

As far as local defence plans are concerned he had this to say:

*"A great deal of civil defence work must be done at local level, and the Government propose to double the money available for this purpose. We shall consult the*

*local authority associations about the allocation of additional resources for planning and training, and the adaptation of premises by district councils to complete the pattern of local authority wartime administrative headquarters and communications. Effective civil defence arrangements depend upon co-operation between central Government and local government. I know that concern has been expressed about variations in civil defence arrangements in different parts of the country. I am satisfied that the Government have adequate powers to ensure that proper standards of protection are provided throughout the country, and it will naturally be our aim, with the local authorities, to see that this is done."*

## Cut-Backs

It is understood that by 1984 civil defence spending will have risen by 60%. This additional cost will be covered by "re-allocation of resources within existing programmes without adding to the total of public expenditure". This means that local government will have to find the money out of their existing budgets, already tightly squeezed by cut-backs. In one county at least, civil defence was described 'second to bottom on the list of priorities'. So even if there is extra cash allocated to it, there are no plans at present for further expenditure on communications in particular. The main priorities are to improve training of volunteers and if possible choose various leading members of the community to help with reorganisation after the holocaust. The consensus of opinion is that if nuclear war, as opposed to conventional war, breaks out, there is little that can be done to prevent huge numbers of casualties. The only course of action therefore, that local government can (reasonably) take is to provide a well trained reorganisation force to help the survivors. However, as one spokesman said, and this must be ETI's quote of the month, "after all, life goes on, you know". I somehow think he won't be standing at ground zero!

So it seems to be largely up to the public themselves to find out what should be going on, then try to do something about it. The 'men from the ministry' whom I contacted, seemed rather upset that the great British malaise is apathy. It generally takes two forms. Firstly, that we believe we will be looked after completely by the Government, something similar to what happened during the Second World War with plenty of shelters and ARP/Home Guard types. Secondly, there is the pacifist attitude that "honour will prevail" and common sense and negotiation will prevent war.

After the Afghanistan crisis the local authorities were bombarded with telephone calls from people either willing to offer their services or simply wanting to find out how to protect themselves. If you want to find out who is in charge of your local defence plans, simply telephone the Home Office in London on 01-213 3000. They were able to supply us with the names, addresses and telephone numbers of all civil defence organisations, or you can contact your local council. For 50 pence you can also obtain the government leaflet 'Protect and Survive' which certainly prompted us to ask a few questions! Keep sending the letters.

**ETI**



# AND THERE'S MORE WHERE THIS CAME FROM

It's a long time since one of our adverts was presented in 'list' form - but simply because we do not try to squeeze this lot in every time doesn't mean that it's not available. Our new style price list (now some 40 pages long) includes all this and more, including quantity prices and a brief description. The kits, modules and specialized RF components - such as TOKO coils, filters etc. are covered in the general price list - so send now for a free copy (with an SAE please). Part 4 of the catalogue is due out now (incorporating a revised version of pt.1).

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7448N	0.56	7448N	0.56
7449N	0.99	7449N	0.99
7450N	0.99	7450N	0.99
7451N	0.17	7451N	0.17
7452N	0.38	7452N	0.38
7453N	0.17	7453N	0.17
7454N	0.17	7454N	0.17
7455N	0.24	7455N	0.24
7456N	0.24	7456N	0.24
7457N	0.17	7457N	0.17
7458N	1.24	7458N	1.24
7459N	0.28	7459N	0.28
7460N	0.28	7460N	0.28
7461N	0.28	7461N	0.28
7462N	0.28	7462N	0.28
7463N	0.32	7463N	0.32
7464N	0.32	7464N	0.32
7465N	0.32	7465N	0.32
7466N	0.32	7466N	0.32
7467N	0.32	7467N	0.32
7468N	0.32	7468N	0.32
7469N	0.32	7469N	0.32
7470N	0.32	7470N	0.32
7471N	0.32	7471N	0.32
7472N	0.32	7472N	0.32
7473N	0.32	7473N	0.32
7474N	0.32	7474N	0.32
7475N	0.32	7475N	0.32
7476N	0.32	7476N	0.32
7477N	0.32	7477N	0.32
7478N	0.32	7478N	0.32
7479N	0.32	7479N	0.32
7480N	0.32	7480N	0.32
7481N	0.32	7481N	0.32
7482N	0.32	7482N	0.32
7483N	0.32	7483N	0.32
7484N	0.32	7484N	0.32
7485N	0.32	7485N	0.32
7486N	0.32	7486N	0.32
7487N	0.32	7487N	0.32
7488N	0.32	7488N	0.32
7489N	0.32	7489N	0.32
7490N	0.32	7490N	0.32
7491N	0.32	7491N	0.32
7492N	0.32	7492N	0.32
7493N	0.32	7493N	0.32
7494N	0.32	7494N	0.32
7495N	0.32	7495N	0.32
7496N	0.32	7496N	0.32
7497N	0.32	7497N	0.32
7498N	0.32	7498N	0.32
7499N	0.32	7499N	0.32
7500N	0.32	7500N	0.32

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4022	0.90
4023	0.17
4024	0.76
4025	0.17
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10.0MHz	2.50
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BC560	0.12

## SWITCHING AND PIN DIODES

### SHOTTKY DIODES

IN6263	0.62
BAJ82	0.19
BA244	0.17
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## SIGNAL DIODES

### & RECTIFIERS

IN4148	0.06
IN4001	0.06
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IN5402	0.15
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BRIDGES:	
1A/50V	0.35
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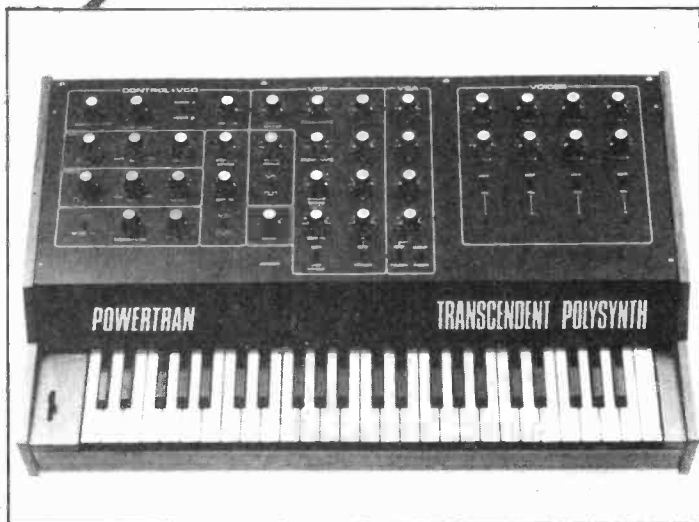


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Look out for the December issue  
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## **TRANSCENDENT POLYSYNTH**

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



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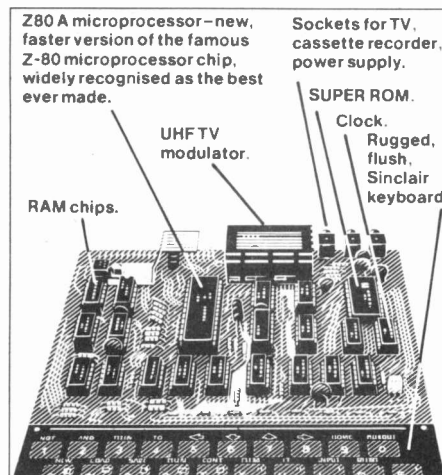
- **Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.**
- **Unique syntax check.** Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
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- FOR/NEXT loops nested up to 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
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- Randomise function, useful for games and secret codes, as well as more serious applications.
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions.USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols
- All characters printable in reverse under program control
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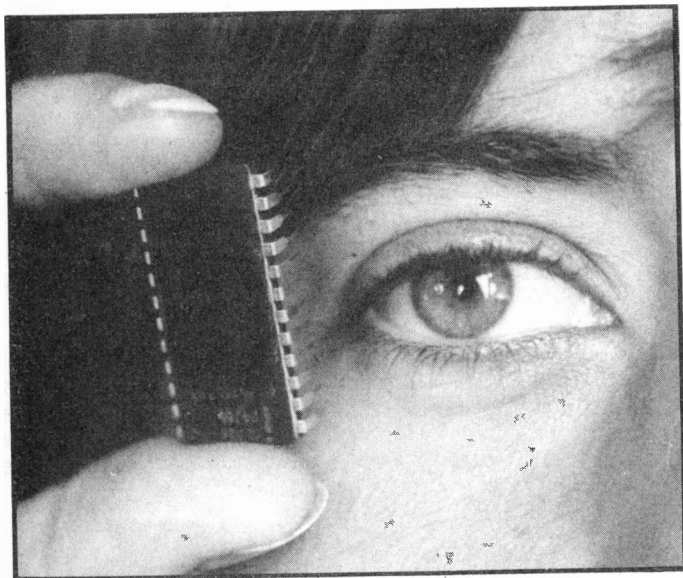
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# MICROBASICS

Remember, remember ETI November. Henry Budgett explains how microprocessors ROaM round the RAM chips. It's all a question of memory.



It is doubtful if even the legendary skills of the elephant could cope with the vast and bewildering array of memory devices that are currently offered with each and every microprocessor. Would you choose dynamic or static; is there any difference between on-line and off-line storage; do bubbles really bubble and many other similar questions often crop up in reader's enquiries and only go to show that the fundamental topic of computer storage is in dire need of a bit of explanation. To that end let's go right back to the fundamentals and take it from there.

## The Elemental Store

Computers of digital type work on the binary system — they process information that occupies one of two states. The commonest logical element that can occupy one of two states is the bistable and, in simple terms, all computer memory can be regarded as constructed of simple bistable elements. We need not concern ourselves with the history of memory devices (it will only serve to confuse the issue), so let's start off with semiconductor devices such as Random Access Memory and Read Only Memory, RAM and ROM to use the common acronyms.

In virtually all computer designs RAM is the fundamental storage system for the user to put his instructions into. Within this family of circuits there are two sub-groups, static and dynamic, but the simplest element is the common bistable. Static RAM is really a vast number of bistables arranged in a special fashion. Some popular arrangements are 1024 by 1, 2048 by 1, 1024 by 4 and many, many others. The numbers specify the way the device is used, for example if you wish to

construct a memory card that could hold 1K bytes of program you would need eight of the first kind of chip or two of the third kind.

## Amnesia

Because these static elements are based on simple logic gates, they will lose their contents when turned off, just as any logic will, but they do have a number of advantages. Once the desired information has been loaded into the memory (more on that later) it will stay there until either it is altered or someone turns the computer off. The disadvantage of this is that it requires the power to be constantly maintained within the chip and thus the current consumption of these devices is high. You do get a good, high-speed response in exchange, though. It is common to find that within the structure of a single microcomputer both static and dynamic RAM devices are used, with the static providing the workspace or 'scratchpad' area for the CPU and the dynamic providing the bulk user RAM and hence saving power.

The fundamental difference between dynamic and static devices is that dynamic devices will lose the stored information if they are not 'refreshed' every so often. The reason for this is that they are based on MOS technology and store the information on tiny capacitors as a charge. This charge will leak away after a finite time and thus has to be constantly topped up. This process

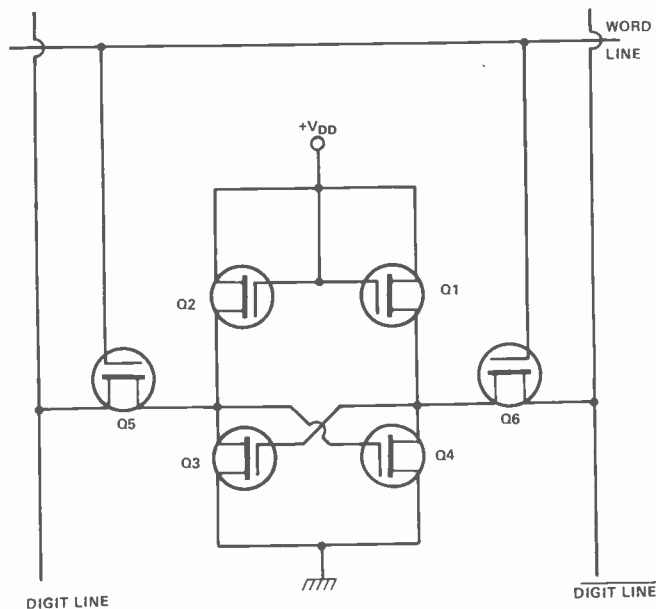


Fig.1 MOS static memory cell.



can either be performed within the chip or by some special circuitry on the memory board or, in the case of the Z80 CPU, by the micro itself. Typical refresh times are between 1 and 2 mS and woe betide the designer who tries to cut it fine because increases in temperature have very undesirable effects that compound the problem.

In summary, therefore, RAM is used by the micro as its immediate store and is based around the humble bistable type of logic element. In strong contrast we have the ROM memories which as their name implies, can only be read and hence are used as permanent stores.

## Memories Are Made Of This

It is worth taking a few minutes to inspect the internal architecture of both static and dynamic devices at the storage element level. Figure 1 shows the equivalent circuit for a static MOS memory cell. Transistors within the chip are all made as MOSFETs which, although slower than bipolar transistors, consume less power and hence allow greater packing densities. Q1 and Q2 are actually being used in this circuit as resistors to bias the bistable element made from Q3 and Q4. The transistors Q5 and 6 act as switching gates to allow information to be read or written to the cell. To read a cell the word line is set to logic one which will turn on either Q5 or Q6 depending on the contents of the cell. To write the word line is again set to logic one but the appropriate digit line is set so that the cell contents are toggled to the correct value.

The dynamic MOS element shown in Fig. 2 uses the technique of stored charge to represent information. To write new information to the cell the row line is set to logic one and the appropriate data is set onto the data line. Reading the cell is performed by setting the row select high and inspecting the state of the data line.

## A Family Affair

If you thought that having two types of RAM was quite enough to cope with then ROM will try your mental processes even more. The original ROMs are truly Read Only in that the user buys them pre-programmed to a specification and there is no way that he can alter the contents. Computer monitor programs are commonly based in ROM, but with the high cost of producing the original 'mask', (that's the pattern to which they are made), several companies are turning to other devices such as the EPROM. The internal arrangement of a ROM chip is not dissimilar to that of a RAM chip except that each and every element is 'hard wired' to either logic '1' or logic '0'. It would obviously be nice if the user could program in his own pattern and try it out and to this end the PROM device emerged. This is a ROM with each element uncommitted, but with a tiny piece of 'fuse wire' called a fusible link fitted to each element. If you wish to select that as a logic '0' you leave it as it is, if you want it to be a logic '1' then you have to 'blow' the fuse, usually with a high voltage pulse.

All very well but once you've cooked it you're stuck with it, or are you? The designers found that if you didn't burn the link away thoroughly enough it started to grow back, embarrassing! This gave rise to the EAROM or Electrically Alterable ROM which allows you to erase the content of the device and later re-program it. It also gave birth to the most common type of device, the EPROM or Erasable Programmable ROM, which uses a

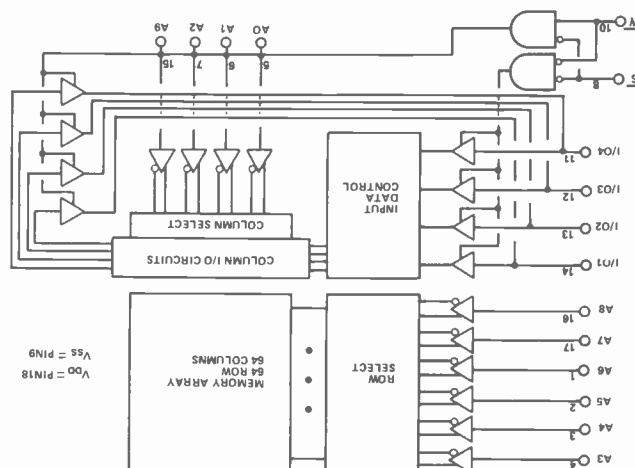


Fig.2 Dynamic memory cell.

slightly different internal structure and can be 'wiped' with ultraviolet light of a certain frequency — the contents of an EPROM will naturally self-erase after about one hundred years anyway!

The programming of these devices requires a special piece of equipment called, not surprisingly, a Programmer. These vary from the very crude to the amazingly sophisticated professional models that allow full program editing and verification and can handle many of the different types.

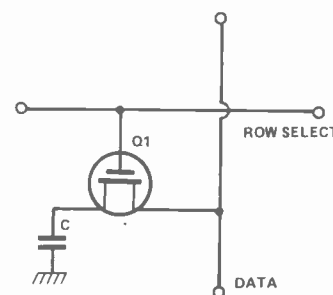


Fig.3 The internal layout of a 4096 bit static RAM device. Compare the architecture of this 1024 by 4 layout to that in Fig.4 of a dynamic 4096 bit device organised by 4096 by 1.

We can now introduce a new term which nicely classifies the two types of computer memory. RAM is called volatile memory; the contents 'evaporate' when the power is removed; ROM is non-volatile because it retains the information. Interestingly, the much-vaunted successor to RAM, the bubble memory device, is a non-volatile store, because it works on magnetism (much like the old-fashioned core memory).

## Reads And Writes

Getting information into and out of memory devices is, generally, a straightforward process. With an eight bit microprocessor which has a 16 bit address bus the maximum amount of memory that you can directly address is  $2^{16}$  or 65536 locations. Because we are working in binary and cannot have nice 'round' numbers this is referred to as 64K where one 'K' is 1024 locations. Each location contains eight bits of data, one byte, and can be uniquely addressed by the 16 address lines. The CPU determines whether the required access is a READ, taking information out of memory, or a WRITE, which puts information into memory by setting a control line to



either a logic one or a logic zero. This line is taken to all the memory devices and, appropriately gated, enables the required area of memory. Figures 3 and 4 show the internal structure of two typical devices.

Once the specified location has been opened, the data stored there is either transferred onto the data bus, in the READ situation, or is overwritten by the information on the data bus, the WRITE situation. It is important to note that the information is overwritten, so saving you the job of clearing out the previous contents.

There is a further control pin on many memory devices called Chip Select. This is set to either logic one or zero (depending on the device) when that memory area is required for use and this prevents possible accidents such as overwriting data in another part of the memory to that which you actually wanted. How can this happen if you have a unique addressing system? In most small computers you only have a small area of memory on the actual CPU card, the actual memory cards hold the bulk of RAM and ROM. Because of this the address bus is not decoded into specific areas; the Microtan 65 is a good example. Now, when you are using

refresh information during the correct cycle time.

The latest versions of dynamic RAM are being equipped with the capability of on-chip refresh. This means that to the outside world they look just like a static device, indeed they are sometimes called 'pseudo-static', and thus save all the problems of timing that are associated with the procedure.

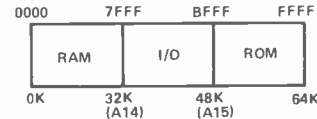


Fig. 5 A simple memory map created by allowing the address lines A<sub>14</sub> and A<sub>15</sub> to select the appropriate memory areas. This causes the contents of the selected chip to be 'reflected' through the entire section of memory, but this does not matter provided that you only access the addresses which are connected to a device.

## Banking On A Solution

In some situations 64K of memory is not enough, believe it or not. It is possible to access more by using a technique known as bank selecting. The required extra memory is treated as a peripheral device and accessed through the data bus, each extra board of memory occupying the same address area but having a unique code that selects it. The NASCOM 2 system is set up to allow up to four 48K RAM cards, that's nearly two hundred thousand bytes of memory to be plugged in. The technique does have another use in the field of Teletext and Prestel information. Here each page must be loaded into memory as it is received, with only 64K you'd soon run out. The technique is to allocate pages of memory to the received information and then to access that information from the paged memory as though it were a peripheral device.

One other technique that is very important, especially when you move into the realms of discs is that of Direct Memory Access (DMA). Because the time taken for the processor to read information from a fast peripheral such as a disc is slow, the disc controller takes command of the processor bus by asserting a control signal. The CPU goes into a high impedance stage, effectively it is disconnected, and the information is passed directly to the memory area specified.

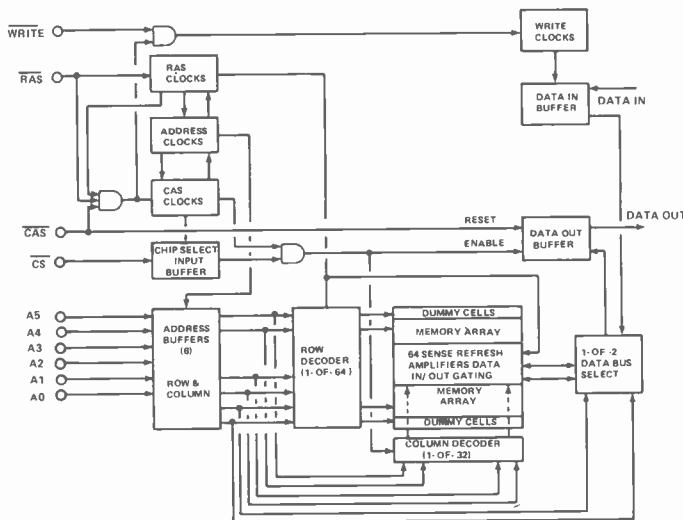


Fig. 4 A 4096 bit dynamic RAM device. Compare with Fig. 3.

only a small amount of memory you don't bother to decode all the addresses, you merely use, say, A<sub>15</sub> to operate the Select on the monitor ROM, A<sub>14</sub> to control the I/O area and A<sub>13</sub> to enable the RAM. This leads to repeating address inside the memory space, but this doesn't matter, because there are no devices physically occupying those actual locations. The trouble starts when you expand and forget to eliminate all these 'reflected' areas. The diagrams in Fig. 5 and 6 show the case on the Microtan before and after memory mapping has been done and illustrates the problem admirably.

## Dynamic Stuff

Because of the different technology used in the consideration of dynamic memory devices, allowing many more locations to be put onto one chip, one finds that, given a sixteen pin package, you don't have enough pins to supply all the necessary signals. This is solved by multiplexing the address bus and supplying the row address first and then the column address. The row address is stored internally, hence giving a complete matrix address and allowing the information to be accessed. The row address is also used to carry the

MEMORY ADDRESS	FUNCTION	
FFFF FC00	1K ROM (TANBUG)	64k
FBFF F800	(TANBUG REFLECTED—1K)	63k
F7FF F000	4K ROM ON TANEX	62k
FFFF E800		
DFFF E000	10KBASIC INTERPRETER ON TANEX	58k
OFFF 0000		
CFFF C000		
BFFF BC00	BFFF BFFF MICROTAN 65 I/O SPARE I/O PORTS	48k
BBFF	40K (DECIMAL) TANRAM	47k
2000 1FFE		8k
0400 03FF	7K RAM ON TANEX	1k
0000	1K RAM ON MICROTAN 65	0k

Fig. 6 A typical system memory map showing the areas used by the system firmware and the spaces left for the user RAM.

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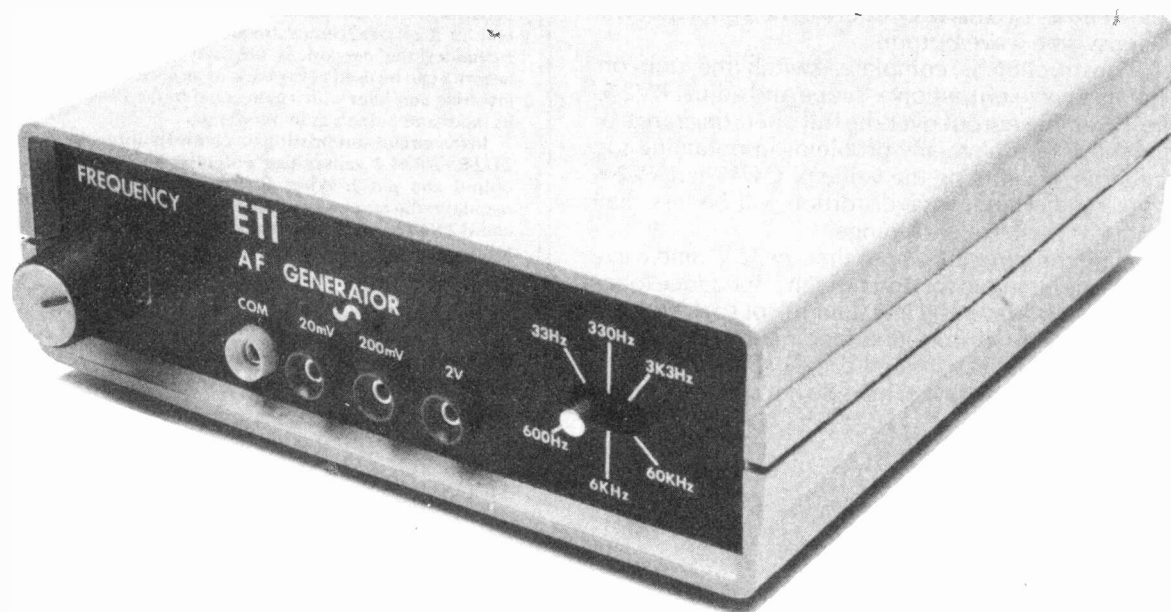
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# AUDIO OSCILLATOR

A testing time for ETI. This unit features sine and square outputs, from 30 Hz to 60 kHz, each with its own level control. Circuit design by Ray Marston. Project development by Steve Ramsahadeo.



Good quality sine/square generators, giving very low sine/wave distortion, are invaluable pieces of test gear but tend to be rather expensive. For the vast majority of practical applications, such as gain and frequency response testing, function checking and sound generation, etc, the expensive 'very low distortion' sine wave characteristic is, however, superfluous, since distortion factors up to several percent are quite acceptable in such applications.

With these points in mind, we've set out to design a really inexpensive and easily built, but genuinely useful,

sine/square generator. Our generator covers the frequency range 30 Hz to 60 kHz in three switch-selected bands. Sine and square outputs are simultaneously available, each with their own independent level controls.

Automatic sine wave amplitude regulation is achieved in the circuit via a pair of back-to-back zeners in a control loop. This method of regulation is very inexpensive but has the great advantage of enabling range-sweeping to be achieved without amplitude bounce. Sine wave output distortion is typically less than 5% over most of the frequency range.





## Construction

The circuit is very simple and construction should present few problems. We decided to construct our prototype unit as a miniature 'squirr box', with an uncalibrated frequency dial. If you decide to follow our method of construction, note that we have fitted the two frequency controls (RV1 and SW1) and the sine wave output terminals to the front panel of our unit and all remaining controls (RV3, RV4 and SW2) and the square wave output terminals to the instrument rear panel. Our unit is powered by two PP3 batteries.

Whatever form of construction you decide to use, note that timing capacitors C1-3 should all be 5% or better types and that RV1 should be a good quality stereo pot, with good tracking between its two halves. Failure to fit a good pot will result in a lousy sine wave output.

When construction is complete, switch the unit on, monitor the sine wave output on a 'scope and adjust RV2 to give the best possible output over the full operating range of the instrument. If you have any problems in obtaining top range oscillation, try altering the value of C4. When RV2 is correctly set, typical sine wave distortion will be less than 5% over most of the frequency range.

When using the generator, note that the '2 V' sine wave output terminal is intended for driving high impedance loads only. If this output is loaded by less than 10k or so the output will become severely distorted under maximum output conditions, due to the very limited drive capability of IC1. The '200 mV' and lower output ranges do not suffer from this loading restriction.

## HOW IT WORKS

The heart of the unit is the Wien bridge oscillator designed around IC1. The Wien network comprises a series C-R network (R1-RV1a and C1a/C2a/C3a) and a parallel C-R network (R2-RV1b and C1b/C2b/C3b) connected in series. Input signals are applied to the top of this network from the output of IC1 and the output of the network is applied to input pin 3 of IC1.

The main feature of the Wien network is that the phase relationship of its output to input signal varies from  $-90^\circ$  to  $+90^\circ$  and equals zero only at a certain 'centre' frequency ( $f = 1/6.28CR$ ). At this centre frequency the network is precisely symmetrical. Thus, the Wien network can be used as the basis of an oscillator by connecting a non-inverting amplifier with a gain equal to the Wien loss factor between its input and output, as in our design.

In our circuit, automatic gain control is obtained by wiring the ZD1-ZD2-RV2-R3-C4 gain-setting potential divider between the op-amp output and pin 2. When RV2 is correctly adjusted, this network maintains the output amplitude of the IC1 signal virtually constant (at about 2 V RMS) over the entire frequency range of the unit (30 Hz to 60 kHz) and results in a typical distortion factor of less than 5% on its sine wave output. The amplitude of the final sine wave output signal is variable via RV3 and the simple R4-R5-R6 attenuator network.

The direct sine wave output of IC1 is fed, via R7, to the input of IC2. This IC is wired as a simple voltage comparator and converts the sine wave input signal to a square wave output. The amplitude of the final square wave output is variable via RV4.

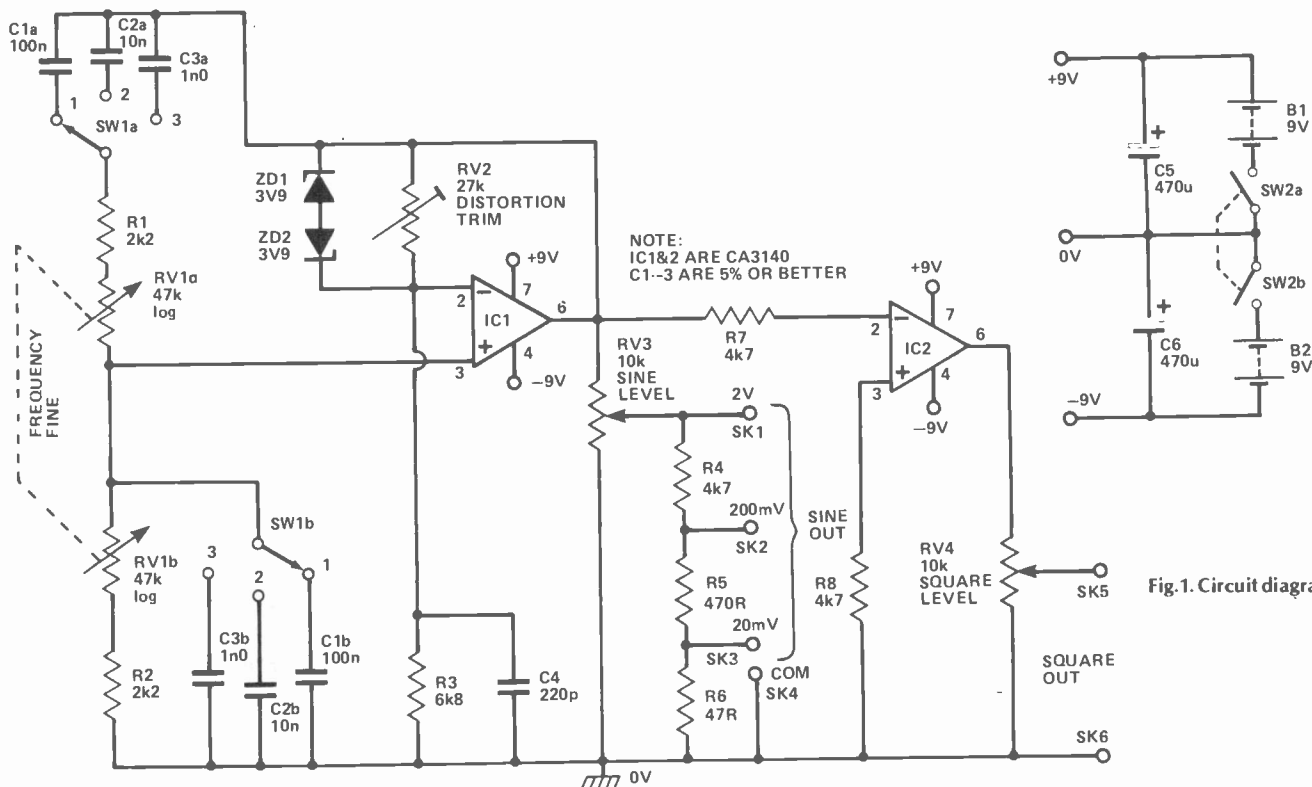
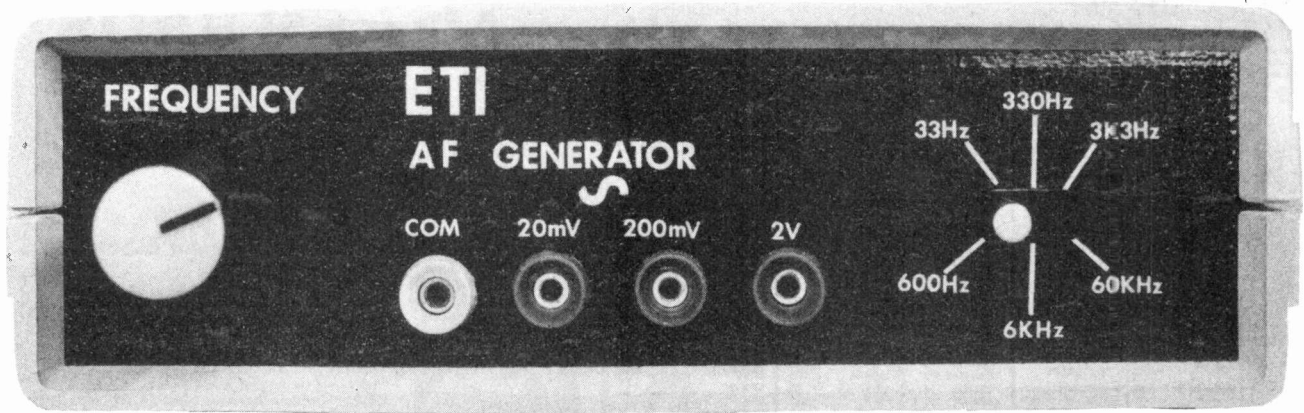


Fig.1. Circuit diagram.





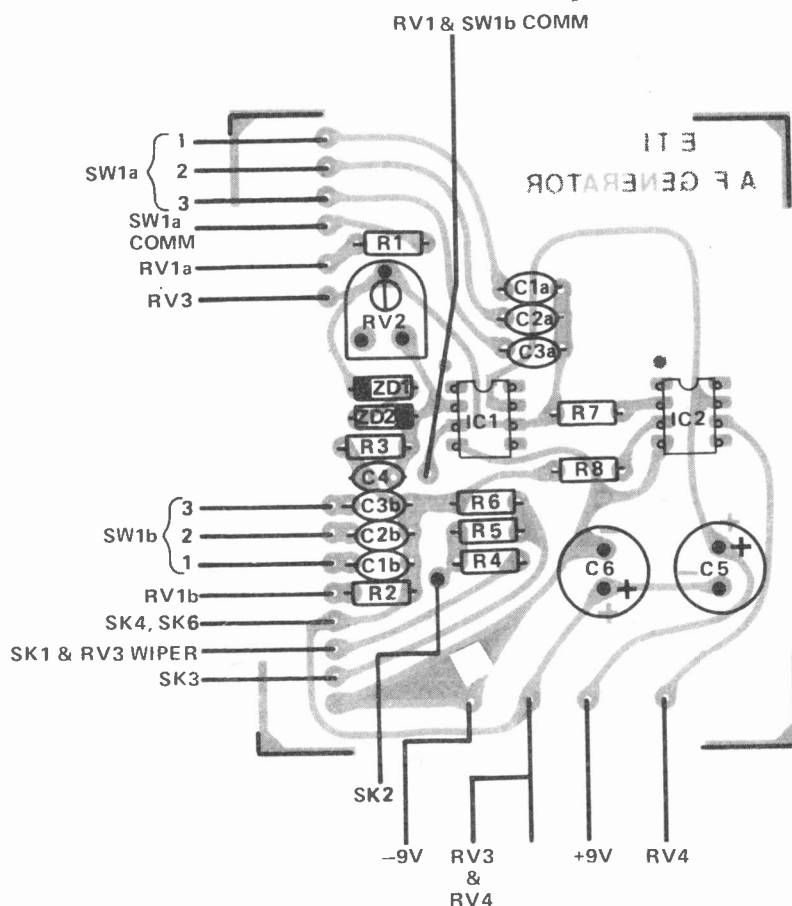
A simple front panel layout for ease of operation.

## BUYLINES

There should be no problems in obtaining any of the components used in the AF generator as all are common types.

The case we used for the project is available from O.K. Machine & Tool Ltd. Order as CM5-125. Phone 0703-610944.

Fig.2. Component overlay.



## PARTS LIST

### AF Generator

Resistors all 1/4W 5%

R1,2	2k2
R3	6k8
R4,7,8	4k7
R5	470R
R6	47R

### Potentiometers

RV1	47k logarithmic dual gang
RV2	22k horizontal miniature
RV3,4	10k linear

### Capacitors

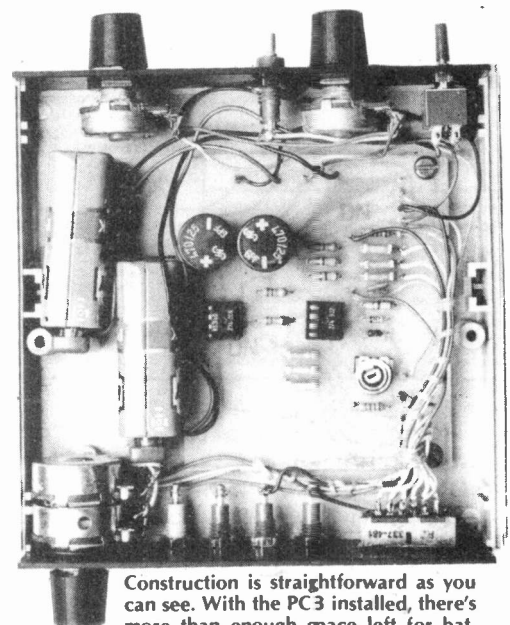
C1a,b	100u 5% polycarbonate
C2a,b	10u 5% polycarbonate
C3a,b	1u0 5% polycarbonate
C4	220p ceramic
C5,6	470u 25V electrolytic PCB type

### Semiconductors

IC1,2	CA 3140
-------	---------

### Miscellaneous

SW1 2 pole 3 position slide switch, SW2 DPDT miniature toggle, SK1-6 to suit, case (see Buylines), PCB.



Construction is straightforward as you can see. With the PCB installed, there's more than enough space left for batteries.

ETI



ALL PRICES IN PENCE EACH UNLESS OTHERWISE STATED

**C-MOS** (BUFFERED)

HEF4001	22	HEF4044	105
HEF4002	22	HEF4046	133
HEF4003	119	HEF4047	109
HEF4007	22	HEF4049	57
HEF4008	100	HEF4050	87
HEF4011	22	HEF4051	87
HEF4012	22	HEF4052	90
HEF4013	57	HEF4053	90
HEF4014	105	HEF4054	475
HEF4015	100	HEF4056	22
HEF4016	57	HEF4057	22
HEF4017	100	HEF4058	22
HEF4018	100	HEF4059	22
HEF4019	58	HEF4060	22
HEF4020	112	HEF4061	22
HEF4021	107	HEF4062	22
HEF4022	103	HEF4063	22
HEF4023	22	HEF4064	22
HEF4024	78	HEF4065	22
HEF4025	22	HEF4066	22
HEF4026	244	HEF4067	22
HEF4027	57	HEF4068	22
HEF4028	89	HEF4069	22
HEF4029	113	HEF4070	22
HEF4030	58	HEF4071	22
HEF4031	250	HEF4072	22
HEF4035	138	HEF4073	22
HEF4040	107	HEF4074	22
HEF4041	94	HEF4075	22
HEF4042	83	HEF4076	22
HEF4043	100	HEF4077	22

**LINEAR**

HEF4512	138	CA3048	84
HEF4516	127	CA3080E	77
HEF4517	478	CA3130E	99
HEF4518	118	CA3140E	48
HEF4519	49	CA3180E	293
HEF4520	118	LM301AN	34
HEF4521	235	LM339N	78
HEF4528	124	LM380N	104
HEF4532	150	LM381AN	198
HEF4534	638	LM3900N	75
HEF4539	138	MC3403P	188
HEF4585	122	NE531	131
HEF4724	214	NE538T	258
HEF4907	113	NE555N	28
HEF4908	92	NE556N	66
HEF4909	78	NE568N	171
HEF4910	149	NE570N	485
HEF4912	149	NE571N	505
		RC4138	148
		TBA1205	88
		TD1022	713
		TD10348	238
		TL061CP	84
		TL064CN	156
		UA741CN	20
		UA741CT	47
		UA7812CU	78
		UA7815CU	78
		UA7812CU	87
		UA7818CU	87
		UA7818CU	230
		UA7815CU	38
		UA7815CU	38

**SEMICONDUCTORS**

IN914	5	BC182L	12
IN4001	5	BC184	11
IN4002	5	BC184L	12
IN4004	7	BC1212	11
IN4007	9	BC1212L	12
IN4148	4	BC214L	11
IN5402	15	BC214L	12
2N2369	21	BC547	13
2N2646	46	BC548	11
2N2929G	13	BC549	12
2N3053	19	BC557	15
2N3054	55	BC558	15
2N3055	55	BC570	15
2N3072	9	BCV71	15
2N3704	9	BD131	39
2N3705	10	BD132	39
2N3773	297	BD139	39
2N3819	22	BD140	39
2N3820	39	BF890	333
2N3904	9	BF895	29
2N5457	39	BF750	17
2N5459	35	BFV51	17
40873	68	BRV39	50
BC107	14	BSX20	21
BC108	14	CLB860	2850
BC109C	18	TIP31	48
BC109	19	TIP32	54
BC109B	14	TIP41C	78
BC109C	20	TIP42C	78
BC148	10	TIP295	75
BC158	10	TIP3085	60
BC177	17	TIS43	36

**Voltage Regulators**

LM309DAIK-119	80
UA723CN	42
UA7805CU	78
UA7812CU	219
UA7815CU	204
UA7812CU	87
UA7818CU	87
UA7818CU	230
UA7815CU	38
UA7815CU	38

**CAPACITORS**

Electrolytic Axial			
-10% to +50% Tol.			
µF	V	25	40
1.0	16	9	9
1.5	16	9	9
2.2	16	9	9
3.3	16	9	9
4.7	16	9	9
6.8	16	9	9
10	16	9	9
15	16	9	9
22	16	9	9
33	16	9	9
47	16	9	9
68	16	9	9
100	16	9	9
150	16	9	9
220	16	9	9
330	16	9	9
470	16	9	9
680	16	9	9
1000	16	9	9
1500	16	9	9
2200	16	9	9

**Polyester Radial Leads**

Dipped Type, C280/352 Style			
Moulded Type, 10.2mm Pitch			
µF	352	380	µF
.001	7	1	7
.0015	7	1	7
.0022	6	7	22
.0033	6	7	33
.0047	6	7	47
.0068	6	7	68
.01	6	8	10
.015	6	8	15
.022	6	8	22
.033	6	8	33
.047	6	8	47
.068	7	8	68

**Electrolytic Radial Leads**

-10% to +50% Tol.			
µF	V	16	25
.47	16	7	7
.68	16	7	7
1.0	16	7	7
1.5	16	7	7
2.2	16	7	7
3.3	16	7	7
4.7	16	7	7
6.8	16	7	7
10	16	7	7
15	16	7	7
22	16	7	7
33	16	7	7
47	16	7	7
68	16	7	7
100	16	7	7
150	16	7	7

**D.I.L. Sockets**

8 Pin Low Profile Socket Tin	12	DIL SKT 8
14 Pin Low Profile Socket Tin	14	DIL SKT 14
16 Pin Low Profile Socket Tin	16	DIL SKT 16

**P.C.B. Components**

Dato Pan, Blue Ink, Slow Drying	69
---------------------------------	----

**RESISTORS**

Carbon Film, Fixed			
0.25W, E24 Values IRO-10M, 5% Tol.			
2 each	Res RD%	100/10 (Multi 10/Value)	Value
0.5W, E12 Values IRO-4M7, 10% Tol.	3 each	Res RD%	Value
Metal Film, Fixed			
0.5W, E24 Values, SR-I-M, 2% Tol.			
2.5W, E12 Values, IOR-27K, 5% Tol.	16 each	Res PR52	Value
Metal Glaze, Fixed			
0.5W, E24 Values, IM-33M, 5% Tol.			
18 each	Res VR37	Value	

**Skeleton Presets, Miniature**

0.1W, E3 Values, 100R-1M, Lin, Vertical Mounting	8	Min. Preset V
0.1W, E3 Values, 100R-1M, Lin, Horizontal Mount	8	Min. Preset H
Skeleton Presets, Standard		
0.2W, E3 Values, 100R-4M7, Lin, Vertical Mounting	11	Std. Preset V
0.2W, E3 Values, 100R-4M7, Lin, Horizontal Mount	11	Std. Preset H
Potentiometer, Rotary		
0.5W, E3 Values, 1K-2M2 Log	39	Ro Pot Lin
0.25W, E3 Values, 4K7-2M2 Log	39	Ro Pot Log
Potentiometer, Slider		
0.5W, E3 Values, 2K2-47K, Lin	45	Sl Pot Lin
0.25W, E3 Values, 1K0-1M0 Log	45	Sl Pot Log

**MAINS TRANSFORMERS**

Secondaries may be connected in series or parallel to give wide voltage range	
Primary: 0-220, 240V	
6VA - Clamp Type Construction	235 each
Approx. 18% Regulation F.C. 70, H48, W35	
0-4.5V, 0-4.5V Secondaries	Trans 6VA
0-5V, 0-5V	
0-12V, 0-12V	
0-15V, 0-15V	
0-20V, 0-20V	
20VA - Clamp Type Construction	380 each
Approx. 18% Regulation F.C. 70, H48, W48	
0-4.5V, 0-4.5V Secondaries	Trans 20VA
0-5V, 0-5V	
0-12V, 0-12V	
0-15V, 0-15V	
0-20V, 0-20V	

**Plastic Boxes - Boss Industrial Mouldings**

Moulded Box and Close Fitting Flange Lid	
ABS Box, C/W Brass Bushes, and Lid In Orange	
Order Code	
L112 W82 D31	99
L150 W80 D50	131
L190 W110 D80	223
Plastic Boxes with Metal Lids	
Recessed Top Box	
ABS Base, C/W Brass Bushes, In Orange	
1mm Aluminium Top Panel Finished Grey	
Order Code	
L85 W58 D29	112
L111 W71 D42	180
L161 W98 D53	208
Diecast Boxes	
Diecast Box and Flanged Lid	
Aluminium Box and Lid in Natural Finish	
Order Code	
L113 W83 D31	124
L152 W82 D50	216
L192 W113 D81	334

**VERO ELECTRONICS PRODUCTS**

2.5" x 5" 1" pitch Veroboard	71	200-21069J
3.75" x 5" 1" pitch Veroboard	79	200-21072D
2.5" x 1" 1" pitch Veroboard (S)	85/Pack	200-21076C
3.75" x 5" 1" pitch Plain Board	68	200-21078H
5.82" x 2.9" 1" pitch V-Q DIP Board	135	200-21084E
Spot Face Cutter	107	203-21013A
Pin Insertion Tool for D40 type pin	147	203-21015F
DS Pins .040 (100)	44/Pack	200-21087G
SS Pins .040 (100)	44/Pack	200-21017H
Veroboard Kit (1 open, 2-wire, 25-comb)	454/Kit	200-21341D
Veroboard Combs (25)	109/Pack	200-21338F
Veroboard Wire (2)	109/Pack	200-21340G

**SWITCHES**

Miniature Toggle - Honeywell	
Order Code	
SPDT	67
SPDT C/OH	61
SPDT Double Bias To Centre	90
DPDT	90
DPDT C/OH	111
Miniature Push - C & K	
Push To Make, Momentary	62
Push To Break, Momentary	62

**GMT ELECTRONICS PROJECTS**

	KIT	BUILT UP
FREE-STANDING COMPLETE TELETXT UNIT - FULL SPEC	£199-90	£275-00
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TELETXT COMPATIBLE TUNER AND P.S.U.	£ 46-90	£ 57-00
TELETXT COMPATIBLE PAL ENCODER + MODULATOR	£ 22-90	£ 35-00
F.E.T. OUTPUT 100W MONO POWER AMPLIFIER MODULE	£ 27-50	£ 35-00
X-BAND DOPPLER RADAR ALARM MODULE - MARK II	£ 35-90	£ 44-00
ONE AMP P.S.U. MODULE (SPECIFY 5 OR 12 VOLTS)	£ 7-50	£ 10-00
SIMULATED INERTIA MODEL TRAIN CONTROLLER	£ 22-50	£ 35-00
SIMULATED INERTIA SLOT RACER CONTROLLER	£ 27-50	£ 40-00
MODEL TRAIN STEAM SOUND SIMULATOR MODULE	£ N/A	£ 5-00

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**PDM35 DIGITAL POCKET MULTI-METER**

LED DISPLAY. DC volts (4 ranges) 1mV to 1000V. AC volts 1v to 500V. DC current (6 ranges) 1nA to 200mA. Resistance (5 ranges) 1Ω to 20MEGΩ. £39.95. AC adaptor £4.25. Padded carrying case £1.95. MN1604 Battery £1.28. Size 157x76x32mm

**PFM200 frequency meter.**

LED display. Range 20Hz to 200MHz. Accessories as for PDM35. Size 157x76x32mm. £57.95.

**DM235 BENCH-PORTABLE DIGITAL MULTIMETER**

LED display. DC volts (4 ranges) 1mV to 1000V. AC volts (4 ranges) 1mV to 750V. DC current 1µA to 1000mA. Resistance (5 ranges) 1Ω to 20MEGΩ. £60.98. Carrying case £8.95. AC Adaptor/Charger £4.25. Rechargeable battery pack £8.95. Size 255x148x40mm

**DM350 & DM450. BENCH-PORTABLE DIGITAL MULTIMETERS**

DM350 3½ digit LED display. DM450 4½ digit LED display. Both provide six functions in 34 ranges. DC voltage 10µV to 1200V (100µV on DM350). AC voltage 100µV to 750V. DC current 1nA to 10A. AC current 1nA to 10A. Resistance 10mΩ to 20mΩ (100mΩ on DM350). Carrying case £8.95. AC adaptor/charger £4.25. Rechargeable battery pack £8.95. Size 255x148x40mm

**SC110 LOW POWER PORTABLE OSCILLOSCOPE**

The SC110 has a 10MHz bandwidth and sensitivity down to 10mV per division. Full trigger facilities are provided, including Bright line and Auto with TV line and frame filtering. £159.85.

**TF200 FREQUENCY METER**

LCD display. The TF200 measures frequencies from 10Hz to 200MHz with a resolution of at least 1ppm (typically better) across the whole measurement range. £166.75.

**TG105 PULSE GENERATOR**

The TG105 is a mains operated 5Hz to 5MHz pulse generator with independent TTL and 500 variable outputs. Period and pulse width are each selected by a 6 position range switch plus vernier control. £98.75.

**CALSCOPE SUPER 6 £186.30**

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**CALSCOPE SUPER 10 £251.85.**

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\* I understand that this will be credited to me in full, should I decide to become a member of either the Cassette or Record Library, or both.

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ETI 11/80

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# AUDIOPHILE

**Disguised as Father Christmas, Ron Harris presides over our Sony competition Prize Day, finds a sticky mat to play with and casts a critical eye over a budget box of tricks.**

Competition results time again. A few Audiophiles ago I ran that appalling, tasteless and thoroughly despicable Sony publicity photo for the 'Stowaway' portable tape player and asked for your captions . . . As usual you did not disappoint me. Six million pieces of paper later I think we have a winner. Well, almost. In fact, two winners, as I was unable to make up my mind between two very witty submissions.

Mr B. D. Barrett of Pickering, Yorkshire and C. R. Thorn of Gloucester (who did not bother to define gender more closely) are, therefore, declared joint 'Wit of the Month' and duly rewarded a year's subscription to ETI. Anyone who thinks second prize is two year's subscription to ETI had better leave now, lest he lose his vitals.

There were many more worthy attempts, but by far the most popular line was "O.K. Scotty, beam us up" which lost by sheer weight of numbers! I have given a few of the better efforts below, the winners first:-

Left: the great Sony picture show which started all this lunacy.

Joint Winners: "Are you sure this will stop me getting pregnant?" Mr R.D. Barrett, Pickering

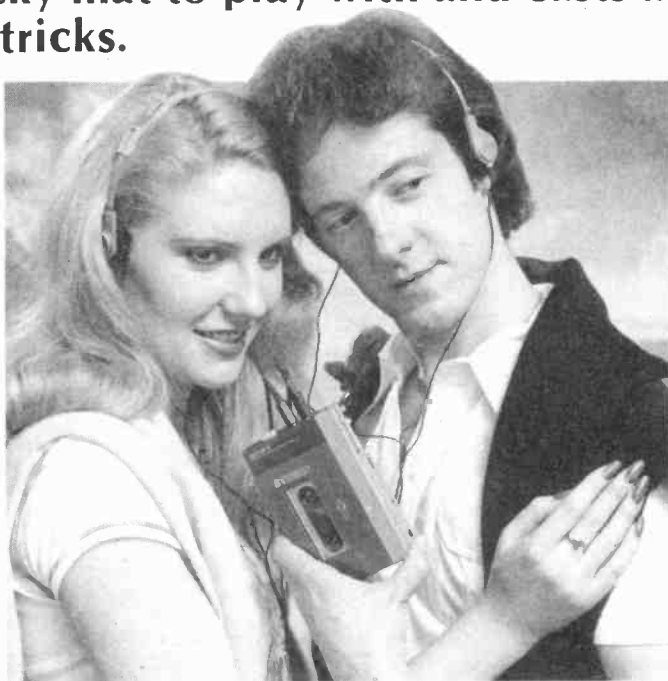
"Darling — I know it's cheaper than a choir, but this is our wedding . . ." C. R. Thorn, Churchdown

Also worth an honourable mention or three:

"His equipment is so tiny . . . but I love the performance". Mr J Wakewell, Shirley, Surrey.

A final chord in this symphony of corn and photographic pap. Just to prove that PR agencies are capable of exhibiting bad taste on a worldwide scale, I reproduce below the hand-out photos for the Stowaway from Japan and the USA . . .

No words of mine could do them justice, therefore — no comment.

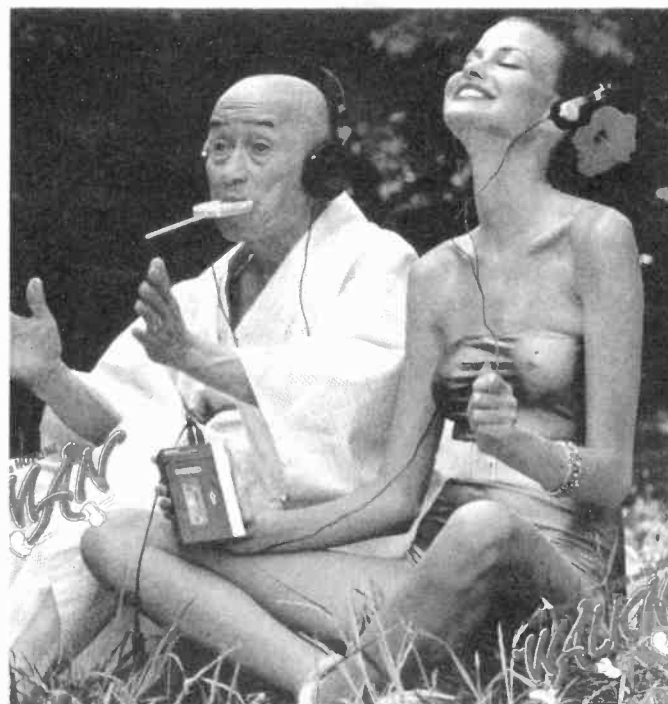


"Here — can you do this with your thumb?" Un-named of Maidstone. (Blew it, didn't you?)

"So this is where you keep the spare batteries . . .". J. Clarke, Sutton Coldfield.

"Darling are you sure your pacemaker's working O.K.?" S. McKinty, Co. Down.

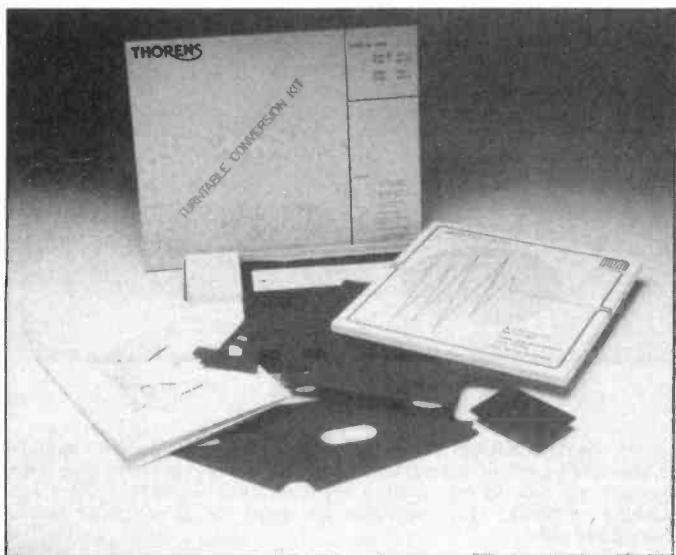
"Step two: place your right hand on your partner's left . . ." P. Skinner, Derby





## On The Mat

Following on from last month's review of the Thorens TD160S turntable, I have more news of the 'conversion' kit to upgrade other models to a similar performance. Similar, but not equal. It seems that most



Thorens conversion kit includes self-adhesive damping material to improve the sub-chassis behaviour under resonant conditions. A new arm-board and turntable mat is also included.

of the changes to the standard 160 which were made to create the 160S are the brainchild of Cambrasound (a merged version of Metrosound and Cambra International) Thorens UK importer.

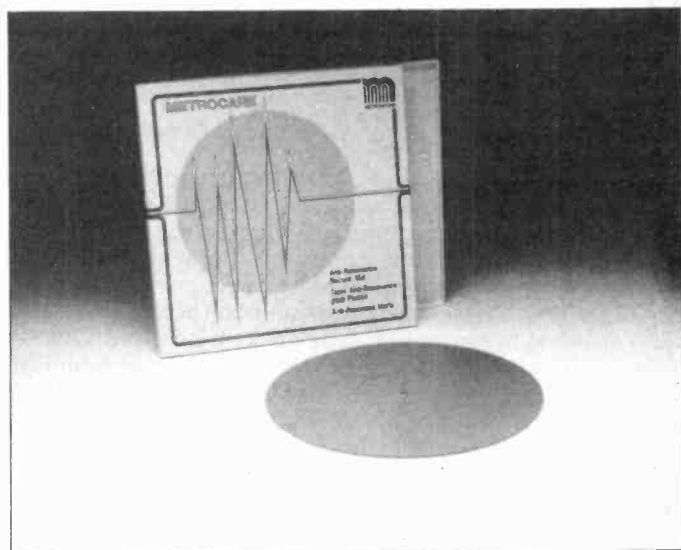
One point of difference exists, however, over the turntable mat. Thorens went their own way and produced a very heavy and sensible specimen which resides in the 160S production model. Metrocare have their own mat — and it is this that is included in the conversion kit. As this item is marketed separately, as a general application turntable mat, I thought it worth a closer look.

It is formed from a silicon elastomer, which is virtually 100% pure polymer. That description makes about as much sense to me as the Arabian Daily News. The material has a very high surface tension — higher on the face which will be in contact with the turntable.

Practically this means it is "sticky" to the touch and bonds very well to the metal surface. The record is effectively held across its entire surface, with no room for air gaps.

## Resonant Peaks

Metrocare claim the biggest benefit lies in the reduction of those resonances which are inherent in all cast platters and cite an improved upper-bass and mid-range reproduction as the audible return for the £16.75 retail price.



Above: the very persistent Metrocare turntable mat, as fitted to the Thorens conversion kit, but not to the production 160S decks. A very high surface tension endows it with considerable LP holding qualities.

Because of the mat's amazing ability to hold dust, the Metrocare must be kept clean — and the deck covered at all times when not in use. Removing records from the mat has to be done carefully as the bonding is not just good, it is excellent. LPs are somewhat loathe to leave.

Having tried the Metrocare on a few decks, including the TD160S, I can confirm that it is indeed a worthy effort. Compared to Thorens' own creation it displays an improved mid-range and tighter control of the bass. Subtle changes, but clearly audible nonetheless. I cannot understand why Thorens would not accept the whole of the advice offered, and fit Metrocare to the TD160S production model. Swiss independence, I suppose. Ah well.

Trying the Metrocare on other decks, including some budget machines, suggested that it has much to offer most hi-fi users in that an audible improvement was obtained on all the decks we dropped it on. It is probably the only one of these "super-mats" that can claim such universal application. ➔







## Budget Trio

In response to readers' calls for budget hi-fi reviews (and because someone told me Felicity Kendal had a Trio hi-fi) I have been taking a look at the new KA-300 from Trio, a 30 + 30 low price amplifier which will retail at somewhere in the region of £80-£90.

Facilities offered are not at all bad for this price area and dubbing between two tape decks is possible. One set of tape sockets (phono) is included in the front panel for ease of access. Not a bad idea if you can hide them somehow with one of those flaps the Japanese are so enamoured of, but a little ugly otherwise. In fact the KA-300 is anything but pretty all round! The controls are well sited and smooth to operate, but the appearance is downright ugly in my opinion. The black plastic ribbing which pops up all over the front panel gives a very strange look to the whole thing.

Individual is perhaps the kindest label to hang there!

On test the Trio acquitted itself well, exceeding the spec on every feature and giving a very competent electrical performance. Power available was somewhere around the 35 W a channel mark and this is well maintained across the audio spectrum. Noise ratios were commendably low for the price and distortion was at a level where it would not be a problem. The test results give you the details, if you're interested.

TABLE ONE

Output Power	; 40Hz - 20kHz	; 25W
Power Bandwidth	; at 0.01% THD	; 10Hz - 45kHz
S/N Ratio, unweighted	; phono	; 60dB
	aux, tuner, tape	; 65dB
Damping Factor	; 8R 40Hz - 20kHz	; 60
Input Sensitivity	; phono	; 2mV at 50K
	aux etc	; 130mV at 27K
Distortion	; THD 1kHz at 20W	; 0.1%
	intermodulation	; 0.05%

Test results for the Trio KA300 amplifier. Noise ratios are excellent. The impedance on the aux input is, however, somewhat less than excellent! A minimum of 50K is to be preferred.

Above: the Trio KA300 budget amplifier. The appearance is certainly striking and bereft of superfluous controls. Loudness could have been disposed of, too, in my opinion without much weeping wailing and gnashing of teeth. Tape facilities are good for an amplifier in the under £300 class.

## Listen with Trio

It is always difficult to decide exactly how to audition budget equipment. Do you hook it onto a top flight set-up, in order to exactly determine its strengths and weaknesses, or use the type of system it is designed to run with and accept that you are only able to judge it comparatively against a rival unit?

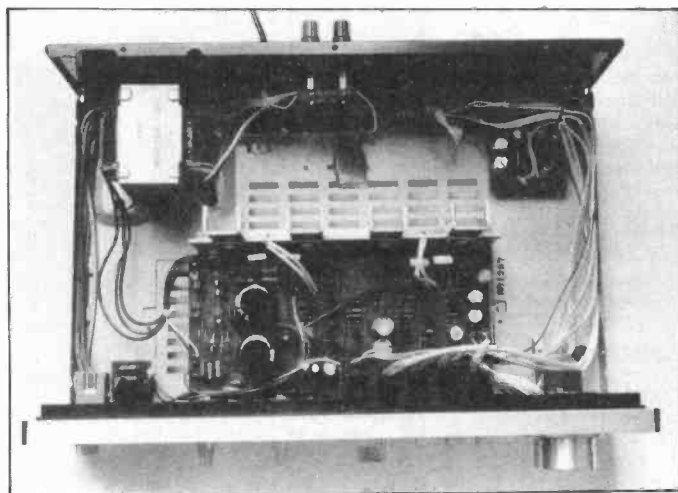
My own approach is simply to do it both ways! Never one to make things less complex, if at all possible. Hence the Trio was substituted into my reference system (driving Kef 105 IIs at one point!), first of all to try to get an absolute idea of performance before moving on. I might add that the Seoum amplifier on offer elsewhere in this issue was also put to the test and used throughout as a comparison to the Trio. Final listening was carried out with reference to a friend's system using the NAD 3020, which is perhaps the best sounding unit in this price bracket.

Having now heard the KA-300, I think that NAD have little to worry about. On an absolute basis the Trio has poor bass control and a tendency to "harden" on complex material. The Seoum sounded a good deal clearer and coped with most material well, although the noise was higher than with the Trio.

On the 'plus' side, the KA-300 is possessed of a good signal-to-noise ratio on both phono and tape and is well engineered. Against that, it has a good sound quality that is bettered by competitors, such as the NAD 3020 and the Seoum, and a highly individual appearance that you will either love or hate.

Sorry Trio, I can't recommend this one at all.





Above: an internal view of the Trio KA300. Lots of space is there not? Surely a smaller cage could have been found without jeopardising the signal to noise ratios too much?

Will readers using the Audiophile hi-fi enquiries service please remember to quote full details of the hi-fi system they are using. It is of great value to me in trying to sort out problems to know what it is I'm trying to sort out!

## Letters Pray

Dear Sir,

I am upgrading my system and have been told that what I ought to change next is the turntable. This is a Thorens TD150 and an SME 3009 and a Shure M75ED cartridge. Amplifier: Armstrong 621. Speakers KEF Cadenzas.

My friend told me to buy a Linn as this will improve my system more than anything else. But this will cost me over £300 and this is more than I paid for the whole system, I wanted to be sure. What would you suggest I do?

Yours sincerely

F. Kendal

London

Hang on whilst I recover from the heart-attack that that name and address induced... People with *that* name should make it clear at the start who they are *not* — not who they are!... Come on heart, don't fail me now... you can make it...

Anyway, Mr Kendal, the first thing I would advise you to do is take your 'friend' on a one way trip to the docks in brand new cement shoes. It is about all he deserves. If your TD150 is in good condition, a Linn will make little, if any, difference to your system. A better immediate upgrade would be to change the cartridge. If you like the Shure sound then the V15 IV is an excellent buy. If you fancy a change then give the Goldring G900 IGC or Empire 600 LAC a try. After that both the amp and speakers could well be replaced — in fact, the deck is the last thing to change!

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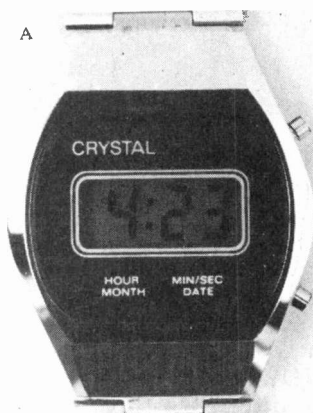




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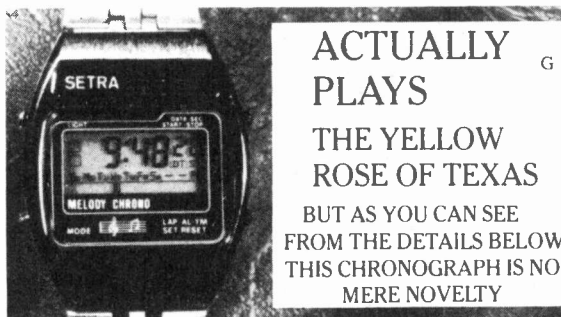




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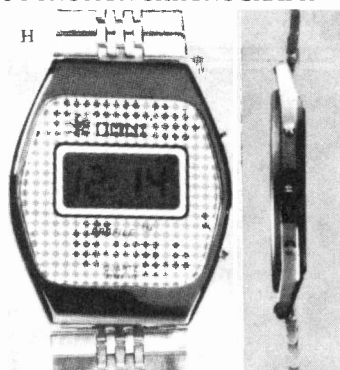
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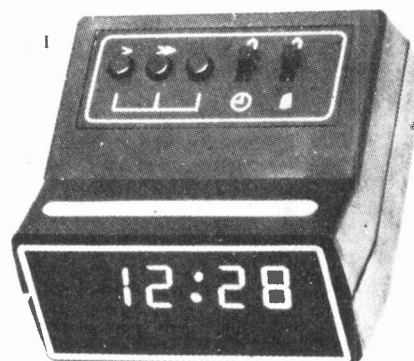
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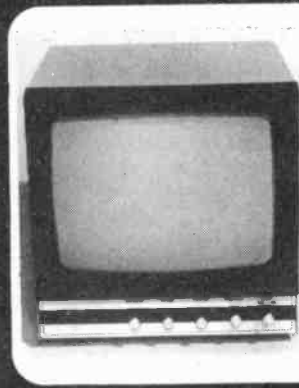
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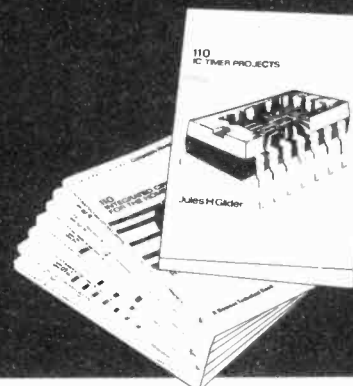
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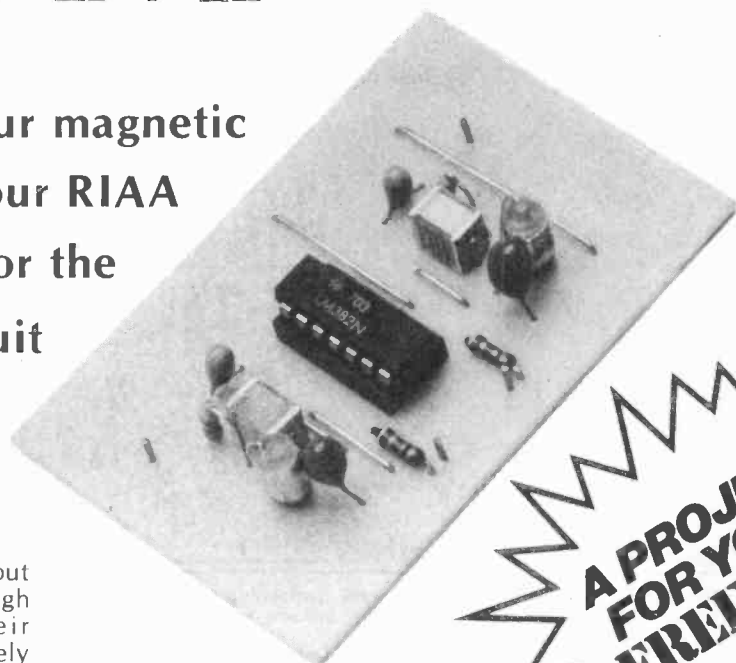
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# RIAA PREAMP

Sounds amazing. Listen to your magnetic cartridge burst into life with our RIAA equalised preamp, designed for the ETI Multi-Option Board. Circuit design by Keith Brindley.



**M**agnetic cartridge pick-ups have very low output levels and consequently require low noise, high gain preamplifiers to boost their signals. Op amps for this application are relatively abundant nowadays. But, things aren't quite that simple — not only is the output level of a magnetic pick-up low, but it varies with frequency. At the top end of the audio spectrum (ie 15-20 kHz) the signal is about 40 dB up, (ie 100 times) that of the lowest end of the range.

The Record Industry Association of America (RIAA) laid down the rules for the frequency response curve, so that when designing such a preamp stage the engineer has only to calculate suitable values for the components in an op amp feedback loop. What is needed is an amplifier response which *diminishes* with increasing frequency over a range of 40 dB, to compensate for the response of the cartridge and give an overall flat output. Given a microcomputer, a sharp pencil and a bottle of vodka it should take him — ages. But why bother, it's all done nowadays (as it often is!) on one chip — the LM382.

## Cue Cavalry

National Semiconductor came to the rescue with the introduction of this device, a wide-range supply voltage (9-40 V) preamp which, with only a handful of other components, gives an RIAA preamp featuring low noise, high gain and the required frequency response.

## Construction

The only components which need correct polarisation are the four tantalum capacitors and the IC, so check the overlay carefully before soldering them into position on the ETI Multi-Option Board.

The input and output connections should be made with screened lead, the screen being taken to 0 V. The only thing to note here is that the input leads must be as short as possible, because the high gain involved in any preamp circuitry makes them very susceptible to hum and noise pickup. Short screened leads help to minimise this problem.

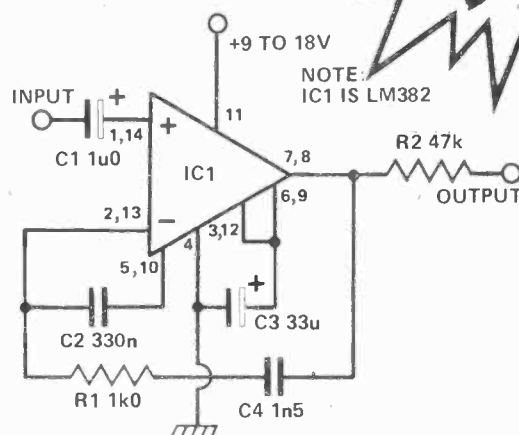


Fig. 1. Circuit diagram of one channel of the preamp.

## HOW IT WORKS

The feedback loops in any RIAA amplifier are fairly conventional and apart from different component values, any one circuit is similar to another. What makes the LM382 novel is the internal resistor matrix available on the chip. This enables an exceptionally low number of external components.

For the technically minded the RIAA transfer function of such an amplifier can be stated as:

$$G = \frac{(1 - jf_2/f_1)}{(1 - jf_1/f_2)(1 + jf_3/f_4)}$$

where  $f_1 = 50$  Hz,  $f_2 = 500$  Hz and  $f_3 = 2.12$  kHz.

This defines the corner frequency exactly and also the various slopes of the frequency response. It just so happens that capacitor/resistor feedback combinations can be used to achieve the required amounts of gain, corner frequencies and roll-offs. The internal resistor matrix of the LM382 simply allows us to use fewer external components in the circuit.



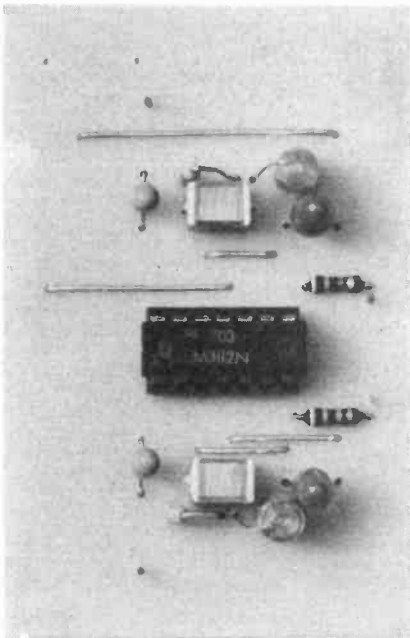
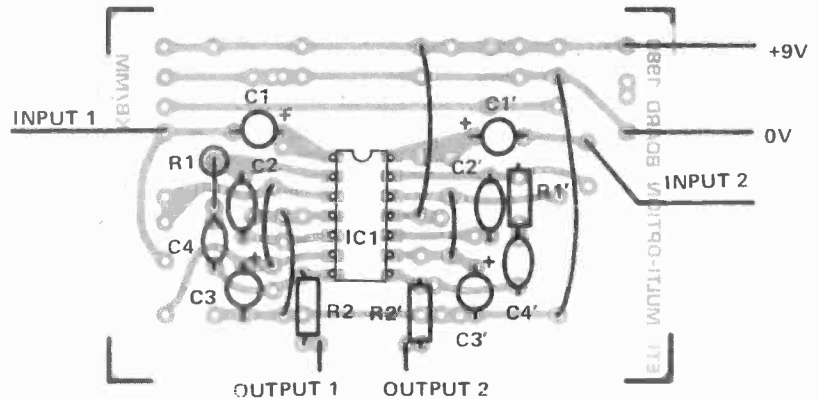


Fig. 2. (below) Component overlay of the stereo preamp fitted onto the Multi-Option PCB.



## PARTS LIST

Resistors all 1/4 W 5%

R1 1k0  
R2 47k

Capacitors

C1 1u0 35 V electrolytic  
C2 330n polycarbonate  
C3 33u 10 V electrolytic  
C4 1n5 polystyrene

Semiconductors

IC1 LM382

Miscellaneous

ETI Multi-Option PCB

## BUYLINES

The one chip and handful of components used should not present any problems. They should be readily available from suppliers advertising in this issue.

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### ULTRA SLIM ALARM - CHRONOGRAPH

WITH 12/24 HOUR DISPLAY  
Only 6.5mm thick including a special battery hatch. Normal display is: Hours, mins, secs, day of the week and p.m. indication. Display mode can be either 12 or 24 hour cycle. Other features include 24 hour alarm, 1/10th sec chrono with lap time and backlight. (Chrome colour).



A201S £13.50 ▶

### DUAL TIME ALARM CHRONOGRAPH

Incredible value for money. Sold elsewhere for £19.95. Normal display is Hours, mins, secs, or date, day of the week, PM and alarm indicator. Other features include, 2nd time zone, 1/10th sec chrono, backlight and 24 hours alarm. Buy now while the stock lasts. (Chrome colour).



◀ LM20 £10.95

### MYSICAL ALARM CHRONOGRAPH

Normal display is Hours, mins, secs, day of the week and Alarm and indicator. Other features include, 1/10th sec chronograph with lap time facility, month, date, backlight, 24 hours musical alarm. Plays FUR ELISE.

Case similar to model LM20



A205S £13.50

As illustrated in the picture

A202S £14.50

As illustrated but with Dual Time (Plays YELLOW ROSE OF TEXAS)

LM101 £15.95



### GENTS 6 DIGITS ALARM WITH DAY OF THE WEEK

Normal display is Hours, mins, secs, day of week. PM indicator and Alarm indicator. (Model A203L has extra large digit for better readability). It has a very useful 24 hour repeat alarm and 4 year auto calendar. (Chrome colour).

◀ A203S £8.50

### LADIES SNOOZE ALARM

Exceptionally good value for money. Normal display is Hours, mins, PM and Alarm on indications, other features include, 4 year auto calendar, backlight, 24 hour alarm with Snooze facility. Fully adjustable, stainless steel bracelet (Chrome colour).



LM102 £9.50 ▶

### LADIES SUGAR COATED DRESS WATCH

Ladies 9 function LCD watch. Hours, mins, secs, month, date, backlight. Auto date/time display mode, 4 year auto calendar. This watch has an optional auto date/time display mode. In this mode time and date is alternatively displayed every 2 secs. (Chrome or gold).



LM39 £8.95 ▶

### LADIES COCKTAIL WATCH

Ladies 9 functions LCD watch. Hours, mins, secs, month, date, backlight, auto date/time display mode, 4 year auto calendar. This watch has an optional auto date/time display mode. In this mode time and date is alternatively displayed every 2 secs. (Chrome colour).



◀ LM38 £5.95

- ★ **ULTRA SLIM DUAL TIME MUSICAL ALARM CHRONO.** Only 7mm thick. Plays 'YELLOW ROSE OF TEXAS'. A204S £14.95
- ★ **VIDEO MASTER.** 24-tune Doorchime £13.95
- ★ **VIDEOMASTER COMPUT-A-TUNE.** 2 octave keyboard, replay with added musical effects. £19.95

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<b>PRESETS (.15W HORIZONTAL)</b>	7p			7408	22p	74125/6	42p	8C169C	13p	BFX29	25p	2N1308	35p
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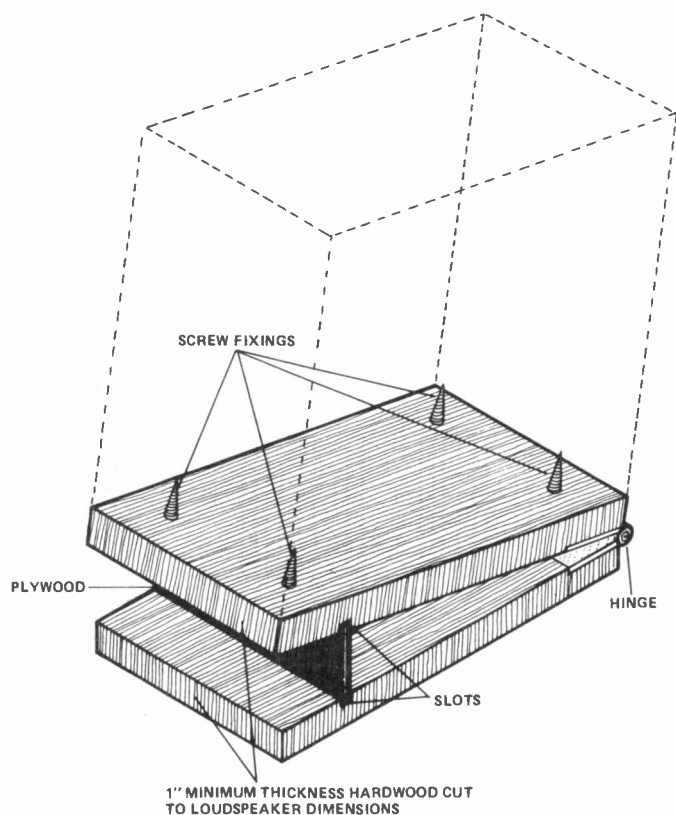
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# TECH TIPS



## Getting off the ground — cheaply

G. Adams, Poole.

The cost of loudspeaker stands prohibit many from buying them, although they are important to floor-standing arrangements for two reasons. They reduce possible colouration via floorboards etc. and, more importantly, they effectively heighten floor-standing loudspeakers so that the sound from each is directed where it should be, to one's ears, *not* to the upholstery and one's ankles!

With the latter problem particularly in mind, this design was finally decided upon. It is rather uniquely versatile, in that by using different sizes of plywood any degree of lift may be obtained. However, a lift of around 10° is considered a useful stone upon which to build.

## High Quality Headphone Amplifier

A. J. Jones, Cobridge

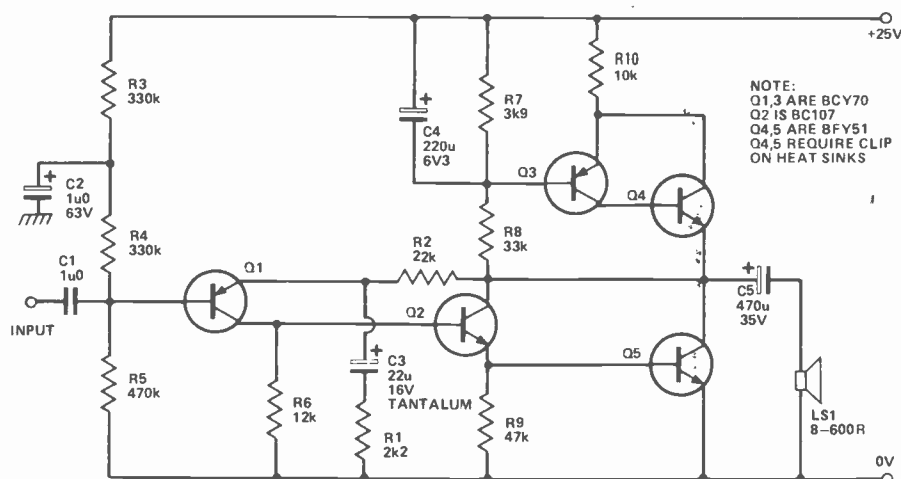
This circuit is capable of high performance using low cost, readily available components. The class A amplifier is designed to drive efficient, high impedance headphones of 150R and above, although it will drive 8R headphones with reduced performance.

Feedback is applied by R1,2 and gain with the specified components is 11. For maximum output the input sensitivity is 0 dB. Q3,4 and C4 form a gyrator circuit and present a high impedance to AC signals. This gives the circuit a high open-loop gain.

Quiescent current is set by R9 (approximately 60 mA).

Performance is good with distortion and noise measured on Radford test kit at less than 0.01%

for maximum output. Noise is less than -80 dB unweighted. Power bandwidth is less than 10 Hz to over 50 kHz. Slew rate is greater than 5 V/uS.



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

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## Efficient P.A. Amplifier

N. D. Sheldon, High Wycombe

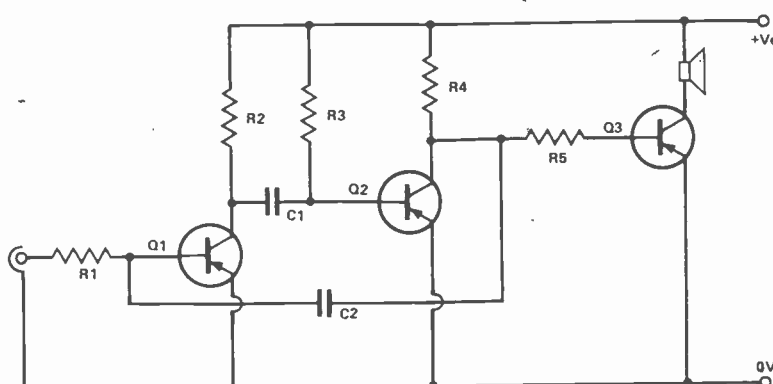
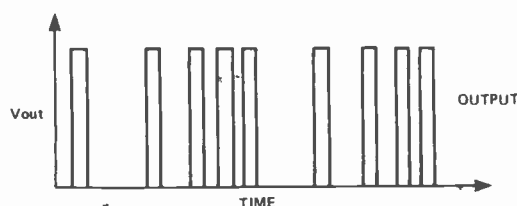
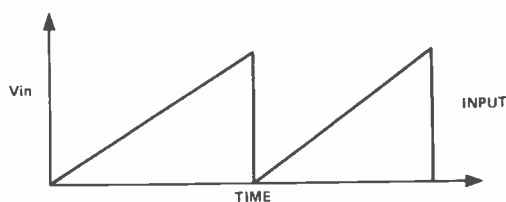
The efficiency of this amplifier is so high that an output of 3 W can be obtained with a BC107 used as the output transistor, even without a heatsink.

The amplifier consists of a voltage controlled pulse width oscillator working at about 6 kHz, driving a class D output stage. Since the output transistor is either hard on or completely off, the dissipation is minute — hence the high efficiency. The output waveform bears no resemblance to the input, but the integral of the output waveform is proportional to the integral of the input waveform, both with respect to time.

A table of component values has been given in order that any amplifier with an output of between 3 W and 100 W can be constructed. Still higher powers up to 1 kW can be obtained.

The drawback is that it produces about 30% distortion and can, therefore, be used for sound reinforcement only. It is especially suitable for public address systems, as speech is completely intelligible.

POWER (W)	R4	R5	Q3	HEATSINK	SUPPLY/V	O/P TRANSFORMER
3	1k5	390R	BC107	50 C/W	15	—
10	1k5	390R	BFY51	22 C/W	24	15R:8R0
30	1k0	270R	BD139	10 C/W	40	22R:8R0
100	820R	180R	BD139	5 C/W	60	35R:8R0



R1 27k	C1 1n8	Q1	BC107
R2 1k5	C2 1n8	Q2	BC107
R3 180k			

## Digital Op-Amp

K. Wood, Leicester

One half of a 4013 package may be used as an amplifier, if one doesn't mind a digital output whose duty cycle is proportional to the expected output voltage. This could always be filtered to recover an analogue output.

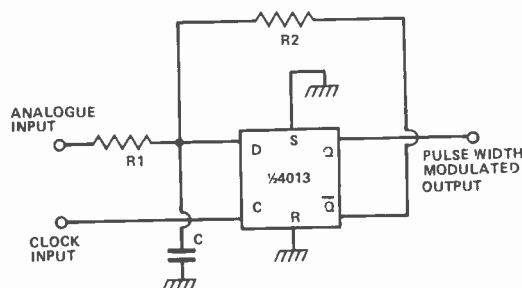
Clock pulses have to be applied as indicated and these should be considerably higher in frequency than the required bandwidth. Gain is  $R2/R1$  and the time constant  $R1R2C/(R1+R2)$  should be longer than the period of the clock pulses.

Uses of the circuit include the following:

1. Take pulses from the zero

crossing point of the mains, drive a triac with the output and you have proportional power control without RFI.

2. Switch driver transistors with the output using a fast clock and you have a high efficiency PWM audio amplifier.





## Interior Light Delay

S.A. Johnson, Newcastle

The circuit shown will delay the car interior light by about 10-15 S, depending upon the time constant of R2-C1.

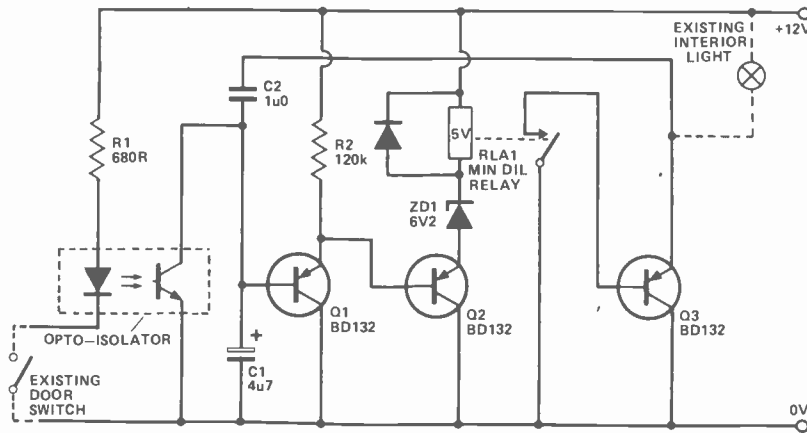
One big fault with most delay units is that the delay is so long that the light is still on when you drive away, which can be very annoying at night. This unit, however, will extinguish the light either 10-15 S after the door is

closed, or when the engine is started, whichever occurs first. The unit may be fitted without running any extra wires to it and may be fixed behind the interior light.

Capacitor C1 charges up through R2; thus turning Q1, Q2, RL1 and Q3 off after 10-15 S. When the door is opened C1 is discharged by the opto-isolator and begins to charge up after the door is closed.

If, however, the engine is started before 10-15 S the supply voltage will drop sufficiently to de-energise RL1, (approx 3V) and give C2 a positive pulse via Q3 which will charge C1 up sufficiently to switch Q1 off. **NOTE:** The value of C2 and ZD1 may need to be altered to get this effect.

The unit draws very little current when not in use and has only ten components.



## Multivibrator

E. Vaughan, High Wycombe

The frequency of a conventional multivibrator is controlled by the R-C time constant of its feedback loops. This circuit has fairly good rise and fall time and will operate at repetition rates as high as 10-15 MHz. The disadvantage of this kind of circuit is poor frequency stability. Also, the frequency can be affected by temperature, voltage variations, and variation (within tolerance ranges) between capacitors and resistors in the feedback loops, the latter affecting not only frequencies, but waveform symmetry.

With the circuits shown, all these disadvantages can be eliminated and the advantages of a conventional multivibrator will not be lost. The same number of components are required as the crystal or crystals replace the capacitor in one or both feedback loops. The resistor value in the feedback is not critical. As it is used with a crystal it no longer controls the time constant.

Both CT cut or AT cut crystals are suitable. The circuit in Fig. 1 uses a crystal of 7 MHz with a low activity. Crystal activity was down to about one tenth of its 7MHz value when in the circuit, so it was not possible for it to operate below 750 kHz. To get below this a higher activity crystal would have to be used. Varying the feedback

resistor in a conventional multivibrator changes the frequency. This had no effect on the frequency the crystal controlled circuit. Then the capacitance of the 7MHz and 3.5MHz crystals in Fig. 2 were measured and came out as 13pF and 12pF respectively.

These capacitors are not in the range that create an R-C time constant that permits the circuit to work at the above frequency, so there is no doubt the crystal was controlling the frequency. With a crystal the circuit operates only at its rated frequency. Frequency tolerances in the order of 0.001 to 0.0001 percent can be obtained with this circuit. The 2N2475 used is a very fast switch. If another transistor is used it need not be as fast,

but should have a switching time that will permit operation at the desired frequency.

The circuit (Fig.1 modified) controls symmetry by employing different frequency crystals in the two feedback loops. R3 and R4 were changed to 10k and X2 to 3.5 MHz. The 7 MHz crystal remained in the second feedback loop. All other values are the same as shown in Fig. 1. This produces a symmetry of 2:1, but maintained a frequency stability of 0.007 percent with a 20 percent supply voltage variation. This modification has other advantages. It can be used to produce an extremely stable asymmetrical square wave. Crystals for this type of operation must have a harmonic relationship.

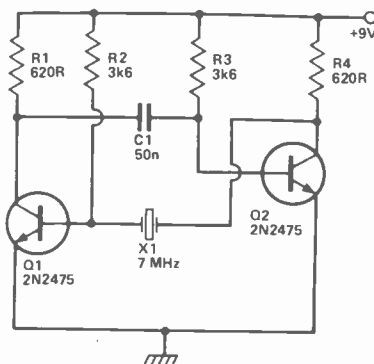


Fig. 1.

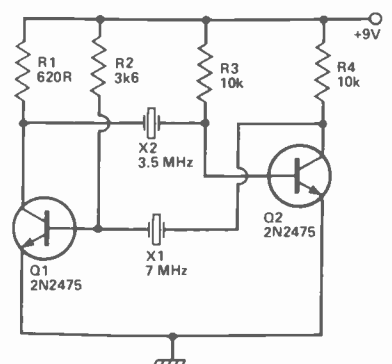


Fig. 2.



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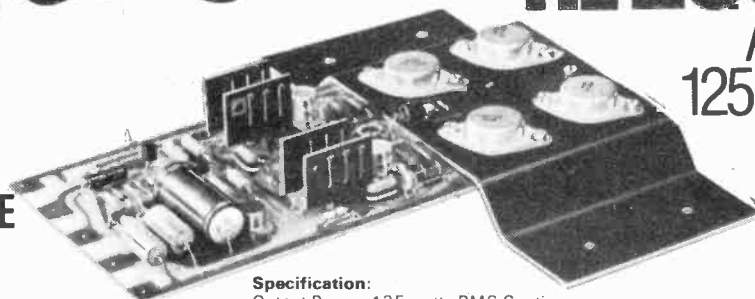
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**STA10.** 10 watts per channel Stereo Amplifier Kit consisting of 2 x AL30 amplifiers, 1 x PA12 pre-amplifier, 1 x PS12 power supply, 1 x 2036 transformer and necessary wiring diagrams **£23.72**

**STA15.** 15 watts per channel Stereo Amplifier Kit consisting of: 2 x AL60 amplifiers, 1 x PA100 pre-amplifier, 1 x SPM80 power supply, 1 x 2034 transformer, 2 x coupling capacitors for 8 ohms 470mfd 30v and necessary wiring diagram **£42.27**

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**STA25.** 25 watts per channel Stereo Amplifier Kit consisting of: 2 x AL60 amplifiers, 1 x PA100 pre-amplifier, 1 x SPM120/45 power supply, 1 x 2040 transformer, coupling capacitors for 8ohms, 470 mfd. 45v, 1 x reservoir capacitor, 2200mfd 100v and necessary wiring diagram **£46.58**

**STA35.** 35 watts per channel Stereo Amplifier Kit consisting of: 2 x AL80 amplifiers, 1 x PA100 pre-amplifier, 1 x 2035 transformer, 2 x coupling capacitors 470mfd at 50v for 8ohms, 1 x reservoir capacitor 2200mfd 100v and necessary wiring diagram **£52.62**

## BI-KITS

**STA50.** 50 watts per channel Stereo Amplifier Kit consisting of: 2 x AL120 amplifiers, 1 x PA200 pre-amplifier, 1 x 2041 transformer, 2 x coupling capacitors 1000mfd 63v, 1 x reservoir capacitor 3300mfd 100v and necessary wiring diagram **£68.87**

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The 555 is a worker! It is adaptable to a wide variety of ideas and designs. It can operate on a power supply of 5 to 18 V. It can sink or source currents up to 200 mA.

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The ETI Touch Buzzer uses the dual version of the 555, which is designated the number 556. It is, of course, constructed on the ETI Multi-Option Board given away free with this issue and is extremely simple to build. You can utilise it as a rather clever VAS (Visitor Announcement System — otherwise known as a doorbell) or you can dream up your own uses for a very adaptable project. For instance, the output of the first half of the circuit from pin 5 of the 556 (see How It Works for circuit explanation), can be used to operate a low voltage relay to turn on and off other items of equipment and the circuit now operates as a touch switch.

## HOW IT WORKS

The 556 is divided internally into two separate multivibrator circuits — a monostable followed by an astable. The monostable is triggered when the voltage at pin 6 of the IC is taken below one-third supply voltage. Normally pin 6 is held high by R2, a 2M7 resistor. However, when a finger is placed over the touch plates the skin resistance takes the voltage low.

The timing period of the monostable is given by the formula  $T = 1.1 \times R1 \times C1$ , which as all you budding mathematicians know (using the values of 100k and 10uF for R1 and C1 respectively) works out to be approximately 1 S. So every time the touch contacts are bridged the output (pin 5) of the monostable stays on (high) for about 1 S afterwards. The output is connected to the reset input (pin 10) of the second half of the chip, wired as an astable. The astable is prevented from oscillating when pin 10 is low and is allowed to oscillate when pin 10 is high. Thus, touching the contacts enables the astable to oscillate for about a second.

The timing components in the astable are set for a frequency of about 500 Hz.

## Construction

No problems with this project — just be careful to get the two tantalum capacitors and the IC in the right way round and you can't go wrong. The overlay shows the position of all components and interconnections so study it carefully. The touch controls can be any suitable pieces of conductive plate which may be at hand.

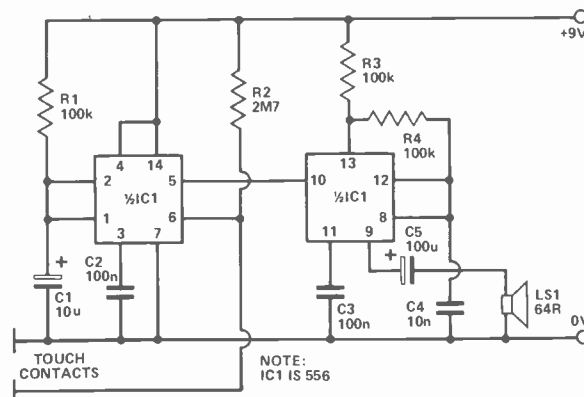
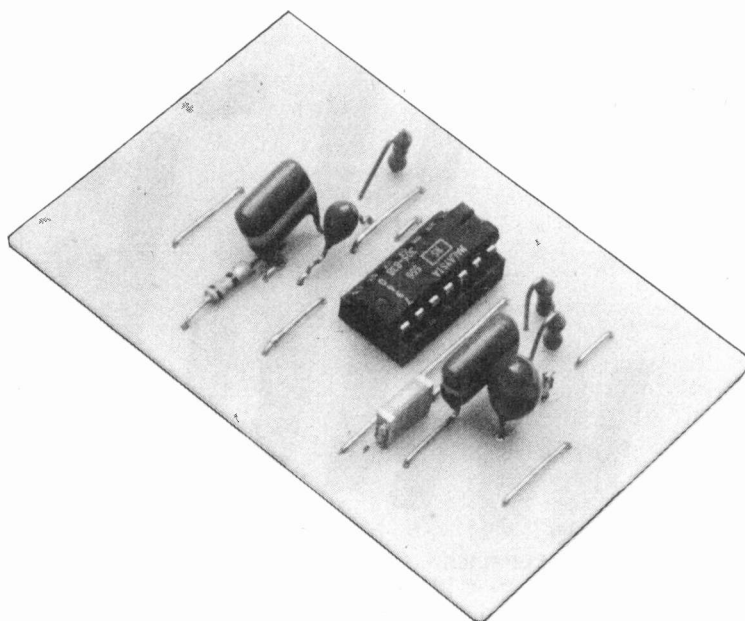


Fig 1. Circuit diagram.



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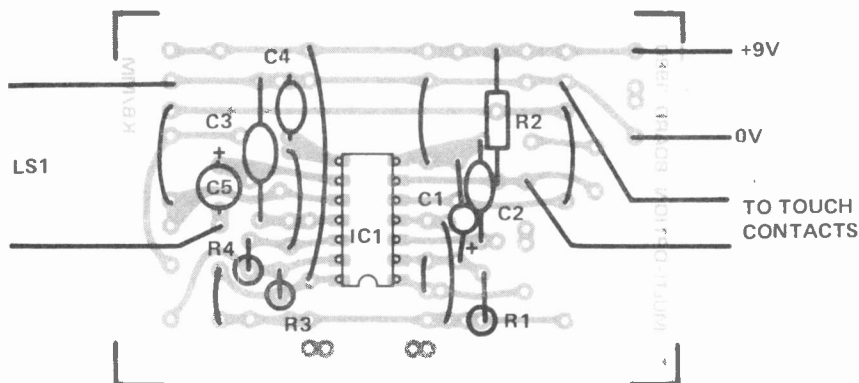


Fig 2. Component overlay. The touch contacts can be any available piece of conductor.

### PARTS LIST

Resistors All  $\frac{1}{4}$  W 5%

R1, 3, 4, 100k  
R2 2M7

Capacitors

C1 10u 10 V tantalum  
C2, 3 100n polyester  
C4 10n polycarbonate  
C5 100u 10 V tantalum

Semiconductors

IC1 556

Miscellaneous

LS1 64R miniature speaker  
ETI multi option board  
9 V battery and connector  
Touch contacts

### BUYLINES

All of the components used in this project should be available from the usual mail order companies who advertise in the magazine.

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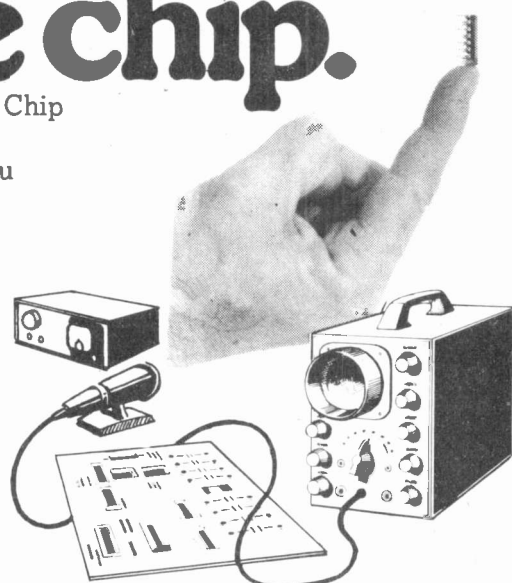
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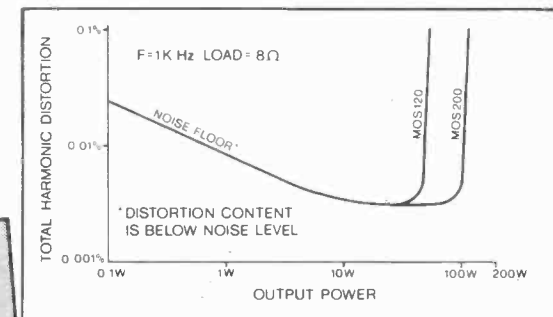
Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
MOS120	60W into 4-8 $\Omega$	0.005%	20V/ $\mu$ s	3 $\mu$ s	100dB	£25.88 + £3.88
MOS200	120W into 4-8 $\Omega$	0.005%	20V/ $\mu$ s	3 $\mu$ s	100dB	£33.46 + £5.02

### BIPOLAR

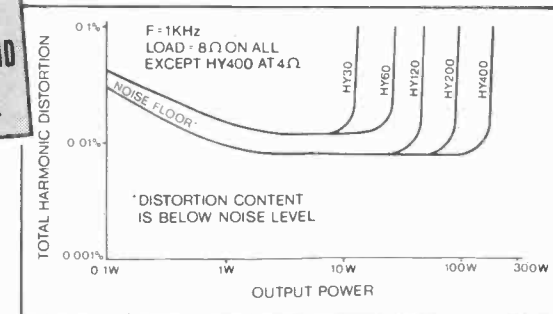
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Model	Output Power RMS	Distortion Typical at 1KHz	Slew Rate	Rise Time	Signal/Noise Ratio DIN AUDIO	Price & VAT
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HY60	30W into 4-8 $\Omega$	0.015%	15V/ $\mu$ s	5 $\mu$ s	100dB	£7.24 + £1.09
HY120	60W into 4-8 $\Omega$	0.01%	15V/ $\mu$ s	5 $\mu$ s	100dB	£15.20 + £2.28
HY200	120W into 4-8 $\Omega$	0.01%	15V/ $\mu$ s	5 $\mu$ s	100dB	£18.44 + £2.77
HY400	240W into 4 $\Omega$	0.01%	15V/ $\mu$ s	5 $\mu$ s	100dB	£27.68 + £4.15

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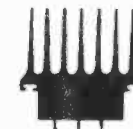
Load impedance both models 4 $\Omega$  -  $\infty$  Input sensitivity both models 500mV Input impedance both models 100K $\Omega$  Frequency response both models 15Hz-100KHz - 3dB



Load impedance all models 4 $\Omega$  -  $\infty$  Input impedance all models 100K $\Omega$  Input sensitivity all models 500mV Frequency response all models 15Hz-50KHz - 3dB

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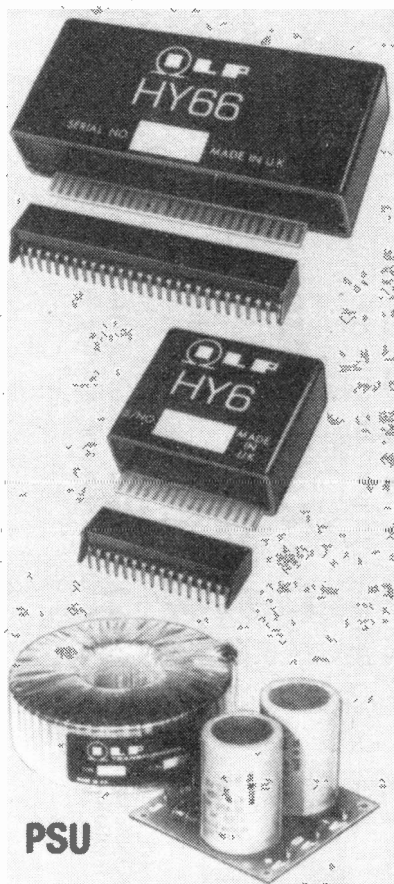


HY120



HY60





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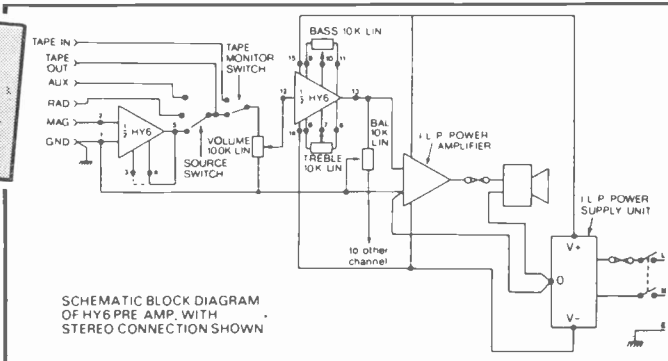
**HY6** mono £5.60 + 84p VAT Connectors included

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# ASTROLOGUE

The Farnborough Air Show opened its doors to the public again this year. Ian Graham reports on the Show with the latest news on the Space Shuttle.

The Space Shuttle was born in the heady days of the Apollo moon-landings, when America was the undisputed leader in the high-technology stakes. However, spaceflight gradually became 'ordinary', Press coverage waned, America's national pride took a couple of severe knocks and the world started downhill towards its worst post-war recession. These factors conspired to influence the Office of Management and Budget to cut the NASA Shuttle budget by thousands of dollars a year.

## Going, Going, Wrong...

The earliest failures were in the main engine. Because of underfunding, NASA departed from its usual practice of proving each component separately before it was integrated into the complete system. The Shuttle main engine was tested as a whole. Consequently, some minor failures were accompanied by major engine damage. The first flight back-up engine was recently shut down automatically ten seconds into a 100 S burn. A defect in the operation of the high pressure liquid oxygen turbopump started a fire, damaging the turbopump, the main engine controller and some oxygen piping.

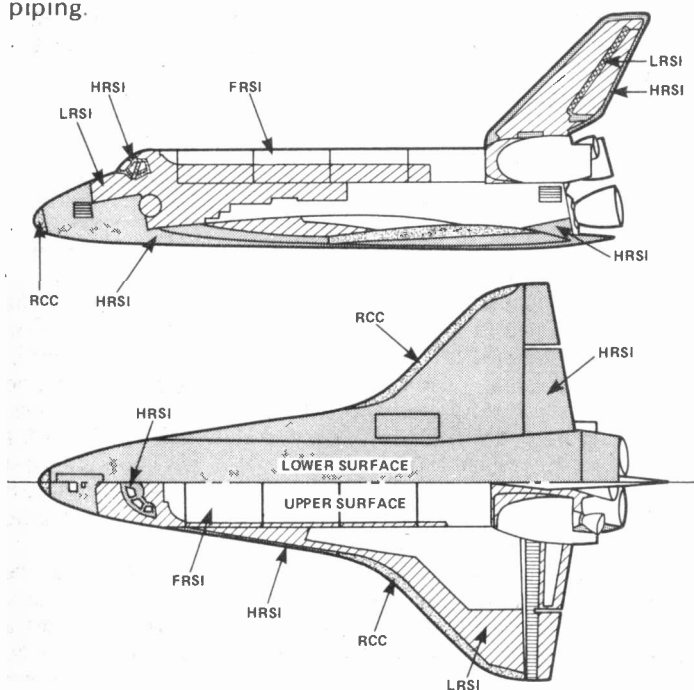
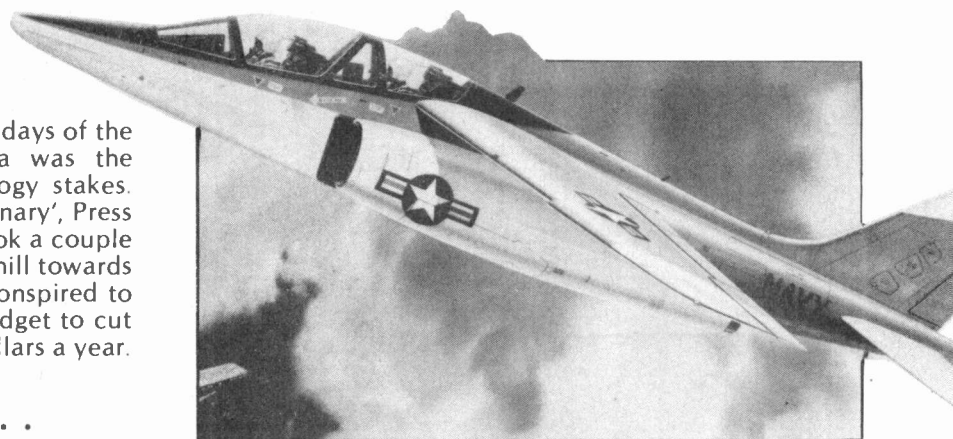


Fig. 1 The Space Shuttle's Thermal Protection System. RCC — reinforced carbon-carbon; HRSI — high temperature, reusable surface insulation; LRSI — low temperature, reusable surface insulation; FRSI — FRSI coated Nomex felt, reusable surface insulation.



An artist's impression of Lockheed's new Alpha Jet during its three week tour of American military bases. The aircraft is competing for selection as a new advanced training aircraft for the US Navy.

## Fact Or Fiction

The heat shield material used on Mercury, Gemini and Apollo was unsuitable for the Space Shuttle, because it could only be used once. On re-entry it slowly boiled off, dissipating the air friction heat. Heat conduction in the silicate developed for the Shuttle was almost zero. (You may remember the alarming photograph published at the time of a technician holding a tile at one corner while the centre glowed red hot).

The process of bonding the tiles to the Shuttle's aluminium skin was not researched as extensively as the tile thermal behaviour. Indeed, air friction alone was sufficient to strip some of the tiles off during a short flight on the back of its 747 carrier aircraft. Several thousand more may have to be removed, strengthened and replaced.

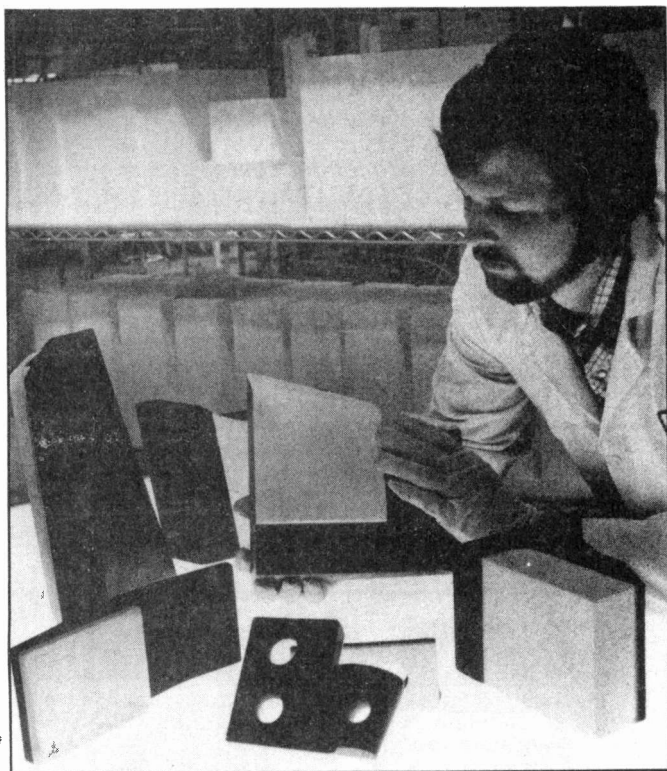
Unfortunately there wasn't a Space Shuttle at the Air Show, but there was a Press conference dealing with NASA's plans for the 1980s. Naturally, though, most interest was focused on the Space Shuttle.

The first launch is still expected by next March. Although we have become accustomed to taking revised launch dates with a pinch of salt, March 1981 *does* seem to be more definite than the others. Some of those involved in making preparation at the Cape are beginning to get 'launch fever'.

## The Retile Trade

November 23rd should see the completion of tile replacement work. I was given a rather distressing demonstration of the mechanical properties of the thermal tiles. A piece of tile material was held up and snapped between two fingers like a piece of polystyrene foam. The endurance of the tiles in service will determine when the Shuttle finally goes operational.





At the Lockheed plant in Sunnyvale, California, a technician examines some of the silica tiles manufactured for the Space Shuttle. As each tile is shaped to fit only one spot on the spacecraft, no two tiles are the same.

That is planned for the fifth flight in September 1982. However, if large numbers of the tiles have to be removed and replaced between flights, the operational date will have to be put back.

Shuttle flights are all booked up until 1986. Therefore, conventional Delta and Atlas-Centaur launchers will continue to fly until at least 1985.

The Shuttle's thermal protection is far from satisfactory. However, the production of the current series of Orbiters is so far advanced that no major hardware changes can now be implemented.

For equatorial flights, the Shuttle will be launched from Cape Canaveral. For polar flights, it will be launched from Vandenberg Air Base. The work necessary to prepare Vandenberg for the Shuttle should be finished in 1984.

## Outdoors

The highlight of the Show was the flying display. I was deafened and delighted by a cross-section of the world's civil and military aircraft. The Shorts Skyvan demonstrated its short (and I mean *short*) take-off and landing capability. Lulled into a false sense of security by the Canadair Challenger and Shorts displays, I was deafened by the Dassault military aircraft. An Alphajet, Mirages and a Falcon screamed around the airfield.

Five Westland helicopters approached the airfield from all angles. Each entertained the land-bound throng and 'parked' in the air in line with its predecessor. The line of aircraft hung in the air for a moment in silent salute and then made off. The British Army have ordered 100 Lynx helicopters. The Royal Navy have ordered 70 to replace Westland Wasps. Total Lynx orders are currently approaching 300.

Stars of the display were the American fighters — General Dynamics' F-16 and McDonnell Douglas' F-15A and F-18. The US Air Force plans to buy no less than 1400 F-16s. The 200th was delivered recently. More than 500 F-15A Eagles have also been delivered. Each has a maximum speed of more than Mach 2.5.

The US Navy needs 1377 F-18 Hornets. Each has a maximum speed in excess of Mach 1.8.

## Optica

The Optica, designed by John Edgley was, perhaps, the oddest participant in the Show. The Bug-eyed EA7 Optica made its first flight from Cranfield Institute of Technology last Summer. It is designed to be used as a three seat observation aircraft. The cabin is mounted in front of the engine, a 180 HP Lycoming IO-360, which drives a ducted propulsor instead of a conventional propeller. The floor area can be modified to carry vertical mounting cameras. It is claimed to be a quiet machine both inside and outside. From the ground, it was certainly one of the quietest craft in the display.

## Cosmic Traffic Jam

We've always thought of space as limitless. However, it is most useful to place a satellite in a geostationary (or geosynchronous) orbit about the equator. That is, the satellite appears to be stationary in the sky — it is orbiting as fast as the Earth is turning. That particular orbit is now becoming overcrowded. Looking towards the 1990s, NASA is carrying out research into new telecommunications techniques to allow fewer satellites to carry greater workloads. In future, tracking and data relay satellites will also replace some ground stations.

NASA may co-operate with the European Space Agency (ESA) to fly a satellite to Halley's comet. ESA is committed to sending the satellite and has offered NASA experimental space on-board. NASA may provide the launcher.

## Indoors

NASA, ESA, satellites...in fact spaceflight in general constituted a very small part of the Show. The two spacious exhibition halls were packed with just about everything with anything to do with aviation and avionics. The main feature of Plessey's stand in the North Hall was a new, fully-equipped production version of a Transportable Air Defence Processing and Control Cabin. It houses the signal processing equipment and displays for the Plessey AR3D Long Range Radar system. The Radar and P & C Cabin provide ground forces with a mobile, autonomous radar command and control post capability. The post can automatically track 40 aircraft and carry out eight interceptions. The AR3D's electronic countermeasures can also be selected.

Ferranti announced the development of a miniature inertial navigation system (FIN2000) for use in military aircraft. Positional data is presented to the pilot on a control and display unit and is typically accurate to within 1 nm/hr of operation. The modular system features extensive built-in test and self-calibration facilities for easy maintenance and enhanced reliability. Pre-production models will shortly begin flight trials at the Royal Aircraft Establishment.

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Picturesque moving display of every note played. One touch melody demonstration. Built-in speaker. Backlight. 2 year battery. Mineral glass. Water resistant case.

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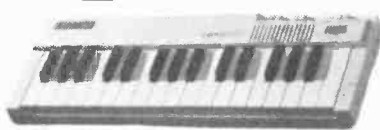


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JET 018 (Equivalent to HV011)

JET 028 (Equivalent to HV005)

JET 994 Gold plated, champagne dial

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### DFT 048

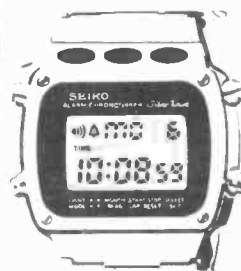
ALARM CHRONOGRAPH

Countdown timer.

Hours, minutes, seconds, alpha day and date. 24 hour alarm and hourly time signal. Stopwatch times in units of 1/100 second to 12 hours, net, lap and 1st & 2nd place.

Countdown alarm timer up to 1 hour. Backlight. Stainless steel. Hardlex glass. Water resistant.

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### DER 048

ALARM CHRONOGRAPH

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Countdown alarm

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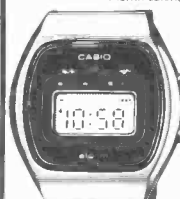
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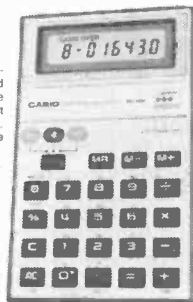
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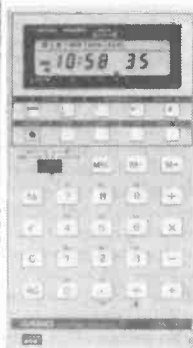
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Very similar to A250 but with dual time facility in lieu of alarms and chimes. Countdown timer with repeat function. 7 YEAR BATTERY

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A250

### F-300 Sports chronograph

Hours, minutes, seconds, am/pm, day and date. 4 year calendar (28 days for Feb.) Stopwatch measures in 1/100 second to 12 hours, net, lap, and 1st & 2nd place times. 2 year lithium battery. Resin case/straps. S/S trim. Mineral glass. Water res.

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### 110QS-37B

As F-300 but chrome plated case. S/S bracelet.

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### F-80E Alarm chronograph



Hours, minutes, seconds, date am/pm, or hours, minutes, alpha day, date, am/pm. 24 hour alarm, hourly chimes. Stopwatch from 1/10 second to 12 hours, net, lap and 1st & 2nd place. Nightlight. Resin case/strap. Mineral glass. Water resistant. 3 YEAR BATTERY

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# METRONOME

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We couldn't design five projects for our free Multi-Option Board without one based on the versatile 555. Circuit design by Keith Brindley

The 555 is such an adaptable integrated circuit that no home can afford to be without at least one. As a timer IC it does its job magnificently, working in a variety of monostable and astable multivibrator modes with just a handful of additional passive components, and its timing period is adjustable from literally just a fraction of a fraction of a second through to hours, simply by selection of one resistor and one capacitor.

## Metro Gnome

Our chosen design using the 555 is a metronome. Before the advent of relatively cheap solid-state electronic components such devices were clockwork. Because of this they had a tendency to start off at a high speed and as the spring slowly wound down they got slower and slower. A completely electronic metronome does not suffer from this problem and yet can be far cheaper than a clockwork counterpart.

The circuit is simply an astable multivibrator. Increasing either the resistors or the capacitor values, or both, the timing period can be lengthened, decreasing the frequency and vice versa.

## Applications

At audio frequencies, ie 30 Hz to 16 kHz, the 64R loudspeaker is an adequate transducer, but outside this range other transducers can be utilised to suit. For instance, if the frequency of the astable is increased to 40 kHz by choosing suitable component values and the loudspeaker replaced by an ultrasonic transducer, then the circuit can be converted into an ultrasonic transmitter. It couldn't be simpler.

## Combinations

You could use the astable as a clock generator for digital circuits, or you could combine this circuit with that of the 2 W Power Amplifier to make a loud siren. The choice is yours.

## Construction

None of the components are at all critical and if you can't obtain exactly the right component value, don't worry. Anything remotely close to the specified values will get your device off the ground and operational.

If your capacitor value is too high, simply use a lower value resistor combination and vice versa. Six links are required to complete the circuit, then you can connect your battery and go.

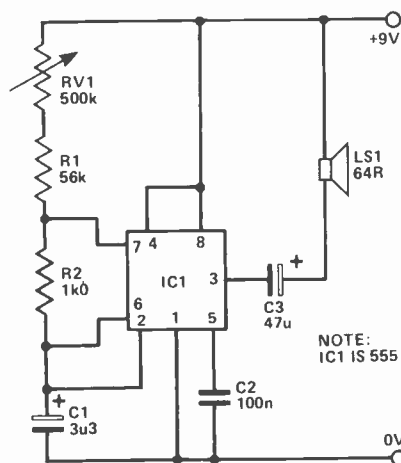


Fig.1. Full circuit diagram of the Multi-option Metronome.

## HOW IT WORKS

The circuit is a standard 555 astable multivibrator which means that the device operates in a free run oscillating mode and the output from pin 3 is constantly switching between 0 V and 9 V at a rate determined by the components in the circuit. This switching output is coupled to the loudspeaker via C3.

The multivibrator mark/space ratio is deliberately kept uneven to provide short, sharp pulses to the loudspeaker, instead of the more usual square-wave normally associated with an astable. This, of course, produces a more pronounced click from the speaker to duplicate the tick of the metronome.

The mark/space ratio is adjusted by changing the values of RV1 and R1 along with R2. Capacitor C1 charges up toward supply voltage through RV1, R1 and R2 and the output of the 555 is low for this period. When the voltage at pin 6 (ie the voltage across this capacitor) reaches approximately two-thirds supply an internal switch operates, sending the output high. In going high, the output takes pin 7 to 0 V internally, which discharges the capacitor through R2 only. When the capacitor voltage falls to about one-third supply, the internal switch changes state again to take the output low. This action repeats itself ad infinitum.

From this you can see how different mark/space ratios are possible — the charge rate (off time) must be greater than the discharge rate (on time) by the ratio:—

$$\frac{RV1 + R1 + R2}{R2} \\ \text{For example, with RV1 in minimum position the ratio is:} \\ \frac{56k + 1k0}{1k0} = 57:1$$

In other words the off time is 57 times as long as the on time.



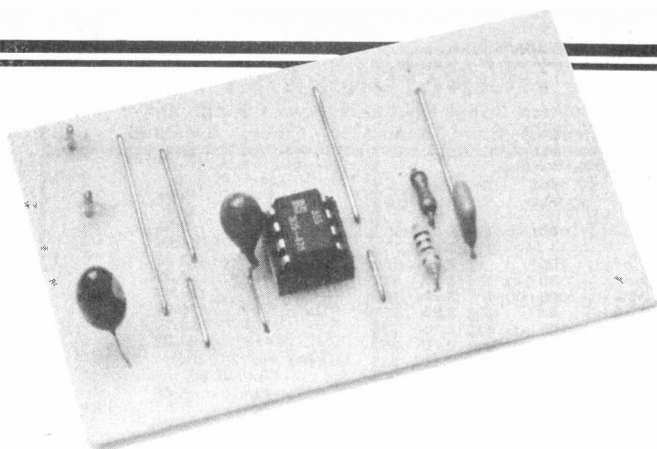
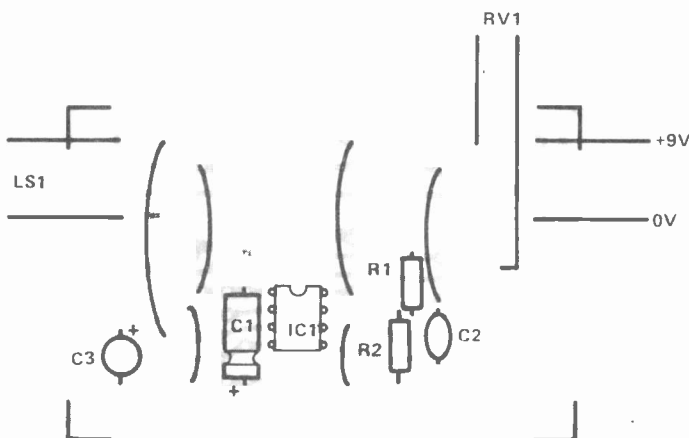


Fig.2. Component overlay for the Metronome. For once you'll have to ignore the unused locations on the PCB.



## BUYLINES

The ETI Multi-Option Board Metronome uses standard components, readily available from suppliers advertising in this issue.

## PARTS LIST

<b>Resistors All ¼ W, 5%</b>	
R1	56k
R2	1k0
<b>Potentiometers</b>	
RV1	500k linear
<b>Capacitors</b>	
C1	3u3 10 V electrolytic
C2	100n ceramic
C3	47u 10 V tantalum
<b>Semiconductors</b>	
IC1	555
<b>Miscellaneous</b>	
ETI Multi-Option Board	
64R speaker	

ETI

## QUESTION?

1. Is your hobby home computing or electronics?
2. Do you understand the application of IC's, Transistors, Diodes, etc?
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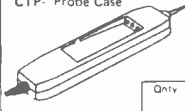
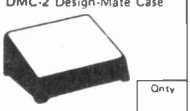
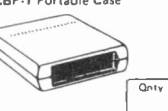

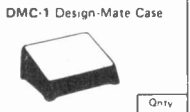
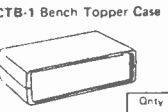
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8	4	108	7.40	1.15
10	5	72	8.20	1.15
12	6	116	8.80	1.15
16	8	17	10.80	1.25
20	10	115	13.80	1.45
30	15	187	16.80	1.45
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Sec: 0-12-15-20-24-30V

Amps	Ref. No.	Price £	P&P
0.5	112	2.80	.85
1.0	79	3.55	.85
2.0	3	5.55	1.00
3.0	20	6.25	1.15
4.0	21	6.55	1.15
5.0	51	9.55	1.15
6.0	117	11.05	1.15
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6.0	107	15.05	1.45
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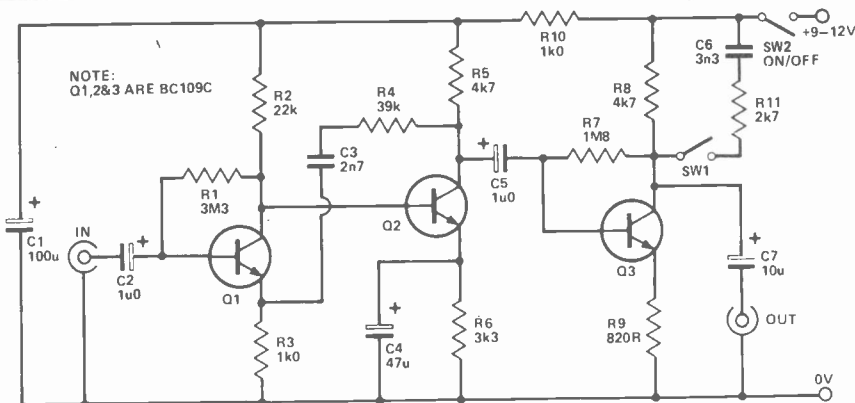
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# SPOT DESIGNS



## Cassette Preamplifier

Used in conjunction with one of the cassette mechanisms currently available on the surplus market (or a mechanism removed from an old recorder or player) this preamplifier circuit makes an inexpensive but useful cassette player for use with a hi-fi system. The circuit is for a mono player, but for a stereo unit it is, of course, merely necessary to make one preamplifier for each channel.

The output signal level from a cassette tape head is typically about 500 uV or so at middle audio frequencies for a mono head and only about half this level for a stereo type. The preamplifier must, therefore, provide a considerable amount of voltage gain in order to match this to a hi-fi amplifier, since these require a signal level of about 1,000 times higher than this. It is also necessary for the preamplifier to provide equalisation, because the output from a tape head rises with frequency at a rate of 6 dB per octave. However, at higher audio frequencies tape heads are not very efficient and require a much lesser degree of roll off.

Q1 and Q2 are used in a conventional two stage, direct coupled, common emitter amplifier and the frequency-selective negative feedback through C3 and R4 provides the appropriate equalisation.

These also set the midband voltage gain of the input stages at about 46 dB (200 times). With such a low input signal level it is obviously necessary to use low noise transistors (such as the BC109C) in order to obtain good results. Running Q1 at a low collector current of about 200 uA also helps to give a low noise level.

Q3 is used as a low gain common emitter stage, which provides the additional amplification needed to give a suitably high output level. R9 introduces negative feedback, which controls the voltage gain of Q1 and the specified value gives a gain of about 14 dB (five times). For a stereo unit R9 should be reduced to 390R in order to give increased gain to compensate for the lower output of a stereo tape head.

When playing a Dolby B encoded cassette SW1 can be closed. This gives a small degree of treble cut which provides a reasonably flat overall response, with a small excess of treble at low signal levels and a slight deficit at the highest levels. A useful level of noise reduction is obtained, although only about half that provided by a proper decoder.

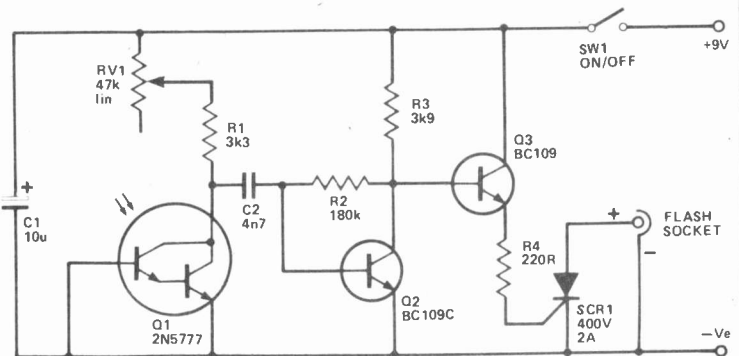
The circuit is capable of excellent results and the output quality is largely dependent on the quality of the tape head, the tape used in the cassette and so on.

## Flash Slave Unit

The photocell used in this circuit is a photo-Darlington transistor. This gives a fairly fast operating speed and high sensitivity. In fact the sensitivity is rather too high, making it likely that the cell would saturate in only moderately light conditions. Its base terminal is, therefore, connected to the negative supply rail to give a suitable reduction in sensitivity. R1 and RV1 form the collector load resistance for photocell Q1 and RV1 acts as a sensitivity control. With RV1 at a low resistance, the increase in the current passed by Q1 when it picks up the pulse of light from the primary flashgun will produce a fairly small voltage spike across the load resistance. With RV1 set at a high resistance, a similar current pulse would produce a much larger voltage spike across the load and high sensitivity is obtained.

One problem with equipment of this type is that under bright conditions the photocell can saturate, preventing the circuit from functioning. When used indoors, saturation is unlikely to occur even with RV1 set for maximum sensitivity. The sensitivity of the unit should be so high that it will trigger reliably even if the primary flashgun and Q1 are aimed in opposite directions. When used outside in bright conditions it would be advisable to back off RV1 and the aim of Q1 and the flashgun will inevitably be more critical (there will probably be less reflected light to trigger the unit in addition to the reduction in sensitivity).

C2 couples the output from Q1's collector to the input of a common emitter amplifier using Q2. This is biased by R2 so that there is a quiescent collector voltage of only about 1 V. Q3 is an emitter



follower buffer stage which is used to drive the gate of SCR1 from Q2's collector. The quiescent voltage at Q3's emitter is insufficient to activate the thyristor, but when Q2 receives the negative voltage spike from Q1 it switches off and the emitter potential of Q3 rises to a high enough level to trigger SCR1 and fire the second flashgun. R4 is a current limiting resistor which prevents Q3 from passing an excessive current.

The current consumption of the circuit is about 2 mA. Note that the flash lead must be connected to SCR1 with the correct polarity or the unit will not operate.



## AF Signal Generator

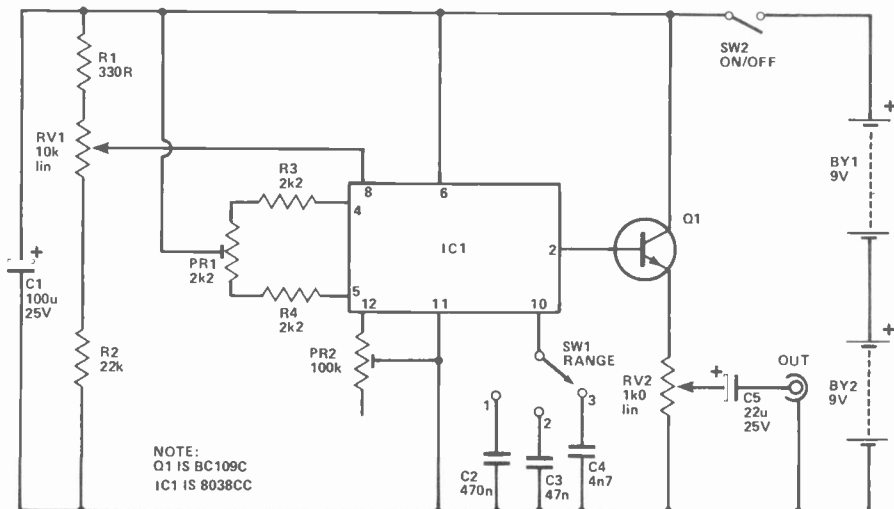
Although the 8038CC is not capable of generating an extremely pure sine wave, it is capable of producing an output of high enough quality for general audio testing. The simple circuit shown here covers the audio frequency spectrum in three ranges — less than 20 Hz to more than 200 Hz; less than 200 Hz to more than 2 kHz; less than 2 kHz to more than 20 kHz. The output amplitude is continuously variable up to a maximum of about 550 mV RMS and is from a low impedance source.

The 8038CC oscillates by first charging a capacitor via a constant current source and then discharging it through another constant current generator. It thus generates a triangular waveform. This is then fed to a trigger circuit to generate a squarewave signal and to a

non-linear amplifier which "rounds off" the signal to give a sine wave output of reasonable purity. C2 to C4 give the three ranges. R1, RV1 and R2 form a potential divider circuit, which is used to control the charge and discharge currents of the timing capacitor. RV1 thus acts as the fine frequency control. PR1, R3, R4 balance the charge and discharge currents, so that a symmetrical output is obtained. PR2 is part of the sine wave shaping circuitry and is adjusted for maximum purity.

The sine wave output at pin 2 of IC1 is at a high impedance and is, therefore, coupled to the output via an emitter follower buffer stage using Q1. RV2 is the output level control, and C2 provides DC blocking at the output. Current consumption is approximately 9 mA.

With the unit adjusted for a fairly low frequency output (about 50-200 Hz), it should be possible to hear the main fundamental frequency plus the higher frequency harmonic signals. The output can be monitored using a crystal earphone or amplifier/loudspeaker. PR1, 2 are adjusted to minimise the harmonics.



## Waa-Waa Unit

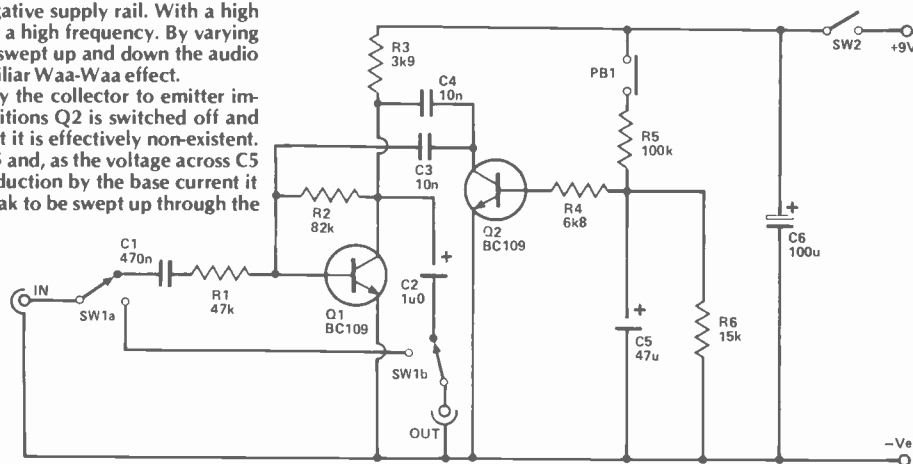
An unusual feature of this circuit is that the Waa-Waa effect is obtained by operating a foot-switch, rather than the more usual method of operating a potentiometer via a pedal mechanism. This method is slightly less versatile than a proper Waa-Waa pedal, but is far simpler for the home constructor to build since it avoids the need for any pedal mechanics.

The basic Waa-Waa circuit uses a quite conventional arrangement based on common emitter amplifier, Q1. Frequency selective negative feedback is provided by C3, 4. These provide little feedback at a certain frequency. A peak in the response of the amplifier is produced at this frequency, as the lack of feedback enables virtually the full voltage gain of Q1 to be realised. The actual frequency at which the peak is produced can be controlled by means of a resistance between the junction of C3, 4 and the negative supply rail. With a high resistance here the peak is produced at a high frequency. By varying the control resistance the peak can be swept up and down the audio frequency spectrum, producing the familiar Waa-Waa effect.

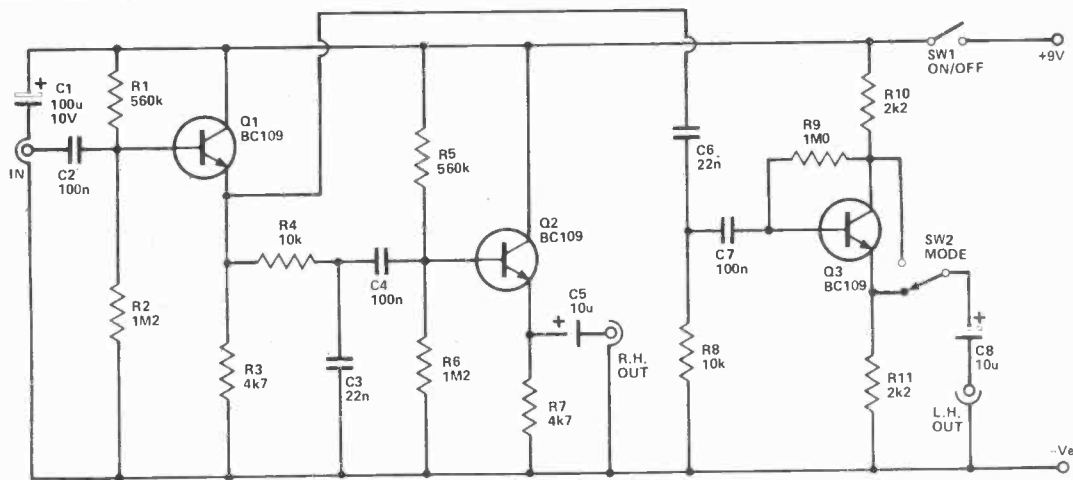
The control resistance is formed by the collector to emitter impedance of Q2. Under quiescent conditions Q2 is switched off and the peak is at such a low frequency that it is effectively non-existent. If PB1 is operated, C5 charges up via R5 and, as the voltage across C5 increases, Q2 is biased harder into conduction by the base current it receives through R4. This causes the peak to be swept up through the

audio band until C5 becomes fully charged. If PB1 is then released, C5 gradually discharges through R4, Q2 and R6, causing the bias on Q2 to decrease and the peak to be swept down the audio spectrum. Thus the required effect is produced by closing and opening PB1. The Waa-Waa frequency is partially controlled by the frequency at which PB1 is operated, but C5 restricts the range of frequencies that can be obtained in practice. However, the value of C5 can be altered to suit individual requirements, or several switched components of different values could be used.

SW1 enables the Waa-Waa circuit to be quickly and easily bypassed. R1 is needed to reduce the gain of the unit which would otherwise be excessive. Current consumption is about 2 mA.







## Stereo Synthesiser

There are two common methods of producing a pseudo stereo effect from a mono signal; playing the mono signal from the two speakers in antiphase and the use of frequency selective techniques, which normally consists of directing lower frequency signals into one channel and higher frequency signals into the other. This circuit uses the second technique, but can additionally give antiphase signals which can give a better effect, especially when using headphones.

Q1 is used as an emitter follower buffer stage which ensures that the two filter networks fed from its output are driven from a low impedance source. If these were driven direct from the input, it is quite possible that they would be fed from a source impedance of a few kilohms or more, which would be quite sufficient to alter their effective characteristics.

The two filters are formed by R4 and C3 (low pass), and C6 plus R8 (high pass). A high roll off rate is by no means essential in this application and the 6 dB per octave attenuation rate of simple RC filters such as these is perfectly adequate. The -3 dB point of each filter is at approximately 800 Hz and the combined output of the

filters, therefore, gives a virtually flat response with no significant peaks or troughs.

Q2 is connected as an emitter follower buffer stage and this ensures that there is minimal loading on the low pass filter. Q3 similarly ensures that there is minimal loading on the high pass filter, but this device is used as a phase splitter. With SW2 switched to take the output from Q3's emitter, Q3 effectively operates as an emitter follower and gives no phase inversion. With SW2 switched to take the output from Q3's collector, Q3 then effectively acts as a common emitter stage with 100% negative feedback (and unit voltage gain) due to R11. It also provides a 180° phase shift so that the two output signals are in anti-phase. An in-phase relationship is needed to give a good central stereo image and the use of anti-phase signals tends to give an impression of increased channel separation.

In a stereo orchestral recording it is normal for the violins to come from the left hand channel, with the cellos and basses from the right hand channel. Therefore, the high frequency signals are fed to the left channel and the low frequency signals are fed to the right channel so that the unit provides a similar effect (although it will obviously function properly with the outputs connected either way).

The current consumption of the circuit is about 3 mA.

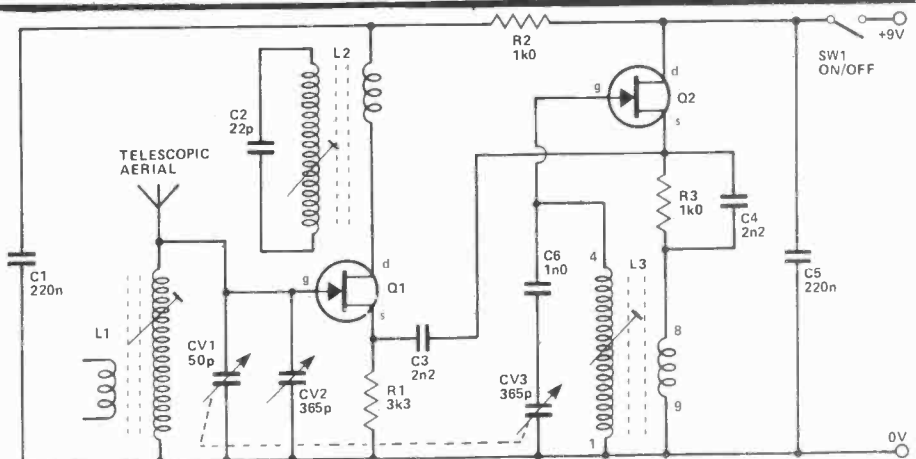


NOTE:  
Q1 & 2 ARE BF244B  
T1 IS DENCO D.P. BLUE AERIAL COIL, RANGE 4  
T2 IS DENCO MW5FR FERRITE AERIAL  
T3 IS DENCO WHITE OSC COIL, RANGE 4

## Short Wave Converter

This SW converter tunes over 5 to 15 MHz approximately and also enables an ordinary MW broadcast receiver to pick up stations operating on the 19, 25, 31, 41 and 49 m broadcast bands.

Signals picked up by the telescopic aerial are directly coupled into the aerial tuned circuit as these signals will be quite weak, necessitating a tight coupling. CV2 is the main tuning capacitor for the aerial tuned circuit and CV1 is the aerial trimmer control. The signals selected by the tuned circuit are coupled directly into the gate of mixer transistor Q1, no coupling winding being needed here due to the use of a JFET transistor with a very high input impedance. The drain load for Q1 is a MW ferrite aerial, but it is used in reverse in this application and is used to radiate the 1.6 MHz IF output of the converter. This is picked up by the MW radio, which is placed near



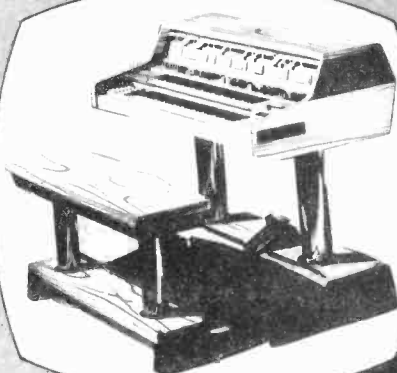
the converter and tuned to a quiet spot on the band in the vicinity of 1.6 MHz. The position of the coil on the ferrite aerial is adjusted to resonate L2 at the appropriate frequency and effect optimum signal transfer.

The oscillator uses JFET device Q2 in the source follower mode, with positive feedback provided by L3. At the resonant frequency of L3 there is sufficient feedback to cause oscillation and CV3 tunes the oscillator over a frequency range which is 1.6 MHz higher than the range of the aerial tuned circuit so that the required difference frequency of 1.6 MHz is produced at the output. C6 is a padder capacitor which gives reasonably good tracking between the aerial and oscillator circuits. Perfect tracking is not required since CV1 can be used to keep the unit peaked for optimum results. C3 is used to couple the output from the oscillator to the input of the mixer stage. The circuit has a current consumption of only 4 mA.



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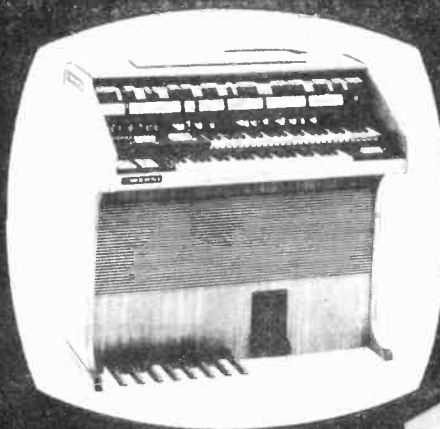
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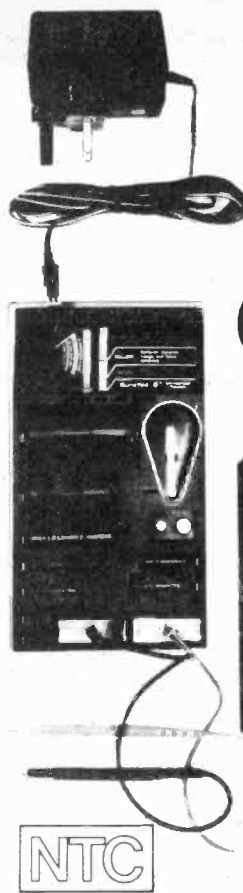
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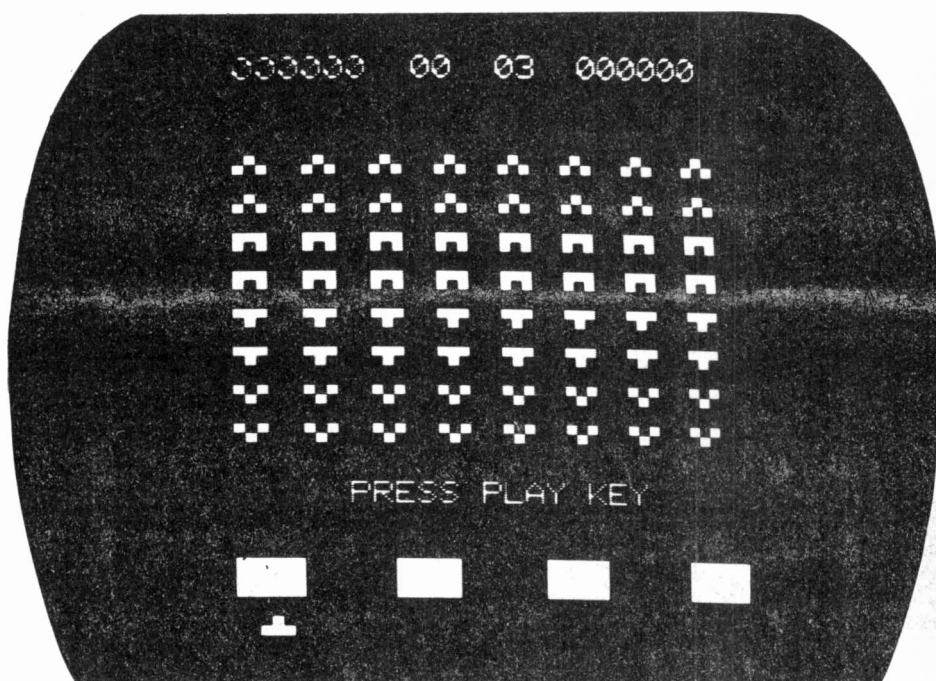
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# SPACE INVASION GAME

You've heard of the beer you drink at home — now ETI is doing its bit to clear the pubs with the Space Invasion game you play at home. Will the social life of England ever be the same?



Hardware design by Paul Johnson. Software by Mike Rose.

One of the fastest growth industries of the last few years must be the production of video games. Only a couple of years ago we were pushing our five pence coins into the slot to play what was laughingly known as tennis (two oblong 'bats' and a blob that bounced all over the screen). Nowadays we can pilot starcruisers into the uncharted depths of space and zap the enemy with laser bolts, launch rescue missions to the Moon, and engage in dogfights with agile aliens who can fly rings round a cathode ray tube. Of course it costs more than fivepence too! Video games have probably led the field in showing the public that the microprocessor is capable of better things than frightening Clive Jenkins.

Life would be a lot better if you didn't have to keep feeding the coin slot to stay in practice, though, and as usual ETI comes to the rescue. Yes, for the first time anywhere we present a home-built version of the country's most popular pastime (all right, second most popular). Before you glance across to Buylines and decide we've got peculiar ideas about how to save you money, it should be pointed out that you get more than just a TV game. A TV game requires a microprocessor, some memory, a graphics generator, a keypad and a UHF output suitable for plugging into your television set. Amazingly enough these are also what you need for a home computer. Once you have the basic Space Invasion game, you can expand it at very little expense into just such a computer, designed by Tangerine Computer Systems.

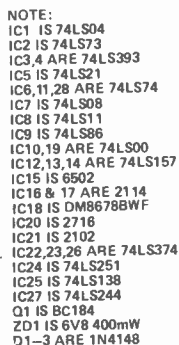
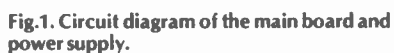
## Playing the Game

The game follows a fairly standard format. Eight columns of eight saucers fly backwards and forwards across the TV screen and slowly descend while you take potshots at them from your laser base at the bottom of the screen. The base may be moved to left and right to aim at the enemy and to dodge the bombs they are dropping on you. If they hit you, your base is destroyed, but there are defences for you to hide under — these are gradually whittled away by the alien barrage. (Your laser bolts can cancel bombs as they fall.) Everything gets faster as the number of aliens decreases, and when they've all been wiped out, lo! another fleet appears.

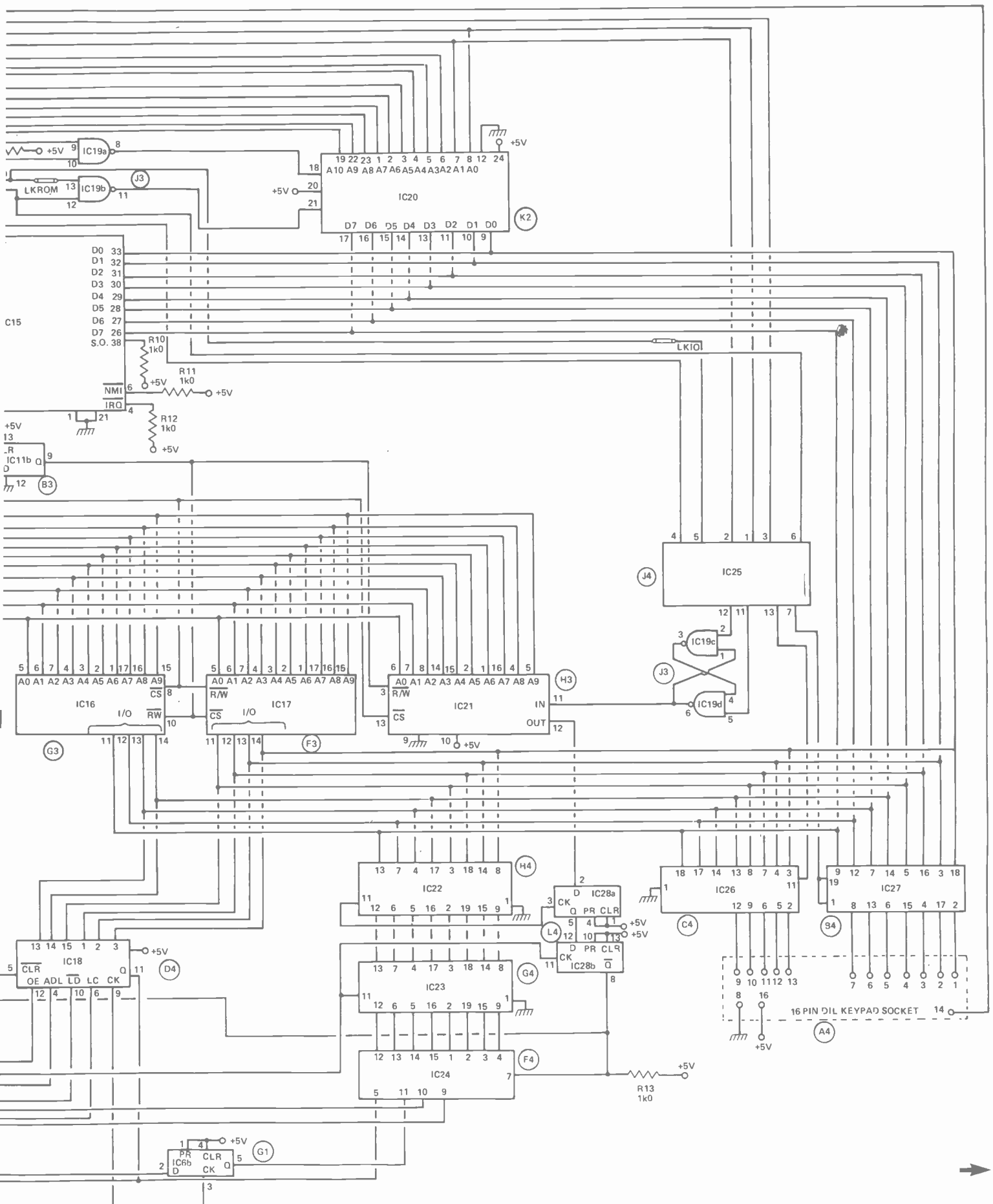
Scoring is as follows: Top two rows — 50; Next two — 40; Next two — 30; Bottom two — 20. Every time you blast a saucer, its score is added to your total. Occasionally a huge saucer flies across the top of the screen; it doesn't drop bombs and hitting it scores 100 points. There are four numbers displayed at the top of the screen, and from left to right they are: score this game, number of saucers left on screen, number of bases you have left and highest score during this session. You start off with three bases and are awarded an extra one for every two thousand points, but you can't have more than four at once.

The switches are provided to select one of four levels of difficulty — these are set to either 0 V or 5 V and provide a binary input, 00 for easiest level (slow) and 11 for expert (very fast).

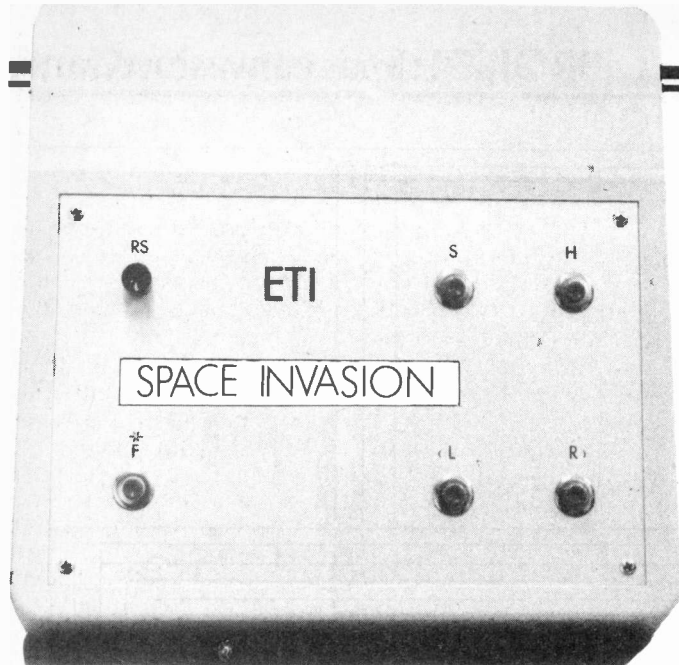












The face of the Space Invasion. The simple controls are reset, start (play), hold, fire, left and right.

## HOW IT WORKS

Although the circuit diagram looks hideously complex, it falls quite naturally into various basic blocks which can be examined separately. The heart of the system is IC15, a 6502 micro-processor. This can be seen at top centre of the circuit, surrounded by its memory and address decoding chips. Below these are the chips that generate the graphics for the display. The I/O port for connecting the main board to the keyboard and sound generator circuitry is on the right. Finally, the entire section on the left produces the timing signals required by the microprocessor, as well as all the synchronising signals which must be mixed with the video information before it is passed to the UHF modulator.

The master oscillator is formed by three of the inverters in IC1; the frequency of operation is set at 6 MHz by crystal X1. IC2, IC3 and IC4 form the complete counter chain for generating all the timing signals and refresh addresses — the various additional gates and flip-flops decode the counter outputs to provide these signals as follows.

IC3 is reset by the output of IC7a; this controls its count length. Three of the outputs of IC3 are decoded by IC8a and IC9a to produce the line sync pulse, which also clocks the line counter IC4. The line blanking pulse is produced at pin 6 of IC11a. The count length for IC4 is controlled by the reset pulse derived from IC10a, and IC10b produces the frame sync pulse. The frame blanking pulse is produced at pin 8 of IC2b. The frame sync and line sync pulses are mixed in IC7c; the frame blanking and line blanking pulses are mixed in IC8c with the video information from the character generator circuitry.

The timing signals for loading the character generator IC18 are produced by IC5 and IC6.

The line blanked and frame blanked video is mixed with the sync pulses by diode 'OR' gate D2. D3, R5, R6 and R7 ensure that the various parts of the composite signal have the correct relative amplitudes before being fed to the input of the UHF modulator. The modulator requires a supply voltage higher than the 5 V that powers the other circuitry — this is derived from chopper transistor Q1 which is driven by one of the outputs of counter IC3. D1, ZD1 and C5 regulate the voltage from Q1 collector to 6V8.

IC12, IC13 and IC14 form the address and control signal selector for the memory. This switches over at the processor clock rate and allows both screen refresh and microprocessor access to occur at full speed without mutual interference. IC20 is the ROM chip; the RAM is provided by IC16, IC17, and IC21. The data output of the RAM is processed by IC22, IC23 and IC24 to produce the graphic pixel cells. IC28 selects either graphics or alphanumeric mode for a particular character cell position.

IC26 and IC27 provide the I/O port to read the paddle switches and drive the sound generator.

A unique feature of this game is the provision of a hold switch. If you want to go to the loo, or answer the phone, you can freeze the action in the middle of the game and carry on where you left off when you get back.

## Objects and Computers

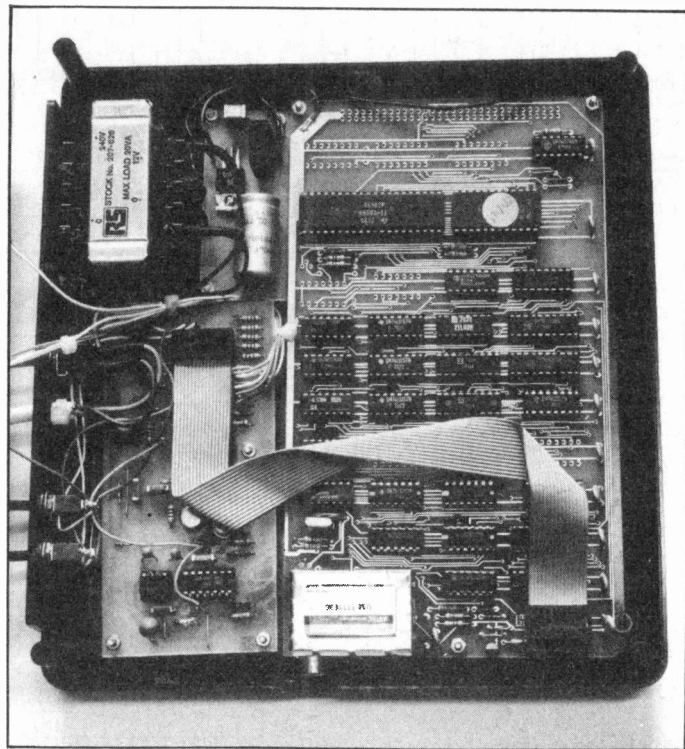
The object of the game is to score 999,999 points! If you manage it a suitable message appears on the screen but we're not going to tell you what it is — play the game and find out for yourself, if you can. You lose if:

- 1) You lose all your bases before reaching 999,999;
- 2) An invader touches your laser base;
- 3) An invader lands on the baseline.

If you already own a Microtan 65 computer than it isn't necessary to build all the hardware for this project — you simply run the Space Invasion software on your existing machine. Sound effects are optional and require the additional circuitry shown in the diagram. The special hardware may be added by connection to the cable socket. All the possible configurations for getting Invasion onto your TV screen are given below.

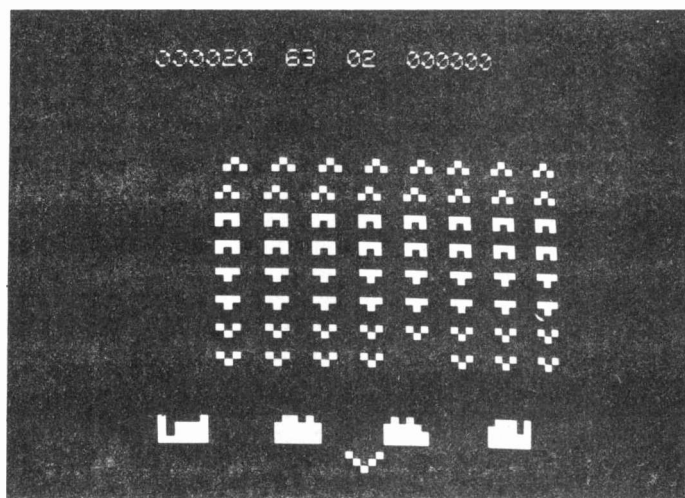
- 1) Invasion PCB + Hex keypad + Invasion PROM
- 2) Invasion PCB + special Key Unit + Invasion PROM
- 3) Microtan 65 + Tanex + Invasion PROM (in position E2) + Hex keypad
- 4) Microtan 65 + Tanex + Invasion PROM + special Key Unit
- 5) Microtan 65 + Tanex + 2K RAM + keyed-in software + Hex keypad
- 6) Microtan 65 + Tanex + 2K RAM + keyed-in software + Key Unit.

Note the use of a Hex keypad — this project will *not* run with an ASCII keyboard.



Inside the box, the main board is fitted into the right hand side, connected to the sound effects board on the left by ribbon cable. The power supply board is squeezed in next to the transformer. The two switches on the rear panel select the level of difficulty.





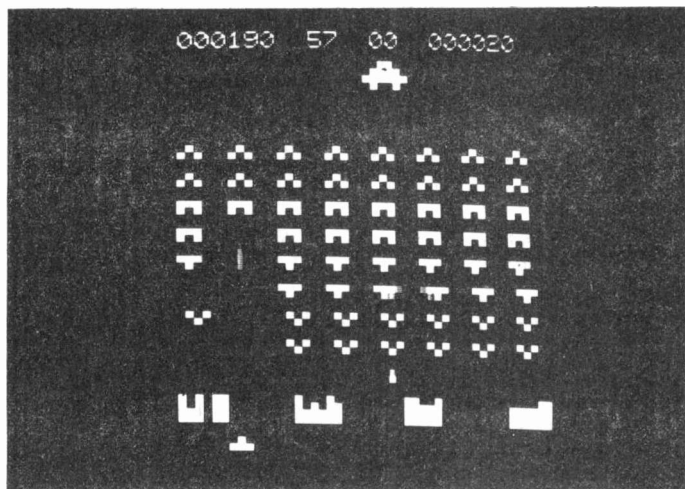
The screen display. This unfortunate space traveller has just been zapped by an alien.

## Construction

Tricky bit first. The main board is double-sided but it isn't necessary to solder components on both sides because the holes are plated through (sighs of relief). Fit the links and the discrete components first, being careful with the polarity where necessary, then solder all the IC sockets in the positions shown in the overlay diagram. You'll find there are more spaces for sockets than there are sockets but don't panic — this is to allow for later expansion into a computer as mentioned earlier. The UHF modulator is fixed to the PCB by soldering the case tags to the large pads provided — make sure it's the right way round. Now, double-checking both device type and orientation very carefully, plug the ICs into their sockets. Fit two lengths of wire for the power supply connections (these solder directly to the copper track) and the main board is complete. Check it again.

Well, there's still a long way to go. We have a score of 480 with 49 aliens still coming and no bases left. But we did better than the last astrogamester. He only scored 20.

With a flying saucer zooming across the top of the screen, one alien has just launched a missile. Hit your left or right button quick! Or try to blow his (its) missile off the screen.



## Operating Differences

The UHF modulator for either version of the game is pre-tuned to Channel 36. Plug into the aerial socket, select a channel and adjust the tuning until the picture appears. If the game has been switched on without 'Reset' being operated, the screen will contain garbage.

If you are using the basic Invasion PCB, then operating the Reset switch brings the system into the 'ready-to-play' condition. If you are running the software on the Microtan 65, use Reset to gain access to TANBUG. The PROM is assembled to live at E800 (Hex), and the listing for the RAM version is assembled to live at 400 (Hex). So for the PROM version, typing GE800 brings the game to readiness by moving to the start address. With the software keyed into RAM, type G400.

If you are using the Hex keypad, the following keys are equivalent:

0 = PLAY

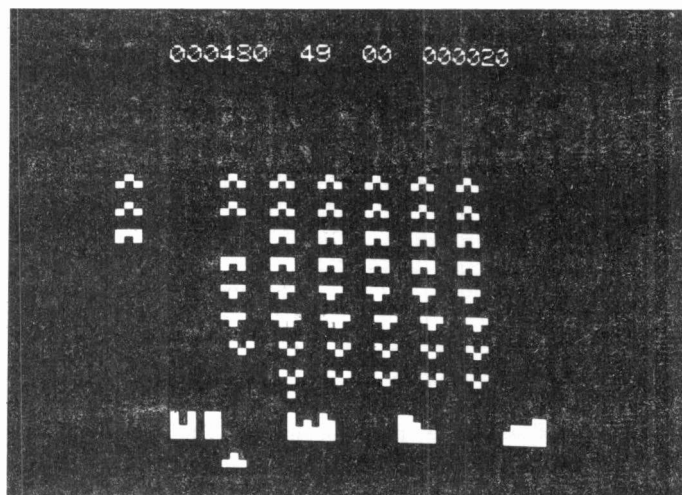
4 = BASE RIGHT

8 = BASE LEFT

C = FIRE

SHIFT = HOLD

Hitting any of the keys except HOLD removes hold.



Now you can sit in front of your telly and make your living room a safe haven for the human race. For details of the modifications to produce a home computer, watch this space!

## BUYLINES

Tangerine Computers Ltd can supply the ETI Space Invasion project built for £99.85 all inclusive (or £80.85 in kit form). The sound generator and keypad section is available built for £20.55 all inclusive (or £15.38 in kit form).

If you want to shop around for your own components you can get the main Space Invasion PCB only for £21.15 all inclusive and the sound generator board for £5.60. The ROM is available for £17.75 all inclusive.

A case with internal PSU will be available from Tangerine soon. Contact them for the latest information on availability and price. Tangerine Computers Ltd, Forehill, Ely, Cambridgeshire.



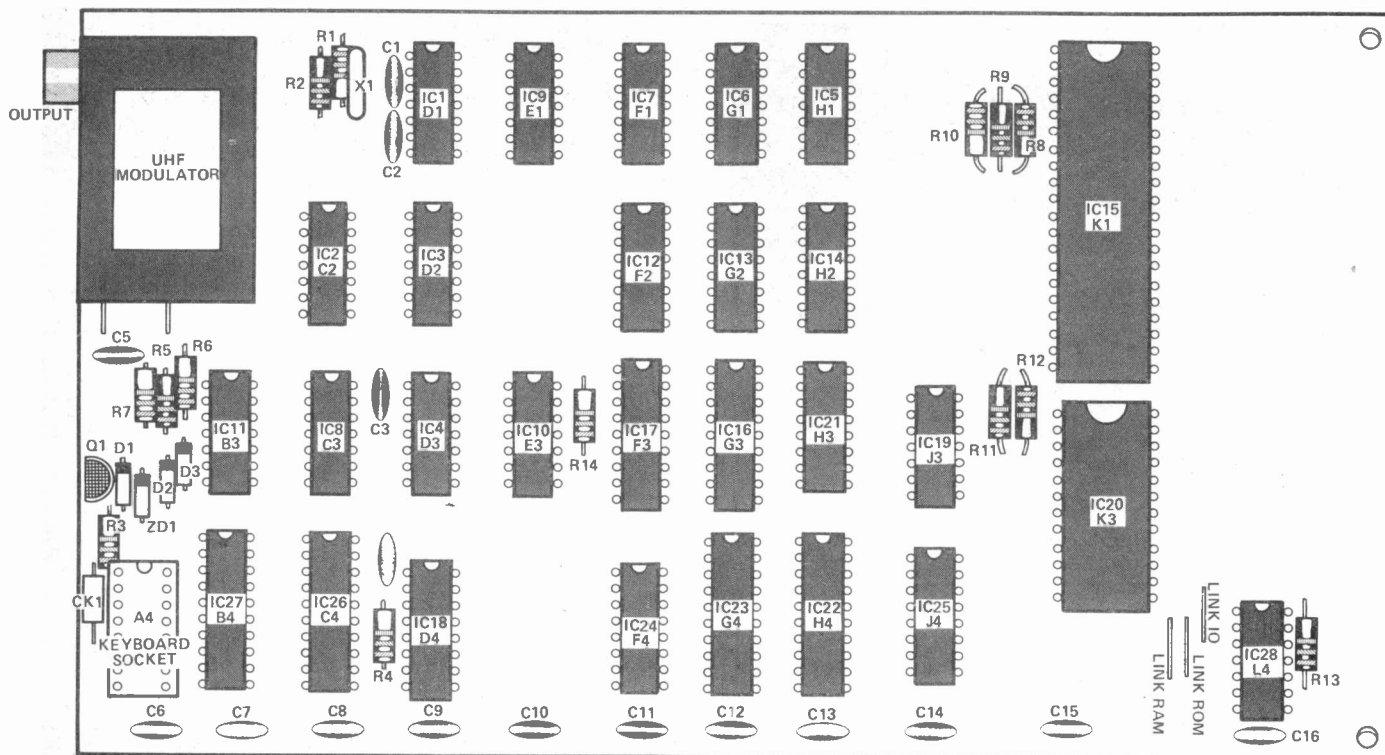


Fig.2. (above) Component overlay for the main board. All the chips face the same way.

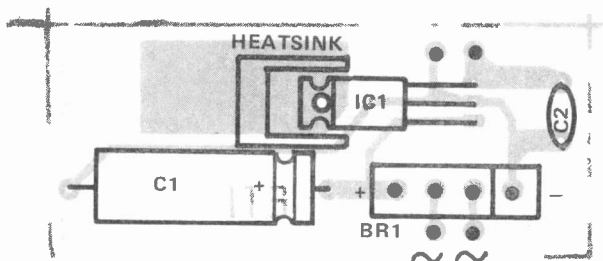


Fig.3. Component overlay of the power supply circuit. The heatsink is a type TV4, available from Watford Electronics.

## PARTS LIST

<b>Capacitors</b>	
C1	1000u 25 V electrolytic
C2	470n polycarbonate
<b>Semiconductors</b>	
IC1	7805
BR1	1.6 A 'In-Line' package
<b>Miscellaneous</b>	
T1	0-9 V @ 1 A
SW1	DPDT miniature toggle
heatsink	

Next month, we conclude the ETI Space Invasion Game with constructional details of the sound effects board.

ETI

## PARTS LIST

<b>Resistors all 1/4 W 5%</b>	
R1,2,4,8,9,10,11,12,13,14	1k0
R3	10k
R5	470R
R6	220R
R7	75R
<b>Capacitors</b>	
C1,4	10n ceramic
C2,3	100p ceramic
C5,6-16	47n disc ceramic
C6-16 are decoupling components, one for each column of ICs.	
<b>Semiconductors</b>	
IC1	74LS04
IC2	74LS73
IC3,4	74LS393
IC5	74LS21
IC6,11,28	74LS74
IC7	74LS08
IC8	74LS11
IC9	74LS86
IC10,19	74LS00
IC12,13,14	74LS157
IC15	6502
IC16,17	2114
IC18	DM8678BWF
IC20	2716
IC21	2102
IC22,23,26	74LS374
IC24	74LS251
IC25	74LS138
IC27	74LS244
Q1	BC184
ZD1	6V8 400 mW
D1-3	1N4148
<b>Miscellaneous</b>	
CH1	100 uH choke
X1	6 MHz crystal
UHF modulator	UM1111E36
PCB, case, 14-pin DIL socket (x13), 16-pin DIL socket (x8), 18 pin DIL socket (x2), 20 pin DIL socket (x4), 24 pin DIL socket, 40 pin DIL socket.	



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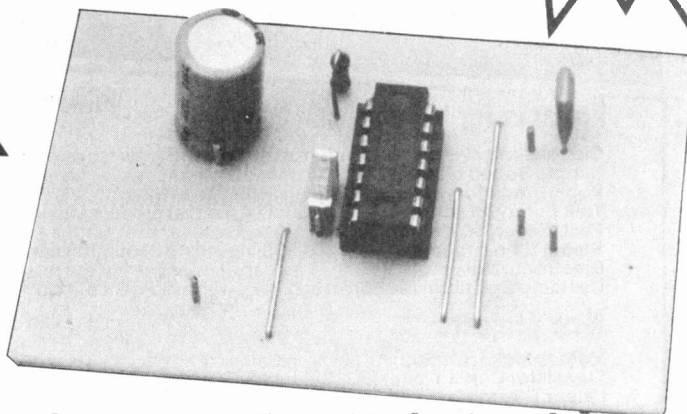
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# 2W POWER AMPLIFIER

A PROJECT  
FOR YOUR  
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This must be just about the simplest power amplifier that you're likely to come across — a few components and a free PCB. No excuses for not building this one. Circuit design by Keith Brindley.

If you need a simple-to-build, inexpensive power amplifier and you've got 15 minutes to spare, unpack your soldering iron and ETI Multi-Option Board. That's all it'll take to get your ETI 2 W Power Amplifier up and running.

We aren't claiming total originality for this circuit. The donkey work, of course, is all done by the well known and loved LM380 power amplifier IC. This chip eliminates the need for preset adjustments of any kind, and distortion and output noise are so low as to render the circuit virtually in the "High Fidelity" category.

Only four other components are needed to complete the amplifier, which will provide the builder with a fine device, needing only a power supply of between about 9-18 V DC (ideal for battery operation) to get things going.

For those interested in technical specifications,

you'll want to know that the IC features an internally fixed gain of 50 (34 dB) and an output which automatically centres at half supply voltage. The output stage is short-circuit current-limited and thermal shutdown in the chip prevents overheating-to-damage point — it turns itself off if it runs a temperature, takes two aspirins and calls you when it cools off again. So, it's safe to assume that the amplifier is just about idiot-proof!

## Construction

Nothing much to comment on here. It's all straightforward. Just make sure the chip is the right way round, as should be the power connections (shown on the overlay).

## HOW IT WORKS

The whole IC can be regarded as a simple op amp with a power output stage tagged on at the end. Pin 2 is the inverting input and pin 6 the non-inverting input. To these can be added the usual feedback connections to tailor gain and frequency response as required, but internal resistors tie what would be the open loop gain to a flat ratio of 50. So with no feedback resistance, a fixed gain of 34 dB occurs whatever the input.

The output stage is a class AB, quasi-complementary pair, emitter-follower. This keeps crossover distortion to a minimum whilst also maintaining quiescent current at less than 15 mA. This latter fact allows satisfactory battery operation, with low distortion.

R1 and C2 form a Zobel network, which effectively suppresses a possible 5 to 10 MHz small amplitude oscillation which can occur during the negative swing into the load. Obviously the oscillations are not in the audio range nor will they pass through the speaker (due to coil reactance), but nevertheless they can cause power loss and other problems in an RF sensitive environment.

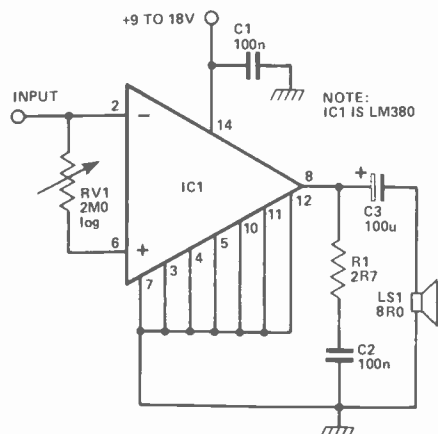


Fig.1 Circuit diagram. Pins 3,4,5,10,11 and 12 are joined internally.



## PARTS LIST

Resistor ¼ W 5%	
R1	2R7
Potentiometer	
RV1	2M0 logarithmic
Capacitors	
C1,2	100n polycarbonate
C3	100u 16 V electrolytic
Semiconductor	
IC1	LM380
Miscellaneous	
LS1	8R0 Loudspeaker
ETI Multi-Option PCB	

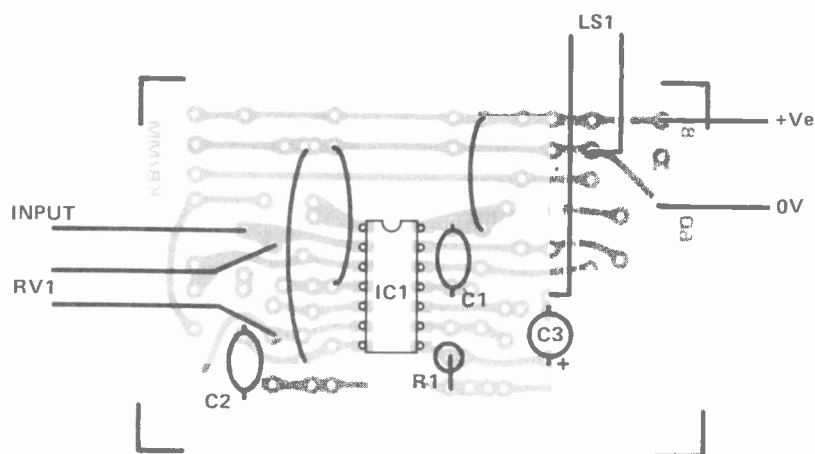


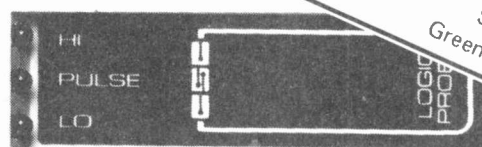
Fig.2 Component overlay.

## BUYLINES

A simple project with few components. You shouldn't meet with any difficulty in obtaining the components. Have a look at the major suppliers advertising in this issue.

ETI

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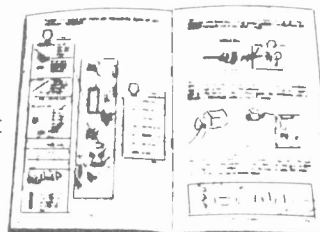


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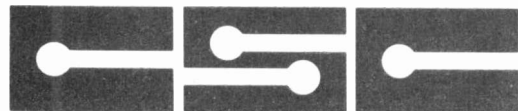
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ACY17	90p	BF183	25p	7824	80p
AD149	55p	BF200	29p	7905	105p
AF127	35p	BF336	33p	7912	105p
ASZ17	120p	BFX30	32p	7915	105p
AU113	150p	BFX86	26p	7918	105p
BC107	7p	BFX88	22p	7924	105p
BC108	7p	BFY50	13p	LM309K	105p
BC108A	7p	BFY51	12p	LM320T5	105p
BC108C	7p	BFY64	28p	LM320T12	105p
BC136	15p	BFY90	56p	LM320T15	105p
BC140	28p	BSX19	80p	LM320T18	105p
BC141	30p	BSY95A	16p	LM323K	450p
BC142	25p	BU204	149p	LM340T5	80p
BC143	28p	BU208	150p	LM340T12	80p
BC147	6p	OC29	89p	LM340T15	80p
BC147B	6p	OC43	50p	LM340T18	80p
BC149	7p	2N696	15p		
BC149C	7p	2N930	20p		
BC159	9p	2N1132	19p		
BC160	35p	2N1304	40p		
BC167A	10p	2N1613	12p		
BC178	12p	2N1711	15p		
BC179	12p	2N2217	20p		
BC182	8p	2N2219A	20p		
BC182L	9p	2N2221	18p		
BC183	9p	2N2368	15p		
BC183L	9p	2N2369	14p		
BC184L	9p	2N2894A	20p		
BC186	20p	2N2904	15p		
BC212	9p	2N2904A	15p		
BC212L	9p	2N2905	15p		
BC213B	9p	2N2906	15p		
BC327	13p	2N2926Y	10p		
BC328	13p	2N2926O	10p		
BC337	16p	2N2926R	10p		
BC338	11p	2N3442	102p		
BC440	32p	2N3702	8p		
BC547	9p	2N3704	8p		
BC548	9p	2N3705	8p		
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BA156	9p	6A 400V	60p		
IN4001	4p	6A 600V	66p		
IN4002	4p	8A 400V	66p		
IN4003	5p	8A 600V	72p		
IN4005	5p	10A 400V	72p		
IN4006	6p	10A 600V	84p		
IN4007	6p	15A 400V	108p		
IN4148	5p	15A 600V	126p		
IS44	3p				

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Leds					
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125 Green	12p	4A 600V	75p		
125 Yellow	12p	6A 400V	75p		
2 Red	10p	6A 600V	90p		
2 Green	10p	8A 400V	90p		
704	110p	8A 600V	95p		
741	160p	10A 400V	95p		
747	160p	10A 600V	100p		
750	160p	15A 400V	120p		
		15A 600V	138p		

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4002	14p	2732	4850p		
4006	69p				
4007	16p				
4008	79p				
4009	36p				
4010	36p				
4011	19p				
4012	16p				
4014	59p				
4015	73p				
4016	42p				
4017	79p				
4018	79p				
4019	45p				
4020	89p				
4021	83p				

CPU'S			MEMORIES		
Mk 3880	950p	21L02	60p		
Mk 3881	625p	2114	300p		
Mk 3882	625p	4027	275p		
		4116	500p		
		4118	1250p		

DIL SOCKETS			CPU'S		
8 pin	10p	2708	750p		
14 pin	12p	2716	1500p		
16 pin	13p	2732	4850p		
20 pin	25p				
24 pin	30p				
40 pin	40p				

CMOS			CPU'S		
4000	14p	2708	750p		
4001	14p	2716	1500p		
4002	14p	2732	4850p		
4006	69p				
4007	16p				
4008	79p				
4009	36p				
4010	36p				
4011	19p				
4012	16p				
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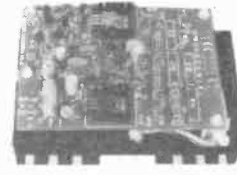
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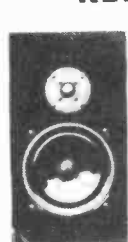
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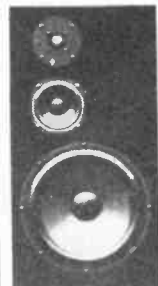
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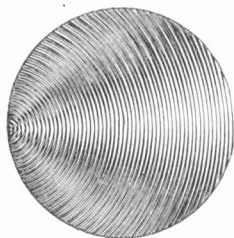
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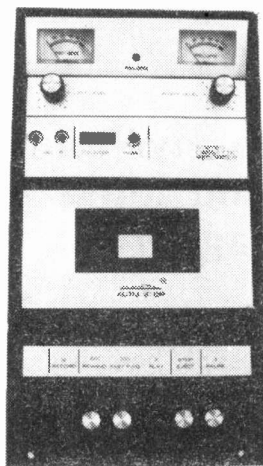


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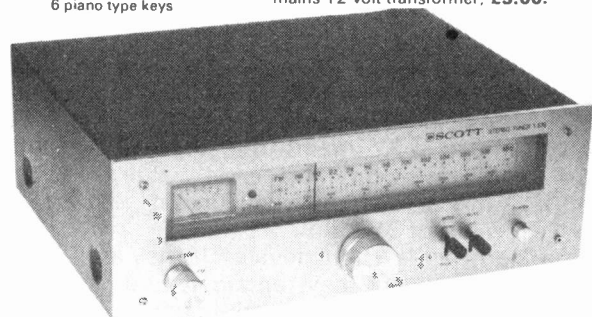
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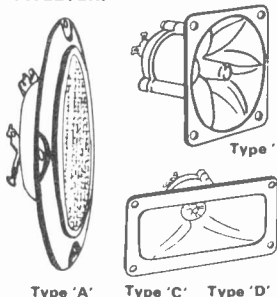
6 piano type keys



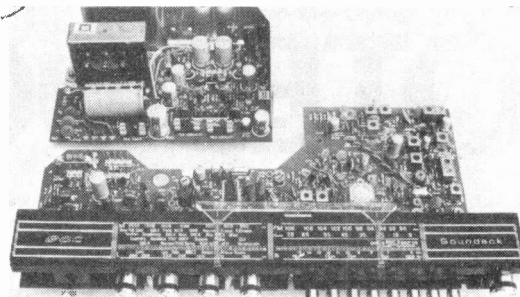
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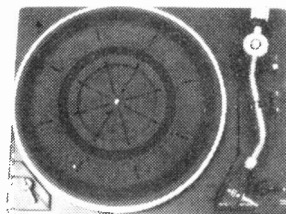


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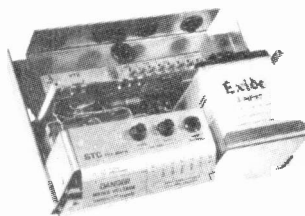


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# DESIGNER'S NOTEBOOK

In this month's 'Notebook' Ray Marston explores the mysterious depths of 'zero-voltage switching' of mains power and looks at some practical applications of the CA3059 'zero-voltage' IC.

There are two basic ways of switching mains power to a load — either via a mechanical switch or via a solid state switch such as a triac. Mechanical switches are fairly slow acting devices: they suffer from severe arcing at the moment of switching and generate a great deal of RFI (radio-frequency interference) at switch-on and switch-off. This RFI can often be heard on domestic radio and TV sets and can cause malfunctioning of delicate electronic equipment.

Triac switches are fast acting devices and do not suffer from arcing problems. Nevertheless, they are still capable of generating considerable RFI at switch on. Why? As the triac turns on, the load current may rise from zero to several amps in a mere couple of microseconds: since this current flows through the mains wiring, the wiring may radiate a great 'splurge' of RFI in response to this heavy surge current. The magnitude of the RFI is proportional to  $dI/dt$  and can be reduced by

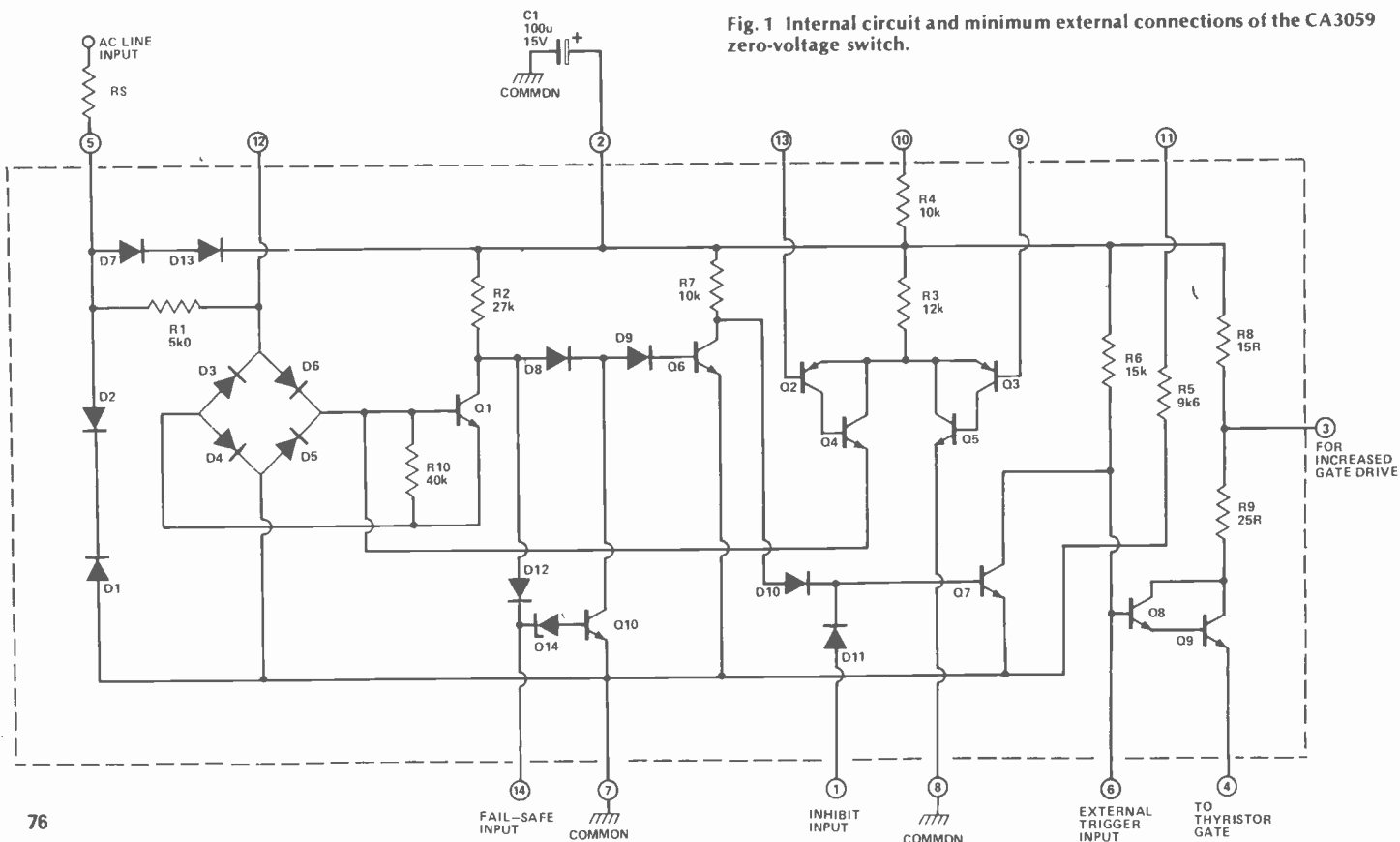
either reducing the surge current amplitude or increasing the surge current rise time, or possibly both: once the triac has turned on, the subsequent large 'rise time' of the 50 Hz mains signal causes virtually zero RFI even when load currents of tens of amps are being drawn.

## Zero-Voltage Switching

Thus, the degree of triac switch-on RFI is proportional to the value of instantaneous mains voltage at the moment of triac turn-on. If a 100R load is being driven from 230 V AC mains, the surge current will be 3A25 if switch-on occurs at a 'crest' value of 325 V, or mere 32.5 mA if switch-on occurs at a 'near zero-crossover' value of 3V25.

Triacs are self-latching devices. If they are turned on by a brief gate signal, they remain on until their main-terminal currents fall below a minimum 'holding' value

Fig. 1 Internal circuit and minimum external connections of the CA3059 zero-voltage switch.





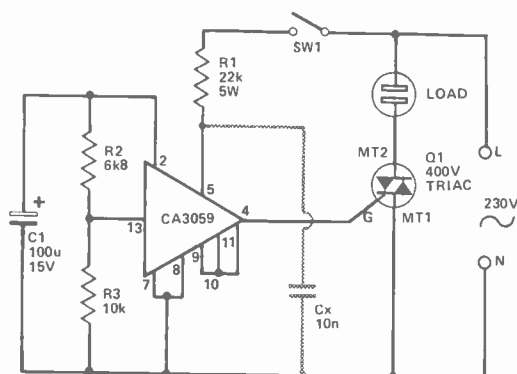


Fig.2 A simple mains-switched zero-voltage switch. Cx may be used to overcome latching deficiencies of some triacs.

of a few milliamps. They automatically turn off at the end of each mains half cycle as their main-terminal currents fall to near-zero. They can be turned on near the start of each half cycle as soon as their main-terminal currents are capable of exceeding the minimum holding value.

Thus, a triac can be persuaded to generate virtually zero switch-on RFI by feeding it with gate current *only* when the instantaneous mains voltage is close to the zero or cross-over value at the start of each half cycle. This technique is known as 'zero-voltage switching'. Special zero-voltage triac-driving ICs are available from a number of manufacturers. One such device is the CA3059, manufactured by RCA.

## The CA3059 Zero-Voltage Switch

The internal circuit and minimal external connections of the CA3059 zero-voltage switching IC are shown in Fig.1. The device is housed in a 14-pin DIL package and incorporated DC power supply circuitry, a zero-crossing detector, triac gate drive circuitry and a high-gain differential amplifier/gating network. Circuit operation is as follows.

Mains power is connected between pins 5 and 7 of the device via limiting resistor Rs (22k, 5 W when 230 V mains is used). D1 and D2 act as back-to-back zeners and limit the pin 5 voltage to  $\pm 8$  V. On positive half cycles D7 and D13 rectify this pin 5 voltage and generate approximately 6V5 across the 100uF capacitor connected to pin 2. This capacitor supplies sufficient energy storage to drive all internal circuitry and provide adequate triac gate drive, with a few milliamps or so spare drive available for powering auxiliary (external) circuits.

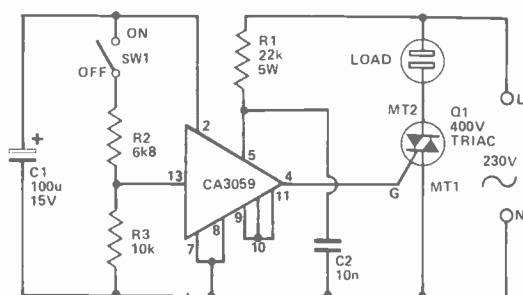


Fig.3 Direct-switched zero-voltage switch.

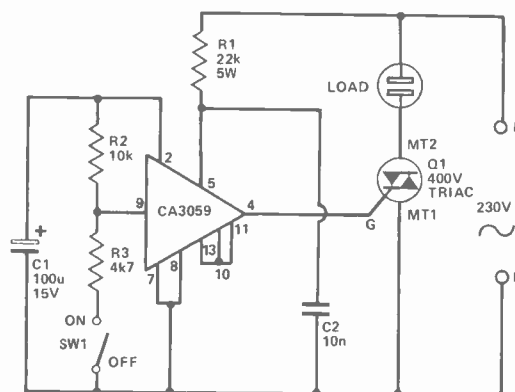


Fig.4 An alternative and very useful method of direct-switching the CA3059 IC.

Bridge rectifier D3-D6 and transistor Q1 act as a zero-voltage detector, their action being such that Q1 is turned on (driven to saturation) whenever the pin 5 voltage exceeds  $\pm 3$  V. Gate drive to an external triac can be made via the emitter (pin 4) of the Q8-Q9 Darlington pair of transistors, but is available only when Q7 is turned off. When Q1 is turned on (pin 5 greater than  $\pm 3$  V) Q6 is turned off through lack of base drive, so Q7 is driven to saturation via R7 and no triac gate drive is available from pin 4. Triac gate drive is thus available only when pin 5 is close to the 'zero-voltage' or cross-over mains value. When gate drive is available, it is delivered in the form of a narrow pulse centred on the cross-over point with pulse power supplied by C1.

## Vive La Differential

The CA3059 incorporates a differential amplifier or voltage comparator, built around Q2 to Q5, for general purpose use. Resistors R4 and R5 are externally available for biasing one side to the amplifier. The emitter current of Q4 flows via the base of Q1 and can be used to disable the thyristor (pin 4) gate drive by turning Q1 on. The configuration is such that the gate drive can be disabled by making pin 9 positive relative to pin 13. The drive can also be disabled by connecting external signals to pin 1 and/or pin 14.

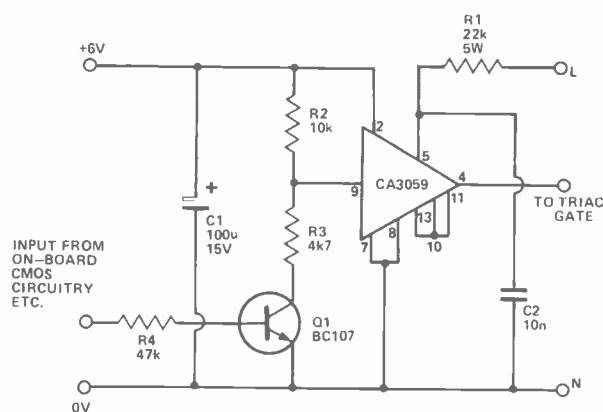


Fig.5 One method of transistor-switching the CA3059 via on-board CMOS circuitry such as one-shots, astables, etc.



## CA3059 Switching circuits

Figure 2 shows the simplest possible way of using the CA3059 as a 'noiseless' switch with the zero-voltage switching provided via the IC and the triac and with on/off switching controlled by SW1. The circuit action is quite simple. The IC is connected to the mains via SW1 and limiting resistor R1. DC energy is stored by C1. The IC is wired in the 'enabled' mode by biasing the pin 9 side of the internal differential amplifier at half-supply (DC) volts via the pin 10 and 11 connections and by biasing the pin 13 side above half-supply via the R2-R3 divider network. Switch SW1 passes only a few milliamps of current and thus generates negligible RFI. The circuit can power mains loads such as lamps and heaters via a suitable rated triac.

The 'zero-voltage' triac-gate-drive pulse of the CA3059 is very narrow. In some applications, the pulse may terminate before the triac main-terminal currents have reached their minimum holding levels and self-latching may fail to occur. This problem can be overcome by wiring Cx as shown in Fig. 2. This capacitor, in conjunction with R1, gives a slight phase shift to the pin 5 signal and extends the 'zero-voltage' pulse further into the start of each mains half-cycle. A value of 10nF is adequate in most applications.

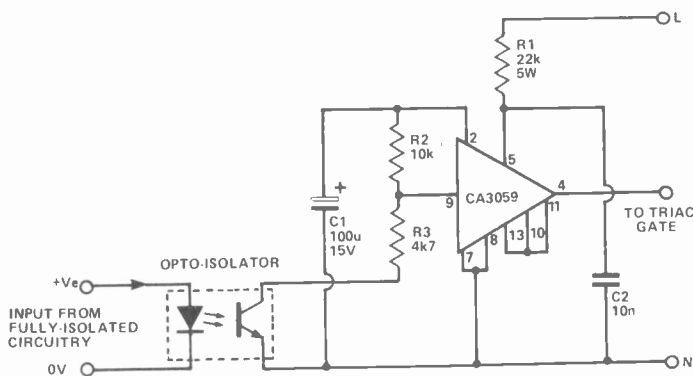


Fig.6 A method of remote-switching the CA3059 via an opto-isolator.

The Fig. 2 circuit consumes virtually zero mains power under the 'off' (SW1 open) condition. The only defect of the circuit is that SW1 operates at full mains voltage. This defect can be overcome by using the switch to directly enable or disable the CA3059 logic circuitry, as shown in Figs. 3 and 4, but in this case the circuit consumes a few watts of power (via R1) when the circuit is in the off mode.

The Figs. 3 and 4 circuits work by using the switch to enable or disable the triac gate drive via the internal differential amplifier of the IC. Remember, the drive is enabled only when pin 13 is biased above pin 9. In the Fig. 3 circuit, pin 9 is biased at half-supply volts and pin 13 is biased via R2-R3 and SW1. In Fig. 4, pin 13 is biased at half-supply and pin 9 is biased via R2-R3 and SW1. In both circuits, SW1 handles maximum potentials of 6 V and maximum currents of 1 mA or so.

Note in Fig. 4 that the circuit can be turned on by pulling R3 low or can be turned off by letting R3 float. Figures 5 and 6 show how this simple fact can be put to use to extend the versatility of the circuit. In Fig. 5, the circuit can be turned on and off by transistor Q1, which

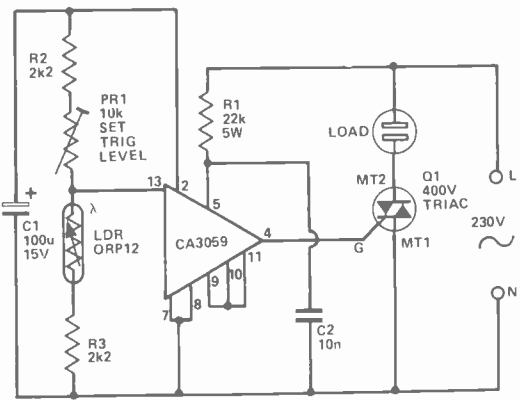


Fig.7 A basic dark-activated zero-voltage switch.

in turn can be activated by on-board CMOS circuitry (such as one-shots, astables, etc) that are powered from the 6 V pin 2 supply.

In Fig. 6, the circuit can be turned on and off by fully-isolated external circuitry via an inexpensive opto-isolator: the isolator needs an input current of only a milliamp or so to give the 'on' action.

## CA3059 Comparator Circuits

The built-in differential amplifier of the CA3059 can readily be used as a precision voltage comparator that turns the triac on or off when one of the comparator input voltages goes above or below the other. If these input voltages are derived from transducers such as LDRs or thermistors, the on/off power control action can be controlled by ambient light levels or temperatures. Figures 7 to 10 show some practical circuits of these types.

Figure 7 shows the circuit of a simple dark-activated zero-voltage power switch. Here, pin 9 is tied to half-supply volts and pin 13 is controlled via the R2-PR1-LDR-R3 potential divider. Under bright conditions the LDR has a low resistance, so pin 13 is above pin 9, the triac is enabled and power is fed to the load. The precise threshold level of the circuit can be preset by PR1.

Figure 8 shows how a degree of hysteresis or 'backlash' can be added to the above circuit, so that the triac does not switch annoyingly in response to small changes (passing shadows, etc) in the ambient light level. The hysteresis level is controlled via R3, which can be selected to suit particular applications.

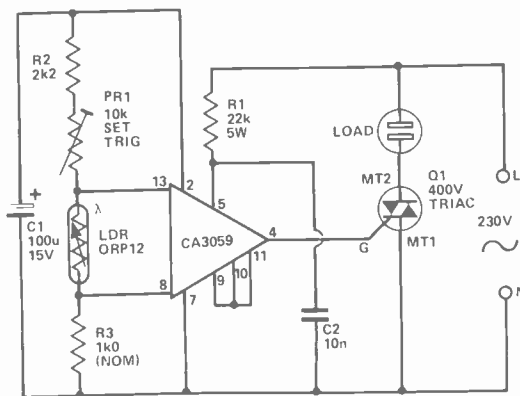


Fig.8 A dark-activated zero-voltage switch with hysteresis provided by R3.

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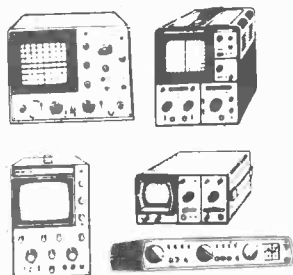
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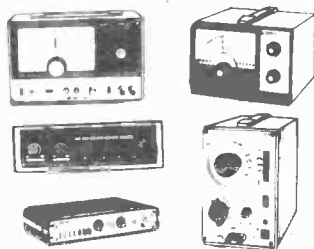
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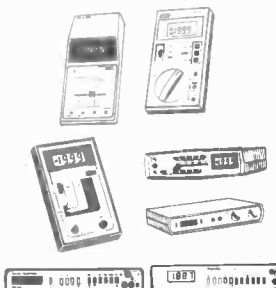
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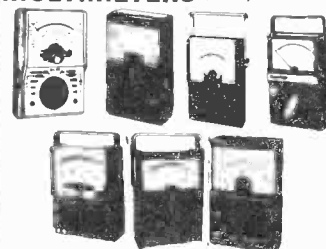
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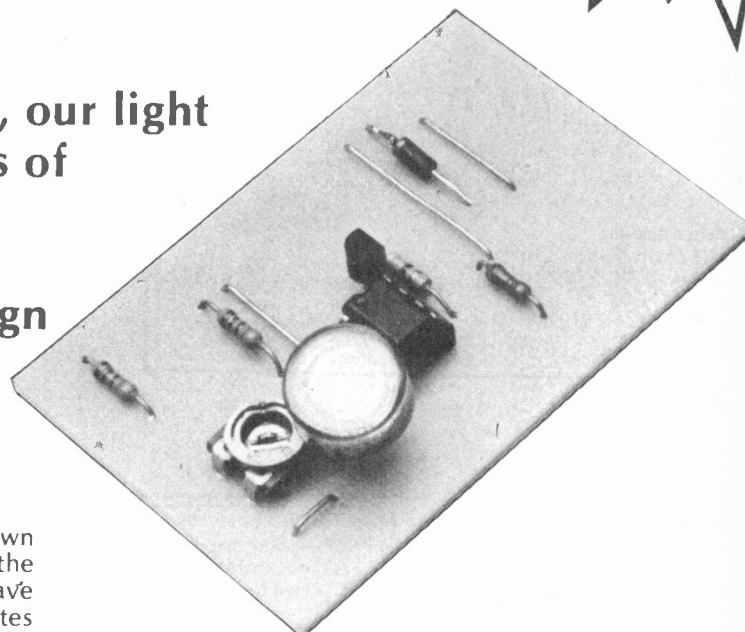
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The circuit diagram of the ETI Light Switch shows the device in its low-light operating mode. When the amount of light on the photocell, LDR1, is lower than the preset amount, the relay is energised. Alternatively, swapping LDR1 and R1 causes the relay to be energised when the light exceeds the preset level.

A single operational amplifier is the active component of the circuit and we have specified this as a type 301. However, don't rush out specially to buy one if you don't have one of these at hand, the only reason we used this particular type was because we had one handy at the design stage. Virtually any 8-pin DIL op amp will function in the circuit eg. 741, 748, 308, 3130, 351, etc can be used as substitutes.

## Construction

Construction, to use a well-worn phrase, is easy if you follow our PCB layout. It is easier still if you have the Multi-Option Board given free with this issue.

There are four links to make and these are best inserted before the components. Next, insert the resistors, the preset pot and the diode. Transistor Q1 is inserted next to IC1, using three of the remaining holes included in the board for a 14 pin DIL IC. Make sure you insert Q1 and the IC the right way round. Finally, make all the off-board connections to the battery, relay and photocell and then switch on and try your completed project. The light level at which the switching action occurs can be adjusted by PR1.

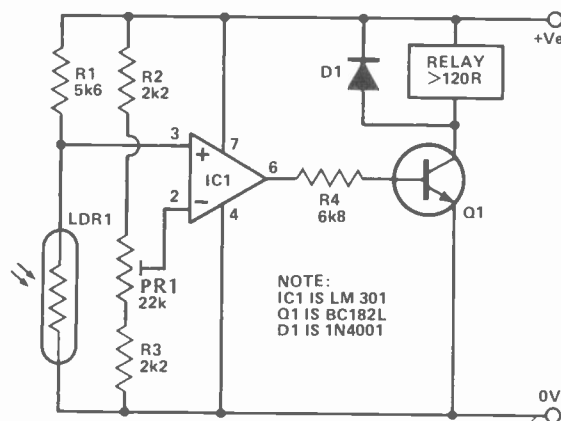


Fig.1. Circuit diagram. The switching threshold is controlled by PR1.

## HOW IT WORKS

LDR1 is a light dependent resistor. The resistance between its terminals varies in inverse proportion to the amount of light which falls on its face — the greater the light intensity the less its resistance. So when it is connected across a power supply with another resistor in series, (R1 in this circuit), the voltage across it decreases with light intensity.

IC1 is a comparator which compares the voltage across the LDR with a predetermined voltage, obtained via resistor chain R2,3 and PR1. As the light level falls, the voltage across the LDR rises until it exceeds the preset level at PR1. At this point the output of IC1 goes high, turning on Q1, which in turn, operates the relay. D1 prevents damage to Q1 from any back EMF when the relay is switched off.

Swapping the positions of LDR1 and R1 means that the voltage at pin 3 of the comparator now rises with increasing light, so circuit operation is reversed.



## PARTS LIST

Resistors	All ¼W 5%	
R1		5k6
R2,3		2k2
R4		6k8
Potentiometer		
PR1		22k miniature horizontal
Semiconductors		
IC1		LM301
Q1		BC182L
D1		1N4001
Miscellaneous		
ETI Multi-Option Board		
Relay (coil 120R)		
LDR1 ORP 12		
9 V battery and connector.		

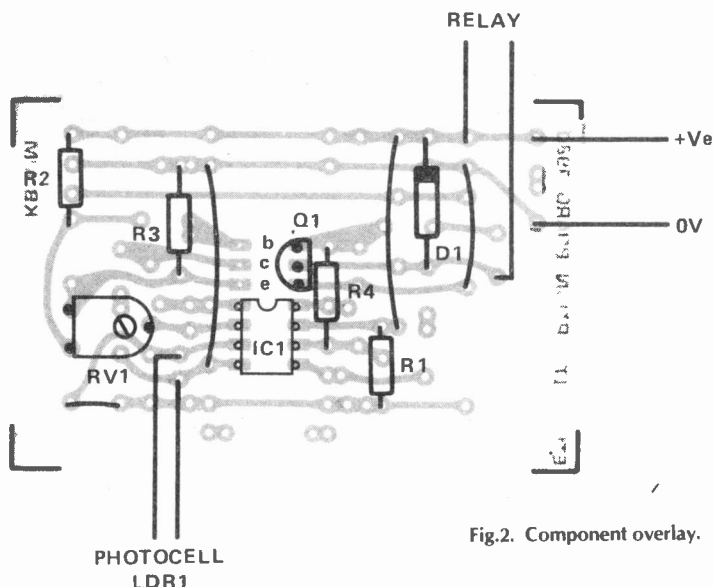


Fig.2. Component overlay.

## BUYLINES

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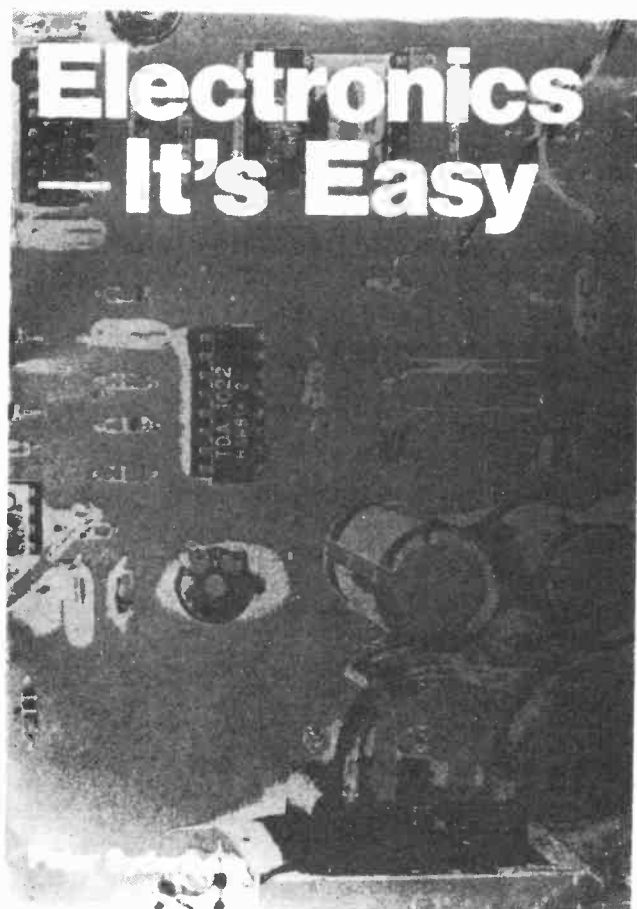
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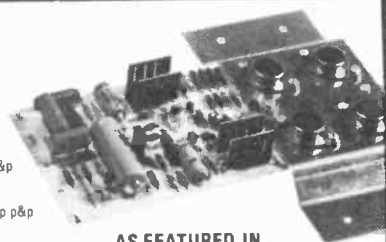
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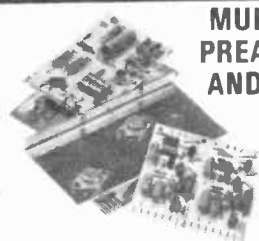
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AS FEATURED IN  
**PRACTICAL ELECTRONICS**  
 OCTOBER ISSUE

## DIY STEREO BARGAIN PACKS FEATURING FAMOUS BUILT MULLARD PREAMP MODULES



### MULLARD STEREO PREAMP MODULES AND TWO 12 WATT POWER AMP KITS.

In easy to build form  
 P.C.B.s backprinted, etched  
 and drilled ready to use.

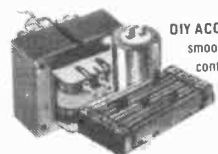
### BUILD A 12 WATTS PER CHANNEL STEREO AMPLIFIER ACCESSORIES AND L.S. KIT EXTRA (not available separately)

**£6.00**

DIY PACK 1 2 x power amp kits  
 LP1182/ preamp module, suitable for  
 ceramic and auxiliary inputs. **£6.00**  
 plus £1.10 p&p

DIY PACK 2 2 x power amp kits LP1184  
 preamp module suitable for magnetic  
 ceramic and auxiliary inputs. **£8.50**  
 plus £1.15 p&p

DIY SPEAKER KIT Two 8" x 5" approx.  
 4 ohm bass. **£3.50**  
 plus £1.70 p&p



DIY ACCESSORIES Mains transformer  
 smoothing capacitor rectifier 4 x slider  
 controls, for base, treble and volume.

**£3.00**  
 plus £1.60 p&p

ACCESSORIES: Available only  
 at time of purchase of Bargain Packs

### 12 + 12 WATT AMPLIFIER KIT

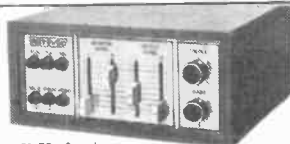
NOTE: for use with 4 to 8 ohms speakers

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

Size 9 1/4" x 8 1/4" x 4" approx.  
 NOTE:  
 for use with 4 to 8 ohms speakers.

**£13.95**  
 plus £2.55 p&p

BSR chassis  
 record player deck  
 with manual set  
 down and return,  
 complete with  
 stereo ceramic  
 cartridge. **£8.50** plus £2.75 p&p when  
 purchased with amplifier available separately **£10.50** plus £2.75 p&p.



TWO WAY SPEAKER KIT, 2 Philips 8" approx speakers  
**£4.75** per stereo pair plus £1.50 p&p when purchased with amplifier  
 available separately **£6.75** plus £1.50 p&p.

ALSO AVAILABLE Stereo magnetic pre-amp conversion kit all  
 components including P.C.B. to convert your ceramic input on the  
 12 + 12 amp to magnetic. **£2.00** when purchased with kit featured  
 above. **£4.00** separately inc. p&p.

BSR Manual single play  
 record deck with auto return and  
 cueing lever. Fitted with stereo  
 ceramic cartridge 2 speeds with 45  
 rpm spindle adaptor ideally suited  
 for home or disco use.



**£12.25** OUR PRICE  
 plus £2.75 p&p

### PHILLIPS RECORD PLAYER DECK GC037

Size approx 15 1/4" x 12 1/4"



Hi Fi record player deck, 2 speed,  
 damped cueing, auto shut-off, belt  
 drive with floating sub chassis to  
 minimise acoustic feedback. Com-  
 plete with GP401 stereo magnetic  
 cartridge—LIMITED STOCK.  
 UNBEATABLE OFFER AT

**£27.50** complete  
 plus £2.75 p&p

**OFFER!** SAVE MONEY by purchasing 12 + 12 amp kit, BSR  
 record deck and speaker kit together for only **£25.50** p&p £4.50.

### PRACTICAL ELECTRONICS CAR RADIO KIT **£10.50** (Constructors pack 7) plus £1.75 p&p

2 Wavebands  
 MW and LW

- \* Easy to build
- \* 5 push button tuning
- \* Modern styling design
- \* All new unused components
- \* 6 watt output
- \* Ready etched & punched P.C.B.
- \* Incorporates suppression circuits
- \* Now with tape input socket

All the electronic components to build the radio, you supply only the wire and solder as featured in the Practical Electronics March issue. Features: Pre-set tuning with five push button options, black illuminated tuning scale, with matching rotary control knobs, one, combining on/off volume and tone-control, the other for manual tuning, each set on wood simulated fascia. The P.E. Traveller has a 6 watts output, neg ground and incor-  
 porates an integrated circuit output stage, a Mullard IF module LP1181 ceramic filter type, pre-aligned and assembled and a Bird pre-aligned push button tuning unit. The radio fits easily in or under dashboards.

Complete with instructions

#### CONSTRUCTORS PACK 7A

Suitable stainless steel fully retractable locking aerial and  
 speaker (approx. 6" x 4") is **£1.95** per pack,  
 available as a kit complete p&p £1.00

Pack 7A may only be purchased at the same time as Pack 7.

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

FEATURED PROJECT IN PRACTICAL ELECTRONICS



### 30 + 30 WATT STEREO AMPLIFIER BUILT AND TESTED

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

READY TO PLAY **£32.90** plus  
 £3.30 p&p



323 EDGWARE ROAD, LONDON, W.2  
 21E HIGH STREET, ACTON W3 6NG  
 ACTON. Mail Order only. No callers.

ALL PRICES INCLUDE VAT AT 15 %  
 All items subject to availability. Price correct at 1.9.80  
 and subject to change without notice

For further information send for instruction booklet  
 20p plus stamped addressed envelope

NOTE:  
 Persons under 16 years not served without parent's authorisation

### BARGAIN OFFER!!



#### ARISTON PICK UP

Ariston pick-up arm manufactured in Japan.  
 Complete with headshell.  
 Listed price over £30.00

**£11.95**  
 OUR PRICE plus £2.50 p&p

### 100 WATT MONO DISCO AMPLIFIER

Brushed aluminium fascia and rotary controls.  
 Size approx 14" x 4" x 10 1/4". Five vertical slide  
 controls, master volume, tape level, mic level, deck  
 level, PLUS INTER DECK FADE for perfect graduated change  
 from record deck No. 1 to No. 2, or vice versa. Pre fade level  
 controls (PRL) lets YOU hear next disc before  
 fading it in. VU meter monitors output level.  
 Output 100 watts RMS 200 watts peak.

**£76.00**  
 plus £4.00 p&p

### 50 WATT MONO DISCO AMPLIFIER

Size approx 13 1/4" x 5 1/4" x 6 1/4". 50 watts rms. 100 watts peak  
 output. Big features include two disc inputs, both for ceramic  
 cartridges, tape input and microphone input. Level mixing controls  
 fitted with integral  
 push-pull switches.  
 Independent bass  
 and treble controls  
 and master volume.



**£30.60**  
 plus £3.20 p&p

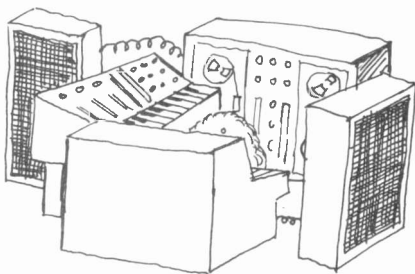
Personal Shoppers EDGWARE ROAD LONDON W2 Tel: 01-723 8432 9.30am-5.30pm Closed all day Thursday ACTON: Mail Order only. No callers GOODS DESPATCHED TO MAINLAND AND N. IRELAND ONLY



# Hobby Electronics

Next  
Month

ON SALE  
OCTOBER 10th



## Thirty Pound Synthesiser

No, not weight, price! That's right, for around thirty quid you can build yourself this high quality, versatile and above all, economical synthesiser. Create outlandish noises, scare your granny, even play a few tunes. This easy-to-build unit features the latest LSI technology to reliably generate the sounds.

We're keeping quiet about the technical details, walls have ears and all that. Suffice it to say that this is the design you've been waiting for. You have four weeks, starting from now to find your £30. It'll be money well spent, we promise you that.

## Electronic Hand Grenade

You'll get a real 'bang' out of this new game. It's the electronic version of that old parlour game 'musical chairs'. The grenade is passed around a circle of players, the longer it is held the greater the chance it will go 'off'. The person that has it then leaves. This ingenious little circuit will provide hours of amusement at parties and can be built by even the most inexperienced constructor in just a couple of hours.



## Guitar Sound Shaper

Gasp, shock, horror, you haven't heard of a Guitar Sound Shaper before. Shame on you. How can you ever hold your head up in decent company? People like you give our hobby a bad name, no wonder dogs cross the street when they see you. There's only one thing you can do, rush out and get next month's copy of HE or forever be a social outcast.

## Battery Eliminator

This 35 kilowatt laser is guaranteed to instantly vapourise any battery from a HP7 to a PP9. Batteries are really becoming a nuisance. Stop their takeover right now. The HE battery Eliminator will forever remove the menace of the dry-cell. Just plug it into your local mains socket and laugh as you count all the money you'll save. Actually it's not really a 35 kilowatt laser but it will save you a few quid. Look out for it in next month's bigger-than-ever issue.



## Transistor Tester

What can we say? Not a lot really, we don't have to tell you that this is the most advanced design ever to measure the collector current of a BC109, you know that already because it comes from Hobby Electronics!

## Stereo

Now for the first time anywhere this century Hobby Electronics has commissioned that Master of the Microcircuit, the Baron of the Breadboard, that well known man of digits, Ian Sinclair (who?) to write the definitive lowdown on Stereo. What is it, how does it do it, what do I do with it? These are just some of the questions that will finally get answered next month in this exciting top-level feature.



The items mentioned here are those planned, but unforeseen circumstances may affect the actual contents.

ETI NOVEMBER 1980



# RADIOACTIVITY

Spend the last three minutes before the bomb drops reading A.S. Lipson's excursion into that frazzling phenomenon of modern physics — radioactivity

In the last few years of the nineteenth century, a French scientist by the name of Henri Becquerel was fiddling about with some uranium compounds, trying to investigate their fluorescent properties. During the course of his work, however, and almost completely by chance, he discovered something quite different. These compounds could fog photographic plates, even if the plates were wrapped in black paper to keep out light! Henri Becquerel had discovered radioactivity.

## One Into Three

As more and more work was done on the new phenomenon, it was eventually found that there are three main types of radiation. These are known, respectively, as alpha, beta and gamma rays, after the first three letters of the Greek alphabet (scientists and mathematicians long ago ran out of English letters to use as symbols. In fact, they're running short of Greek now, as well. Hebrew letters — Oy Vey! — are beginning to come into use for some things).

What makes the three types of radiation different from each other, though? Suppose we have a lump of some radioactive material. We know it's giving off rays of some sort, but how do we find out which type they are?

## Eeny Meeny . . .

Well, actually it isn't all that bad. The three radiation types have quite different properties from each other and it's quite easy to tell the difference between them. One of the simplest ways is based on their different penetrating powers. Alpha rays, you see, don't take an awful lot of stopping. Even a moderately thick piece of paper in the way is enough to cut out most of them. Beta and gamma radiation, however, are not stopped so easily. It takes several millimetres of aluminium or lead to block off beta radiation effectively and as for gamma — nothing short of several centimetres of lead will stop that.

## Shields Up, Scotty

Suppose, then, that we have a radioactive source and some means of detecting radiation, such as a Geiger counter (Fig.1). If we find that the radiation from the source is cut off when a piece of card is placed in front of the detector, then it is very likely that the radiation is alpha type. If the radiation is virtually unaffected by card, but is effectively stopped by 5 mm or so of lead, then it is probably beta radiation, whereas if it is only reduced by placing several centimetres of lead in the way, it is most likely to be gamma radiation.

Some radioactive materials give off more than one type of radiation, but, by finding the amount by which the radiation is reduced with different thicknesses of shielding, the amounts of each type present can be discovered. (Easy, Innit?).

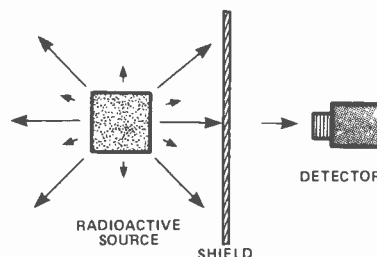


Fig.1. Alpha particles are stopped by thick paper. Beta particles are stopped by several millimetres of aluminium or lead. Gamma rays can only be stopped by several centimetres of lead.

There are other ways of detecting the difference between the three types of radiation. For instance, in an electric or magnetic field, alpha particles will be deflected one way and beta particles the other way, while gamma radiation remains unaffected. This is because alpha radiation carries positive electric charge, beta radiation carries negative charge and gamma radiation is neutral. By finding which way the radiation is bent in an electric or magnetic field, then, it is possible to work out what type of radiation it is (Fig.2). It is this method of detection, in fact, which is used by physicists to detect many other less common types of radiation and subatomic particles encountered in nuclear physics.

## But What Are They?

So far, we have only looked at the different ways in which alpha, beta and gamma radiation behave without really saying much about what they are. What is it that makes a beta ray different from an alpha or a gamma ray? Why should alpha and beta radiation carry electrical charge — alpha positive and beta negative — while gamma radiation is neutral?

## The Gamma Story

Light can be thought of as a wave of electromagnetic radiation travelling through space with a speed of nearly 300,000 kilometres per second with a wavelength of between  $4 \times 10^{-7}$  and  $7 \times 10^{-7}$  metres. In fact, the wavelength determines the colour of the light. There is, however, other electromagnetic radiation, travelling with exactly the same velocity as light and identical to it in every way except that of wavelength. Radio waves, for instance, are this type of radiation, but with much longer wavelengths (up to thousands of metres). Gamma radiation is also this sort of electromagnetic radiation, but with a much shorter wavelength than light (anything under  $10^{-16}$  or  $10^{-17}$  metres).

Gamma radiation, then, is very short wavelength electromagnetic radiation and as such it carries no electric charge, any more than light or radio waves do (Fig.3).



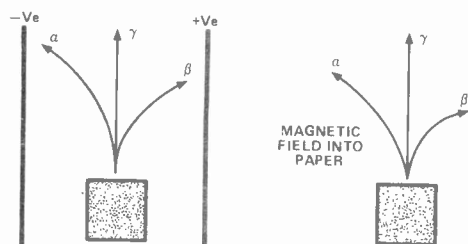


Fig.2. Alpha or beta particles carrying electrical charge can be deflected by electric or magnetic fields. Gamma rays, which are neutral, are not deflected.

## A,B,...

Alpha and beta radiation are a little harder to explain. The atom consists of a very small, central region — the nucleus — which carries a positive charge. Surrounding the nucleus, and taking up the bulk of the atom, are electrons, which, being negatively charged, counteract the positive charge of the nucleus and make the atom as a whole neutral. The nucleus consists of two types of particles — protons and neutrons. Protons are positively charged and neutrons, as the name indicates, are neutral. The number of protons in the nucleus decides which element the atom belongs to. The number of neutrons present doesn't matter so much, but in most atoms there are at least as many neutrons as protons. (One notable exception is hydrogen, which has a nucleus consisting of just one proton). The protons, you see, being positively charged, all repel one another. The neutrons, by some mechanism still not properly understood, seem to hold the whole kaboodle together in a relatively stable lump. In some atoms, however, — particularly the larger ones, with more than 90 or so protons — the nuclei are not quite stable enough. In fact, they are liable literally to fall apart! This, as you probably guessed, is where the alpha and beta radiation comes in...

## Let There Be Helium

It turns out that there are two ways in particular in which atoms 'like' to fall apart. One of them is by giving off two protons and two neutrons together, in a lump. In fact, this 'lump' is exactly the same as a normal helium nucleus, carrying the positive charge of two protons. It is this positively charged helium nucleus, which unstable atoms tend to release, that we call the alpha particle.

And what of the beta particle? Well, it was found by experiment that beta particles are actually free electrons. Because of this, you might be tempted to think that it was one of the electrons from around the atom, which has been released. This is not, however, the case. (It's such an obvious explanation that it can't possibly be right — Murphy's Law). Occasionally, within the nucleus, a neutron will turn into a proton, giving off an electron — and, at the same time, another particle called an anti-neutrino. The anti-neutrino really belongs in an article by itself, so we'll pass it by, except to say that it has no charge, little or no mass, and is virtually impossible to detect, although it is undoubtedly one of the most intriguing particles discovered yet. The electron given off when this happens is (you guessed it!) the beta particle.

We can see, then, that, although we say alpha, beta and gamma 'rays', only the gamma type is a ray. The other two types are really particles. However, when they occur in streams with large numbers of the particles, it is just as convenient to call them rays.

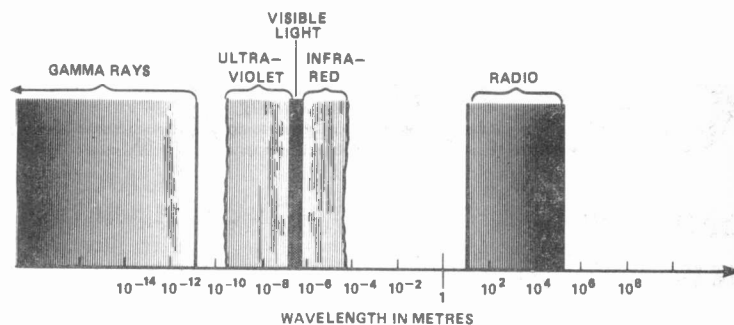


Fig.3. The electromagnetic spectrum.

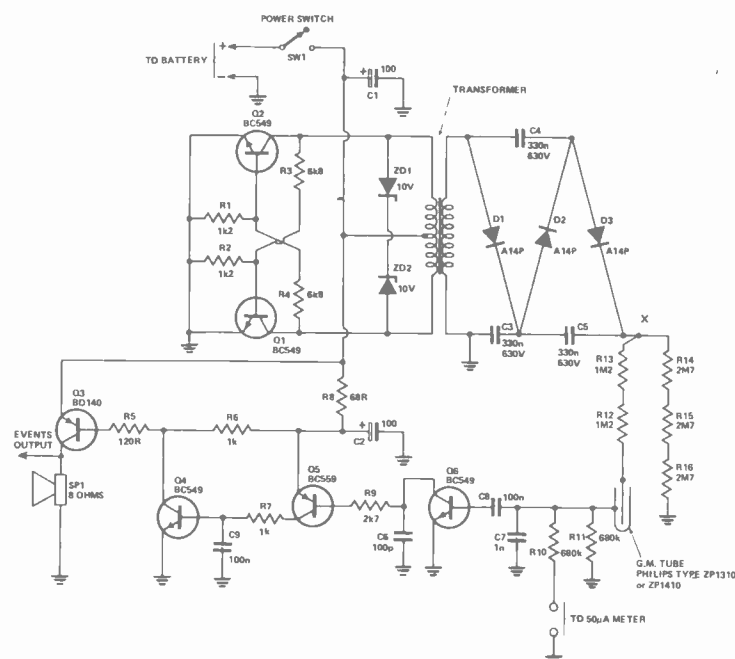


Fig.4. Circuit diagram of a Geiger-Muller tube radiation detector.

## Lead Into Gold

A while back, we stated that the number of protons in the nucleus determined which element the atom belongs to. However, when alpha or beta radiation is given off, the number of protons changes (with alpha radiation, it decreases by two, and with beta radiation, it increases by one). Hence, when atoms 'decay' radioactively, by giving off alpha or beta radiation, they actually turn into other elements! Interestingly enough, the particular elements they turn into, when possessing the numbers of neutrons actually available, are not always themselves stable and so they may decay further. For instance, if you take an atom of astatine with 85 protons and 132 neutrons in the nucleus and allow it to decay radioactively, then it would decay into a bismuth atom by giving off an alpha particle. Now, although a bismuth atom with the right number of neutrons (126) is stable, the bismuth atom produced from astatine has 130 neutrons. Because of this, it is unstable, and will itself decay (usually giving off a beta particle, but occasionally an alpha). It is possible, in fact, to find whole chains of elements, which decay radioactively into one another!

## Age Before Theory

One of the most exciting applications of all this (yes, it isn't just theory; there actually is a use for it) is in radio-carbon dating, in which it is possible to tell the age of an object from measurements of the amount of radioactive carbon in it. That, however, is another story altogether...

ETI



# Metac

## ELECTRONICS & TIME CENTRES

### QUARTZ LCD 11 Function Slim Chronograph

12:30<sup>pm</sup>  
Hours mins secs

8 14<sup>TH</sup>  
Month date day

0:00<sup>00</sup>  
Min sec 1/10 1/100



Price only  
**£7.95**

Also available:  
SOLAR CHRONOGRAPH  
M9 Price £11.95

6 digit, 11 functions,  
Hours, mins., secs., day,  
date, day of week,  
1/100th, 1/10th, secs.,  
10X secs., mins.  
Split and lap modes.  
Back-light, auto calendar.  
Only 8mm thick.  
Stainless steel bracelet  
and back.  
Adjustable bracelet.

SAME DAY DESPATCH.

M3 Price includes POST & PACKING

### QUARTZ LCD ALARM with Snooze Alarm

12:30<sup>pm</sup>  
Hours mins secs

8 14<sup>TH</sup>  
Month date day

7:30<sup>A</sup>  
Alarm



Price only  
**£7.95**

6 functions plus Alarm.  
Conference signal,  
5 minute snooze alarm,  
Conference signal sounds  
4 secs. before main alarm  
to give advance warning  
and an option to cancel.  
Snooze sounds 5 mins.  
after main alarm and is  
always preceded by the  
conference signal.

SAME DAY DESPATCH.

M4 Price includes POST & PACKING

### QUARTZ LCD ALARM CHRONOGRAPH with 12/24 display

12:30<sup>pm</sup>  
Hours mins secs

8 14<sup>TH</sup>  
Month date day

0:00<sup>0</sup>  
Min sec 1/10th

7:30<sup>A</sup>  
Alarm



Price only  
**£11.95**

Also available:  
SOLAR ALARM CHRONO  
M7 Price £17.95

Hours, mins, secs, day  
of week, Month, date,  
day of week, alarm,  
hour, mins., a.m./p.m.  
24 or 12 hour display  
mode. Alarm test.  
Chronograph, lap  
time, stop watch 1/10  
secs.

M64 Price includes POST & PACKING

### QUARTZ LCD Ladies Day Watch

Hours, mins., secs., day,  
date, back light, auto  
calendar.

12:30  
Hours mins

8 14  
Month date

:45  
Secs



Price only  
**£4.95**

Fully adjustable bracelet.  
Only 25 x 20mm and  
6mm thick.  
Silver or Gold.

M15 SAME DAY DESPATCH. P.&P. included

### QUARTZ LCD Ladies Cocktail Watch

Beautifully designed with a very thin bracelet.

12:30  
Hours mins

8 14  
Month date

:45  
Secs



Price only  
**£10.95**

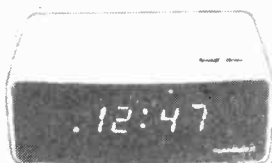
Hours, mins., secs., day, date,  
backlight and autocalendar.  
Bracelet fully adjustable to  
suit slim wrists.  
State Gold or Silver finish.  
Only 25 x 20 x 6mm.

M18 SAME DAY DESPATCH. P.&P. included

### HANIMEX Electronic LED Alarm Clock

Features and Specification:

Hour, minute display. Large LED display with  
p.m. and alarm on indicator. 24 Hours alarm  
with on/off control. Display flashing for power  
loss indication. Repeatable 9-minute snooze.  
Display bright/dim modes control. Size: 5.15"  
x 3.93" x 2.36" (131mm x 11mm x 60mm).  
Weight: 1.43 lbs (0.65 kg).



M13

Price only  
**£10.20** Mains operated.  
Thousands sold!

### QUARTZ LCD 5 Function GENTS/BOYS

Hours, mins., secs.,  
month, date, auto  
calendar, back light,  
quality metal  
bracelet. 6mm thick.

12:30  
Hours mins

8 14  
Month date

:45  
Secs



Price only

M1 SAME DAY DESPATCH. **£5.95** P.&P. included

### METAC GUARANTEE

All METAC products carry 12 months guarantee and we also refund your money if not satisfied with our goods or service in the first 10 days.

METAC's well equipped service centre minimises service delays. Please note, we do not delay your order to clear cheques.

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24 hour answering service  
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COUPON

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Send for our trade price list and order details. Sell our products to your friends and earn yourself

**£££'s**



## NEW 24 HOUR DESPATCH SERVICE

METAC have opened a new even faster Mail Order and Service Centre at DAVENTRY. Orders received before 3.30 p.m. will be despatched same day.

# VISIT OUR ELECTRONIC TIME CENTRES AND SEE ONE OF THE MOST IMPRESSIVE QUARTZ WATCH RANGES IN BRITAIN

## QUARTZ MELODY Alarm Chronograph

INCREDIBLE WATCH

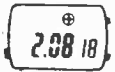
34 Functions



Count-down Timer



Alarm



Time Zone



Chronograph



5 independent working modes, day of week in English, French or German. (Just select the one you like). Hours, mins., secs., day, date, countdown alarm, dual time zone, 1/100th sec., stopwatch. Lap/split time, 1st and 2nd place times. Melody test function.

M30 SAME DAY DESPATCH.

Price only

£16.95

Price includes  
POST &  
PACKING

## SEIKO ALARM CHRONOGRAPH

With WEEKLY Alarm, Hours, mins., secs., month, date, day, am/pm. Weekly alarm — can be set for every day at designated time, e.g. 6.30 am on Monday, Wednesday and Friday. Alarm set time displayed above time of day. Full stopwatch functions, laptime, split etc.



SAME DAY  
DESPATCH.  
M10

Price only

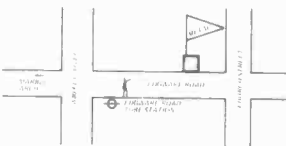
£49.95

including POST & PACKING

### METAC IN

### LONDON

327 EDGWARE ROAD, LONDON, W2  
01-723 4753



### 58 QUEENSWAY, LONDON, W2

Opposite Bayswater Tube Station  
Shop open 12 hours/day, 7 days/week

Situated in the heart of London's fast-moving electronics area. A very large selection of watches and consumer electronics products. Also many bargain discount/sale items.

2nd only to Oxford Street, this is London's round-the-clock international tourist area. An excellent selection of expensive famous watches, plus all the popular models.

### METAC IN

### NORTHAMPTON

11 ST. GILES SQUARE, NORTHAMPTON  
Tel: (0604) 39550

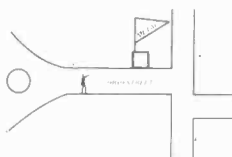


An excellent selection of watches and electronics. This shop also has televisions and video recorders to rent or buy.

### METAC IN

### DAVENTRY

67 HIGH STREET, DAVENTRY

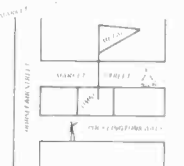


Situated in the middle of Daventry, only a short walk from Metac's Mail Order Centre, the shop stocks a wide range of watches and consumer electronic products. You may also rent or buy televisions and video recorders here.

### METAC IN

### LEICESTER

OMNI SHOPPING CENTRE, 27 MARKET STREET  
LEICESTER



Situated in the Omni walk-round shopping centre. Metac at Omni stocks an excellent range of quality watches at very attractive prices.

### ALSO IN STOCK

NEW SEIKO	Digital-Analogue Alarm Chrono	£73
SEIKO	James Bond Memory Bank	£39
BEL-TIME	Now only Pico-Quartz 50 Function All Singing, all Dancing Wrist Computer	£29.95
BEL-TIME	Alarm	£12.95
BEL-TIME	Chronograph	£10.95
BULER	Swiss Digital and Quartz-Analogue Collection	
CASIO	Alarm Chrono. Lowest price anywhere. Send for details	
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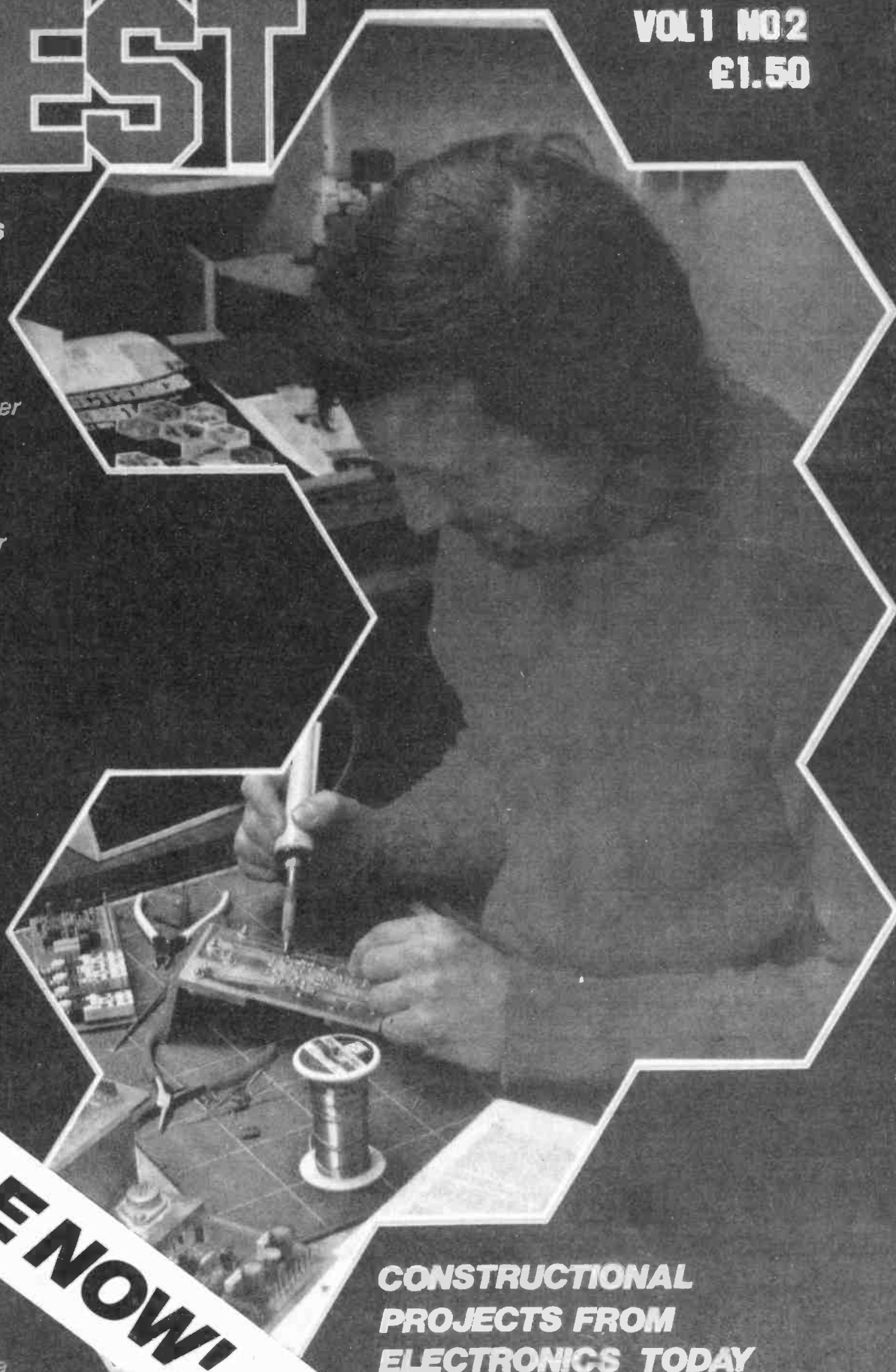
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# DMM SURVEY

The DMM is an invaluable aid to both the handyman and the professional. Tina Boylan explores the low cost end of the digital multimeter market.

The seventies saw the emergence of the digital multimeter onto the test equipment market and since Fluke produced the 800A in 1972 an explosive growth in production and design has been witnessed. A short life-span (three to five years) and the continuing introduction of new models from America and the Far East, as well as from Great Britain, has ensured lower prices and improved performance. The original LED display has been forsaken for the LCD display, despite early teething problems like poor refractory angle, slow response and blackening after two or three years. The LCD display now boasts a life of ten years.

## Analogue to Digital

The analogue meter has been with us for as long as 80 years and, despite its low cost, it contains some unwelcome characteristics which have caused problems in testing and for many of these problems the digital multimeter provides a more reliable service. Primarily the analogue meter contains moving parts which are prone to damage, overload, reverse polarity and wear. On the other hand the digital multimeter contains only electronic components, up to 20% of which may be used solely for protection purposes, and these, as well as being more rugged, mean that the meter itself can be made smaller and lighter than its analogue counterpart — by virtue of the latest integration methods.

As far as hand-held DMMs are concerned, those with standard features, (voltage, current, resistance) are sure to continually drop in price, thus serving the end of the

market traditionally held by the low cost hand-held analogue meter, while it maintains enough room to expand the capabilities of the same size meter for including complicated features.

For the professional, analogue meters can still appear to provide better testing facilities, particularly where bench-top models are concerned, but this is a myth which is fast being disproved by the technical advances being made in the DMM field. Until recently digital versions gave difficulty in reading transients or peaks because of the rapidly changing display, due in part to the fast analogue/digital conversion times of the DMM. The latest models now incorporate a peak reading memory, and these even take the guesswork out of watching a moving needle and making approximate readings.

## Microprocessors

Present trends in DMM development are focusing on the use of microprocessors in their design which will make the instrument easier and faster to use, as well as making it more powerful in terms of computational and mathematical facilities. This coupled with lowering price trends will mean that the man in the street will soon have a sophisticated DMM for his handyman activities while it remains an essential to the engineer and technician.

ETI has compiled a list of some of the low priced DMMs, both of the hand-held and bench varieties, to give some indication of the diverse types which are currently available.

### AVOMETER DA211

PRICE: £45.00 ex. VAT

BATTERY: Single 9 V dry cell

BATTERY LIFE: 200 hours approx.

DIMENSIONS: 90 x 171 x 31 mm

WEIGHT: 280 g

SELECTION OF RANGE OR FUNCTION: 8 in-line push buttons.

FUNCTIONS: Voltage, current, resistance

DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V

AC VOLTAGE RANGE: 5 ranges, 200 V to 1000 V

DC AND AC CURRENT: 4 ranges, 200  $\mu$ A to 200 mA plus 5th range measuring up to 10 A DC.

RESISTANCE RANGE: 4 ranges, 0 and 2M $\Omega$  plus low voltage diode test facility.

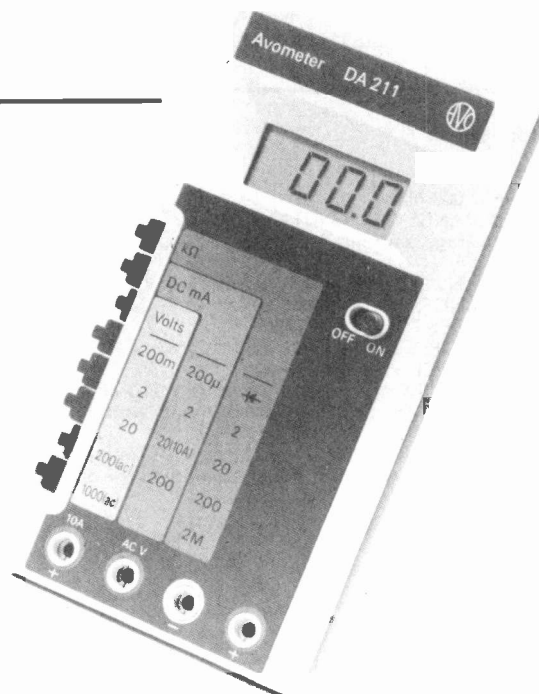
DISPLAY: 3½ digit LCD

HEIGHT OF DISPLAY CHARACTERS: 13 mm

READING RATE: 2.5/s

OVERLOAD PROTECTION: 500 mA fuse

OTHER FEATURES: Auto-polarity, auto-zero.





**AVOMETER DA212**

PRICE: £65.00 ex VAT

BATTERY: Two R6 (HP7)

BATTERY LIFE: Approx. 200 hours

DIMENSIONS: 160 x 96 x 47 mm

WEIGHT: 340 g

SELECTION OF RANGE OR FUNCTION: Rotation of two selector switches.

FUNCTIONS: Voltage, current, resistance

DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V

AC VOLTAGE RANGE: 5 ranges, 200 mV to 750 V

DC AND AC CURRENT: 200  $\mu$ A to 1000 mA

RESISTANCE RANGE: Two voltage levels, Hi or Lo, by push button.

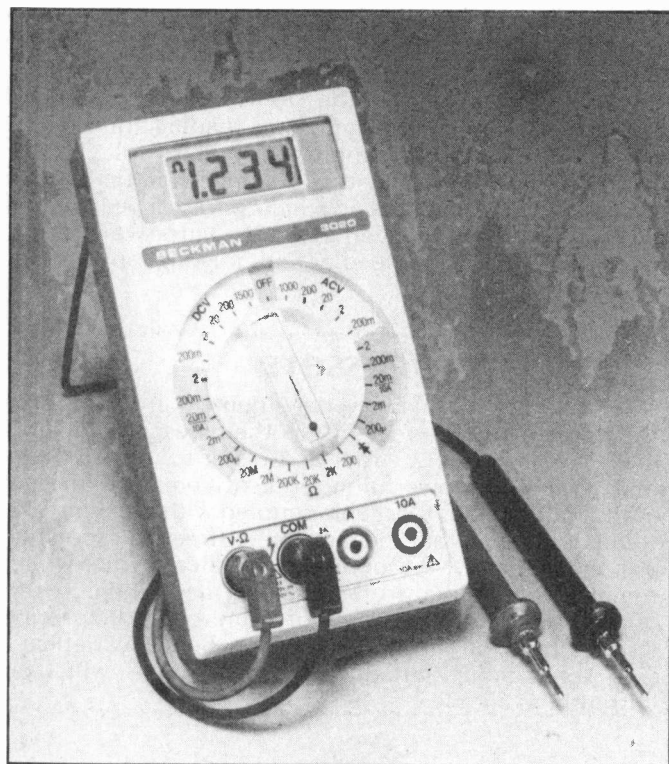
DISPLAY:  $3\frac{1}{2}$  digit LCD

HEIGHT OF DISPLAY CHARACTERS: 13 mm

READING RATE: 2.5/S

OVERLOAD PROTECTION: to 1000 V on voltage ranges and 250 V on all other functions.

OTHER FEATURES: Controlled by on/off switch, auto-polarity, auto-zero, battery low indicator.

**BECKMAN 3020**

PRICE: £115.00

BATTERY: 9 V transistor type

BATTERY LIFE: 2,000 hours

DIMENSIONS: 17.4 x 9.3 x 4.6 cm

WEIGHT: 453 g

SELECTION OF RANGE OR FUNCTION: Single central dial

FUNCTIONS: Voltage, current, resistance

DC VOLTAGE RANGE: 5 ranges, 200 mV to 1500 V

AC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V

DC AND AC CURRENT: 5 ranges, 200  $\mu$ A to 2 A. Separate input extends this to 10 A.RESISTANCE RANGE: 6 ranges from 200 $\Omega$  to 2M $\Omega$ DISPLAY:  $3\frac{1}{2}$  digit LCD

OVERLOAD PROTECTION: Voltage input protected to 1500 RMS AC. Resistance protected to 300V DC or RMS AC. Current inputs with 2 A fuse.

OTHER FEATURES: Insta-Ohms™ instant continuity test indicator, semiconductor test function provides 5 mA of test current, accuracy within 0.1%  $\pm$  1 digit on all DC voltage ranges, battery low indicator.**BECKMAN RMS 3030**

PRICE: £176.00

BATTERY: 9 V transistor type

BATTERY LIFE: 2,000 hours

SELECTION OF RANGE OR FUNCTION: Rotary switch

FUNCTIONS: Voltage, current, resistance, AC voltage and current in true RMS.

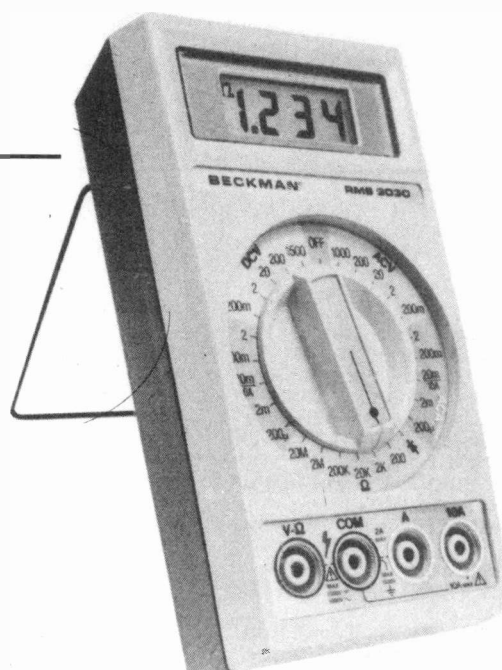
DC VOLTAGE RANGE: 5 ranges, 200 mV to 1500 V

AC VOLTAGE RANGE: 200 mV to 1000 V in true RMS

DC AND AC CURRENT: 200  $\mu$ A to 2 ARESISTANCE RANGE: 6 ranges from 200 $\Omega$  to 2M $\Omega$ DISPLAY:  $3\frac{1}{2}$  digit LCD

OVERLOAD PROTECTION: Input up to 1500 V DC or 1000 V RMS, resistance up to 300 V DC or RMS. Current inputs with 2 A fuse, 10 A range up to 20 A for 30 S.

OTHER FEATURES: Instant continuity test, RMS input accuracy is 0.5%, battery low indicator, calibration guaranteed for one year.





## FLUKE 8022A

PRICE: £75.00

BATTERY: 9 V

BATTERY LIFE: Alkaline 200 hours, zinc-carbon 150 hours.

DIMENSIONS: 18.0 x 8.6 x 4.5 cm

WEIGHT: 37 g

SELECTION OF RANGE OR FUNCTION: 8 in-line push buttons.

FUNCTIONS: 6 functions, 24 ranges

DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V

AC VOLTAGE RANGE: 5 ranges, 200 mV to 750 V

DC AND AC CURRENT: 4 ranges, 2 mA to 2000 mA

RESISTANCE RANGE: 200R to 20M

DISPLAY: 3½ digit LCD

OVERLOAD PROTECTION: Withstands 500 V on resistance, 1000 V on voltage, 2 A on current and 6 kV voltage transients.

OTHER FEATURES: Auto-polarity, auto-zero, battery low indicator, Tilt Stand.

## FLUKE 8024A

PRICE: £135.00

BATTERY: 9 V

BATTERY LIFE: Alkaline 200 hours, zinc-carbon 150 hours.

DIMENSIONS: 18.0 x 8.6 x 4.5 cm

WEIGHT: 480 g

SELECTION OF RANGE OR FUNCTION: 8 in-line push buttons.

FUNCTIONS: Voltage, current, resistance, conductance, temperature, continuity, level detection.

DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V

AC VOLTAGE RANGE: 5 ranges, 200 mV to 750 V

DC AND AC CURRENT: 4 ranges, 2 mA to 2000 mA

RESISTANCE RANGE: 200R to 20M

DISPLAY: 3½ digit LCD

OTHER FEATURES: Audible continuity test, fully compensated direct temperature readings from 0°C for any K-type thermocouple, peak hold feature for transient signals, auto-zero, auto-polarity.

## FLUKE 8010A/8012A (Bench Top)

PRICE: 8010A: £159.00

8012A: £199.00

BATTERY: Option of rechargeable NiCad batteries (-01 series)

BATTERY LIFE: 40 hours for DC voltage, 10 hours on other measurements.

DIMENSIONS: 6 x 22 x 25 cm

WEIGHT: 1.08 kg

FUNCTIONS: Current, voltage, resistance, conductance, high current

DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V

AC VOLTAGE RANGE: 5 ranges, true RMS, 200 mV to 750 V

DC AND AC CURRENT: AC: 5 ranges, 200 µA to 2000 mA

DC: 4 ranges, 200 µA to 2 A

RESISTANCE RANGE: 6 ranges, 200R to 20M, 8021A low resistance 2R to 20R

DISPLAY: 3½ digit LCD

OTHER FEATURES: Battery low indicator, one year guarantee, auto-zero, auto-polarity, touch and hold, 8012A has two additional low resistance ranges.



## FLUKE 8050A (Bench Top)

PRICE: £199.00

BATTERY: Rechargeable battery option (-01 series)

FUNCTIONS: Voltage (including AC voltage in true RMS, AC coupled) current, resistance, conductance, relative reference, direct readings in decibels. 39 measurement ranges.

DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V

AC VOLTAGE RANGE: 5 ranges, 200 mV to 750 V

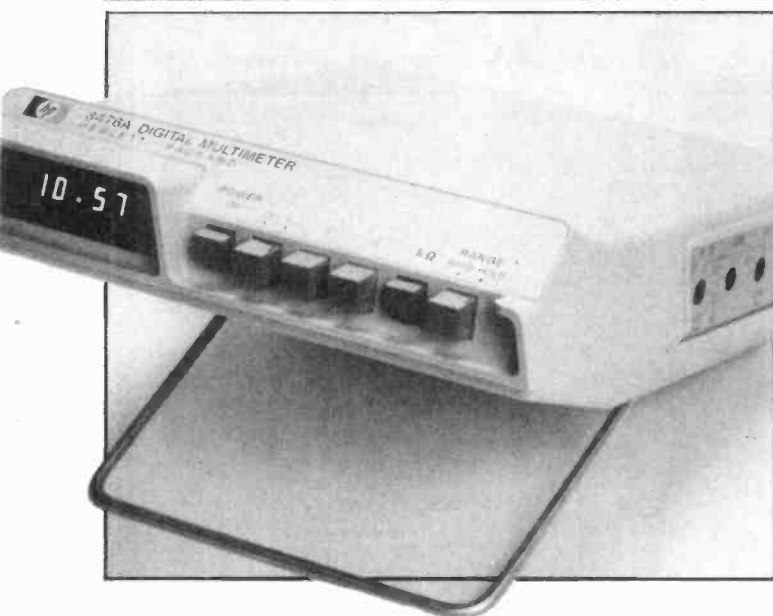
DC AND AC CURRENT: 5 ranges, 200 µA to 2000 mA

RESISTANCE RANGE: 200R to 20M

DISPLAY: 4½ digit LCD

OVERLOAD PROTECTION: Voltage: 750 V AC or 1000 V DC. Resistance: 300 V DC, short transients to 6 kV. 2 A fuse for current input plus heavy duty fuse.

OTHER FEATURES: Microprocessor control, DC accuracy of 0.3% for one year, safety indicator for input above 40 V.



## HEWLETT PACKARD 3476A/3476B (Bench Top)

PRICE: 3476A: £126.00

3476B: £155

BATTERY: Rechargeable NiCad batteries with 3476B.

BATTERY LIFE: 8 hours with 3476B

DIMENSIONS: 5.8 x 16.8 x 20.6 cm

WEIGHT: A: 0.77 kg, B: 0.97 kg

FUNCTIONS: Voltage, current, resistance

DC VOLTAGE RANGE: 100 µV to 1000 V

AC VOLTAGE RANGE: 3.3 mV to 700 V (RMS)

DC AND AC CURRENT: AC: 3.3 mA to 1.1 A

DC: 100 µA to 1.1 A

RESISTANCE RANGE: 1R0 to 11M

DISPLAY: LED

READING RATE: 3/S

OTHER FEATURES: Autorange, auto-polarity, auto-zero.



**KAISE MODEL SK-6100, SK-6110**

PRICE: SK-6110: £56.48, SK-6110: £65.17 ex VAT

BATTERY: Two 1.5 V, UM-3 or AA

BATTERY LIFE: 200 hours continuous operation.

DIMENSIONS: 155 x 85 x 28 mm

WEIGHT: 250 g

SELECTION OF RANGE OR FUNCTION: Rotary switch

FUNCTIONS: Voltage, current, resistance, low-power resistance.

DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V auto ranging

AC VOLTAGE RANGE: 4 ranges, 2 V to 600 V

DC AND AC CURRENT: 20 mA to 200 mA

RESISTANCE RANGE: 200R to 2M $\Omega$  and low power resistance 2k $\Omega$  to 2M $\Omega$ .

DISPLAY: 3½ digit LCD

HEIGHT OF DISPLAY CHARACTERS: 10 mm

READING RATE: 2/S

OTHER FEATURES: Auto display, auto ranging, range hold function, overrange indication, battery low indicator, 0.5% accuracy, SK-6100 has continuity check with buzzer, SK-6110 has 10 A AC/DC range.

**KAISE SK-6200, SK-6220**

PRICE: SK-6200: £34.74, SK-6220: £43.43 ex VAT

BATTERY: Two 1V5 type UM-3 or AA

BATTERY LIFE: 200 hours continuous operation.

DIMENSIONS: 155 x 85 x 28 mm

WEIGHT: 250 g

SELECTION OF RANGE OR FUNCTION: Rotary switch

FUNCTIONS: Voltage, current, resistance and low power resistance.

DC VOLTAGE RANGE: 200 mV to 1000 V auto ranging

AC VOLTAGE RANGE: 2 V to 600 V auto ranging

DC AND AC CURRENT: 200 mA, SK-6220 only 10 A

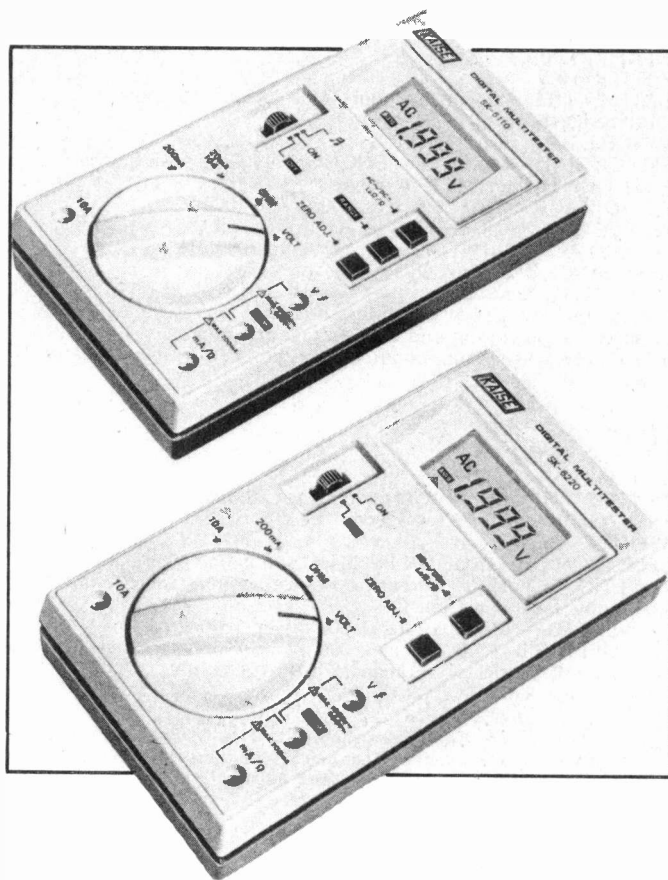
RESISTANCE RANGE: 200R to 2M $\Omega$ 

DISPLAY: 3½ digit LCD

HEIGHT OF DISPLAY CHARACTERS: 10 mm

READING RATE: 2/S

OTHER FEATURES: Full auto ranging, auto display, range hold function, overrange indication, 0.8% accuracy, battery low indicator. SK-6220 has 10 A AC/DC range.

**KEITHLEY 169 (Bench Top)**

PRICE: £110.00 plus VAT

BATTERY: Six 1V5 "C" cells

BATTERY LIFE: 1,000 hours carbon-zinc, 2000 hours alkaline.

DIMENSIONS: 85 x 235 x 275 mm

WEIGHT: 1.4 kg

SELECTION OF RANGE OR FUNCTION: Colour-coded push button switches.

FUNCTIONS: Voltage, current, resistance

DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V

AC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V

DC AND AC CURRENT: 5 ranges, 200  $\mu$ A to 2000 mA

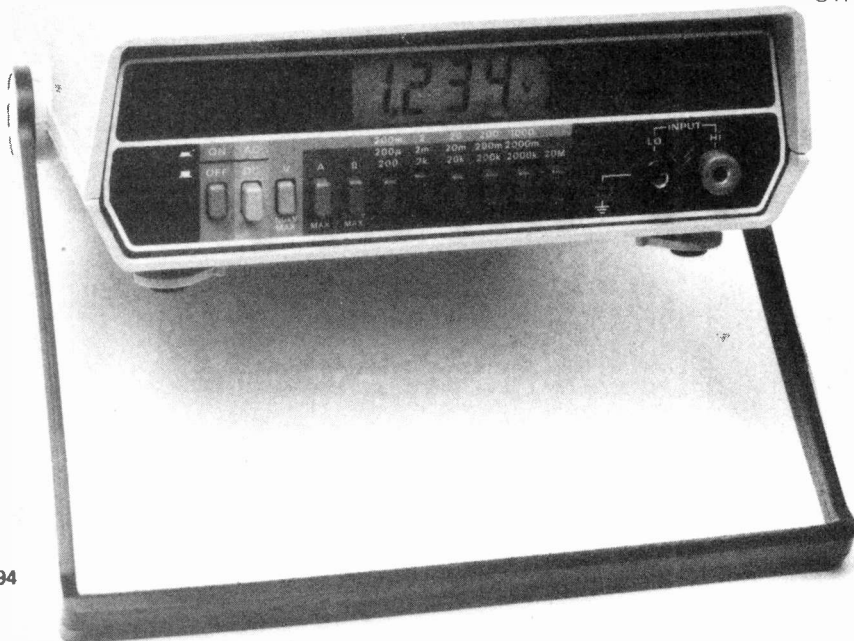
RESISTANCE RANGE: 6 ranges, 200R to 20M

DISPLAY: 3½ digit LCD

HEIGHT OF DISPLAY CHARACTERS: 0.6"

OVERLOAD PROTECTION: Voltage to 1400 V peak, resistance to 300 V RMS, current by 2 A fuse.

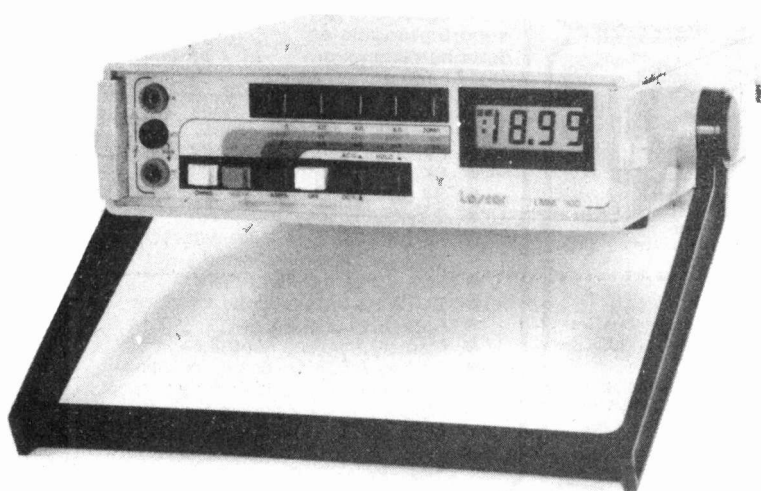
OTHER FEATURES: Auto-zero, out of range indication.





## KEITHLEY MODEL 130

PRICE: £79.00 ex VAT  
 BATTERY: 9 V alkaline or carbon-zinc  
 BATTERY LIFE: Alkaline 200 hours, carbon-zinc 100 hours  
 DIMENSIONS: 178 x 78 x 38 mm  
 WEIGHT: 400 g  
 SELECTION OF RANGE OR FUNCTION: Rotation of two selector switches.  
 FUNCTIONS: Voltage, current, resistance  
 DC VOLTAGE RANGE: 5 ranges, 200 mV to 1000 V  
 AC VOLTAGE RANGE: 5 ranges, 200 mV to 750 V  
 DC AND AC CURRENT: 5 ranges, 2 mA to 10 A  
 RESISTANCE RANGE: 200R to 20M  
 DISPLAY: LCD  
 HEIGHT OF DISPLAY CHARACTERS: 0.6"  
 OVERLOAD PROTECTION: mA input: 2 A fuse (250 V) externally accessible; 10 A input: 20 A for 15 S unfused.  
 OTHER FEATURES: Auto-zero, auto-polarity, stand mounted, overrange indication.



## LASCAR LM100 (Bench Top)

PRICE: £88.61  
 BATTERY: PP7  
 BATTERY LIFE: 2,000 hours  
 DIMENSIONS: 60 x 210 x 255 mm  
 WEIGHT: 1.2 kg  
 FUNCTIONS: 5 functions, 25 ranges  
 DC VOLTAGE RANGE: 6 ranges, 200 mV to 1000 V  
 AC VOLTAGE RANGE: 6 ranges, 200 mV to 1000 V  
 DC AND AC CURRENT: 6 ranges, 200 uA to 20 A  
 RESISTANCE RANGE: 200R to 20M  
 DISPLAY: 3½ digit LCD  
 HEIGHT OF DISPLAY CHARACTERS: 12.5 mm  
 READING RATE: 3/S  
 OTHER FEATURES: Auto-zero, auto-polarity, digital hold facility.

## SOLARTRON 7045 (Bench Top)

PRICE: £360.00  
 BATTERY: 4 type D NiCad rechargeable (Optional)  
 DIMENSIONS: 200 x 70 x 260 mm  
 WEIGHT: 2.1 kg with batteries  
 FUNCTIONS: Voltage, current, resistance, temperature  
 DC VOLTAGE RANGE: 6 ranges, 19.999 V to 1000 V  
 AC VOLTAGE RANGE: 5 ranges, 199.99 V to 750 V  
 DC AND AC CURRENT: AC 6 ranges, 19.99 uA to 1999 mA  
 DC 6 ranges, 19.999 uA to 1999.9 mA  
 RESISTANCE RANGE: 6 ranges, 199.99R to 19.999M  
 DISPLAY: 4½ digit LED  
 READING RATE: 4/S  
 OTHER FEATURES: Battery low indicator, freeze display button, automatic ranging.

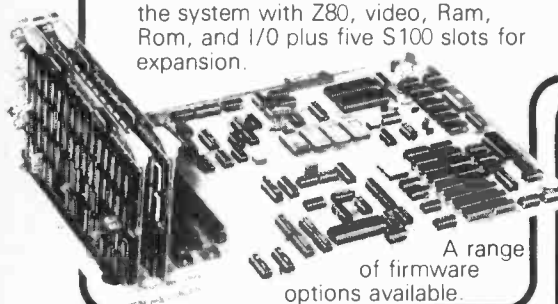




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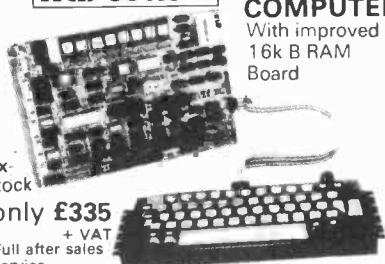
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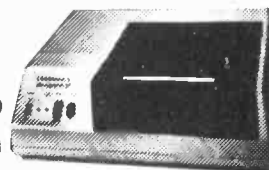
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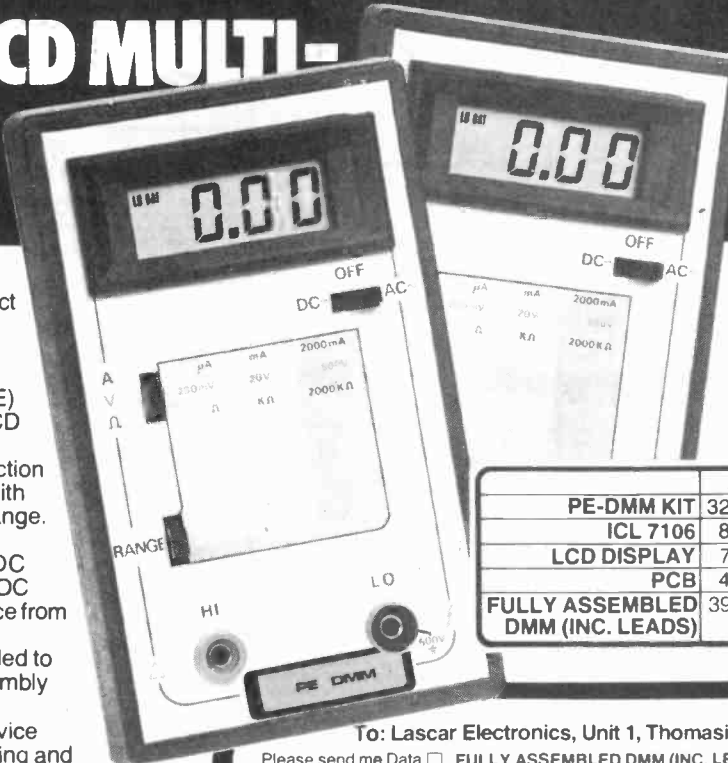
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# VOLTAGE REGULATOR DESIGN

If you've got the DC DTs, Karl Wright comes to the rescue with this simple design to stabilise your supply

The function of a DC voltage regulator is to supply a constant DC voltage to a load from a specified range of input voltages. The basic circuit of the DC regulator is shown in Fig.1. This circuit is usable over a wide range of input and output voltages. The actual function of regulation is performed by sampling the DC output of the regulator by a potential divider, formed by R5, R6 and RV1 and comparing it, via Q2, with a reference voltage provided by ZD2 and R3, the potential difference being passed to the DC amplifier, also formed by Q2. The DC signal then passes to the control section, formed by Q3 and Q4, which makes the necessary adjustment to maintain the output voltage at the specified value. The remaining components, R1, R2, ZD1 and Q1, form a constant current source, which supplies the collector of the DC amplifier, Q2, and the base of the control section, Q3. C1 is included to prevent high frequency instability and R4 is included to provide a leakage current path and to allow low load current operation.

## Design Procedure

In order to design the DC regulator to suit the individual requirement of a piece of equipment, the initial specifications must be defined as follows: — the output voltage required,  $V_o = 40$  V DC, the maximum output current required,  $I_o = 1$  A5, the range of input voltages to be used,  $V_{in(min)} = 45$  V DC,  $V_{in(max)} = 60$  V DC, the operating temperature range,  $T_{min} = 50^\circ\text{C}$ ,  $T_{max} = 125^\circ\text{C}$  and the output resistance,  $R_o \leq 0.25$ .

The values shown for each of the parameters will be used in the calculations as an example. The first step is to determine the parameters of the transistors in the control section, Q3 and Q4.

$$\begin{aligned} V_{ce4(min)} &= V_{in(min)} - V_o = 45 - 40 = 5 \text{ V} \\ V_{ce4(max)} &= V_{in(max)} - V_o = 60 - 40 = 20 \text{ V} \\ I_{e4(max)} &= I_o = 1 \text{ A5} \\ P_{tot} &= V_{ce4(max)} \times I_{e4(max)} = 20 \times 1.5 = 30 \text{ W} \end{aligned}$$

By reference to a semiconductor index the TIP29 is found to be adequate for this purpose. It also has a minimum value of  $H_{fe} = 40$ , which is used to determine the base current of Q4.

$$I_{b4} \leq \frac{I_{e4}}{H_{fe4(min)} + 1} = \frac{1.5}{40 + 1} = 36.66 \text{ mA}$$

Q3 is selected by the following parameters;

$$\begin{aligned} V_{ce3(max)} &= V_{ce4(max)} - V_{be4} = 20 - 0.7 = 19.3 \text{ V} \\ I_{e3} &= I_{b4} = 36.66 \text{ mA} \\ P_{tot3} &\leq V_{ce3(max)} \times I_{e3} = 19.3 \times 0.03666 = 0.7075 \text{ W} \end{aligned}$$

By reference to a semiconductor index the BFX50 is found to be suitable for Q3. It also has a minimum value of  $H_{fe} = 30$ .

$$\begin{aligned} \text{So, } I_{b3} &\leq \frac{I_{e4}}{(H_{fe4} + 1)(H_{fe3} + 1)} = \frac{1.5}{(40 + 1)(30 + 1)} \\ &= \frac{1.5}{1271} = 1.18 \text{ mA} \end{aligned}$$

$I_{c1}$  is at least  $= 2 \times I_{b3}$ , thus  $I_{c1} = 3$  mA and  $I_{e2} \geq I_{b3}$ . Using a silicon transistor for Q1 will allow the regulator to operate over the maximum temperature range, i.e.  $-50^\circ\text{C}$  to  $+125^\circ\text{C}$ . As Q1 is a PNP type, a BFX29 is chosen, with an  $H_{fe(min)} = 50$  and  $V_{be} = 1$  V0. Therefore, if  $I_{c1} = 3$  mA,  $I_{e1} = I_{c1} + I_{b1} = 3 + 3/50 = 3.06$  mA.

$V_{ZD1}$  is chosen as 2V7.

$$R2 = \frac{V_{ZD1} - V_{eb1}}{I_{e1}} = \frac{2.7 - 1}{3.06 \times 10^{-3}} = 555.56 \Omega \sim 560 \Omega$$

$$\begin{aligned} R1 &= \frac{V_{in(min)} - V_{ZD1}}{I_{ZD1} + I_{b1}} = \frac{45 - 2.7}{(148 + 0.06) \times 10^{-3}} \\ &= 285.69 \Omega \sim 300 \Omega \end{aligned}$$

$V_{ZD2}$  is not critical, so a value of 6V2 is chosen.

Current through ZD2 must be sufficient to maintain breakdown, thus a value of  $I_{ZD2}$  which is larger than  $I_{e2}$  is chosen, in this case 5 mA.

$$R3 = \frac{V_o - V_{ZD2}}{I_{ZD2}} = \frac{40 - 6.2}{5 \times 10^{-3}} = 6760 \Omega \sim 6 \text{ k}\Omega$$

The collector current of Q2 will be approximately 3 mA, so a BFX50 is chosen for Q2.

RV1 is chosen as 250R and is a wire wound type.  $I_{R5}$  is chosen as 5 mA.

$$R5 = \frac{V_o - V_{be} - V_{ZD2}}{I_{R5}} = \frac{40 - 0.7 - 6.2}{5 \times 10^{-3}} = 6620 \Omega \sim 6 \text{ k}\Omega$$

$$R6 + RV1 = \frac{V_{be} + V_{ZD2}}{I_{R5}} = \frac{0.7 + 6.2}{5 \times 10^{-3}} = 1380 \Omega$$

$$\begin{aligned} \text{So, } R6 &= 1380 - RV1 = 1130 \Omega \sim 1 \text{ k}\Omega \\ C1 &= 100 \text{ nF} \\ R4 &= 33 \text{ k}\Omega \end{aligned}$$



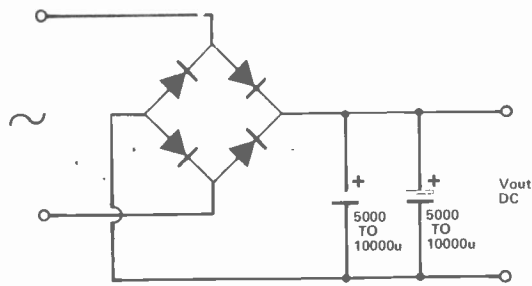
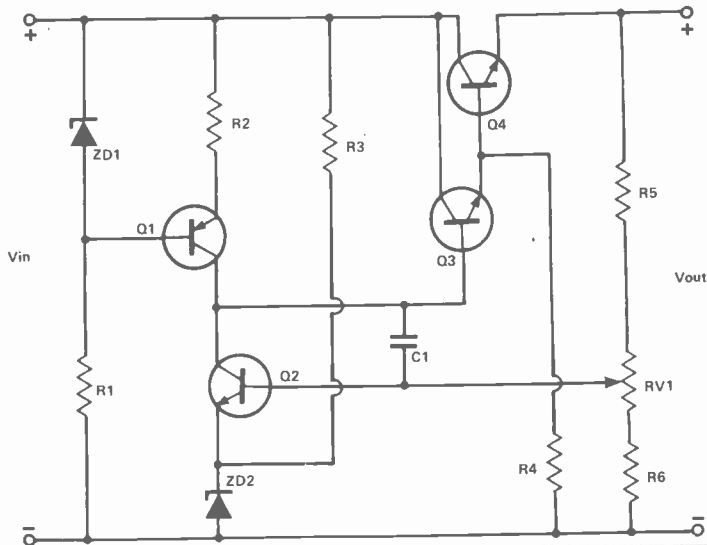
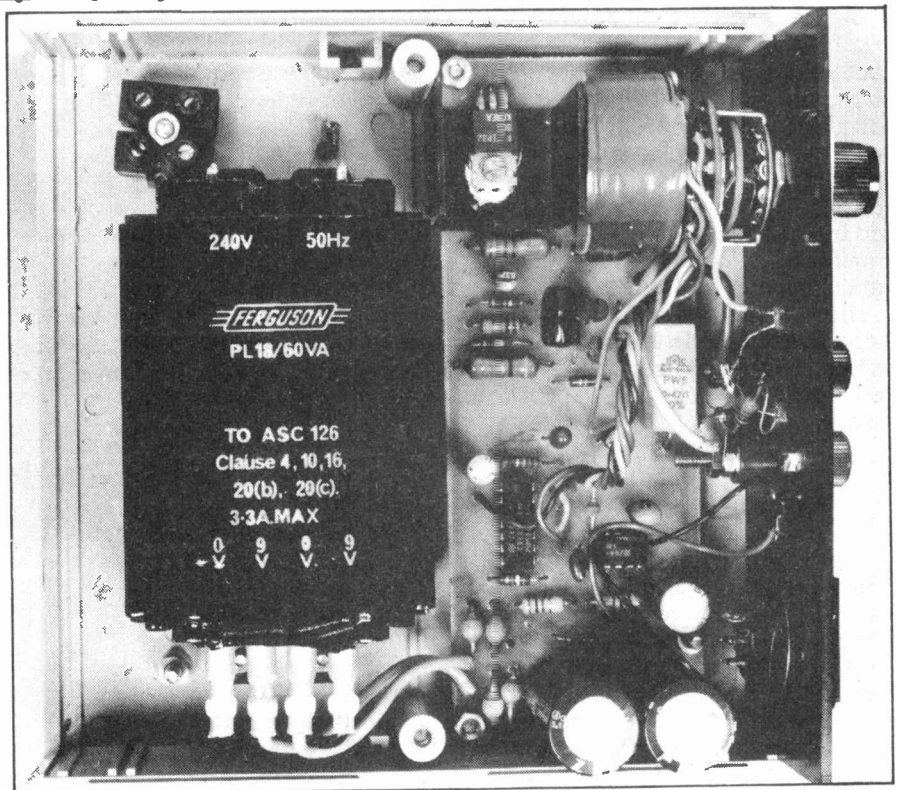


Fig. 1. (top) The basic circuit of the DC regulator.

Fig. 2. (above) This simple circuit will feed the regulator with a smoothed, but unregulated supply.

This is how professionals do it (right). This commercial power supply unit produces a regulated output voltage by the same principles as those on which the above simple design is based.



It should be noted that with the TIP29 operating at 30 W it should be mounted on an adequately sized heatsink. Alternatively a higher power transistor could be used.

The regulator needs a relatively smooth input voltage. This can be supplied by the circuit shown in Fig.2. This is simply a standard full wave bridge rectifier circuit with a large reservoir capacitance.

The DC output from the circuit can be calculated by;  $V_{DC} = 1.414 V_{AC}$ .

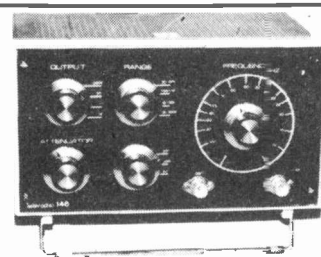
The ripple output from the regulator is negligible as long as the ripple from the basic rectifier is relatively small, this being achieved by using a large reservoir capacitance.

If a high output voltage from the regulator is necessitated, then the positions of ZD2 and R3 should be interchanged, this being done to allow the transistor Q2 to operate at low levels irrespective of output voltage.

ETI

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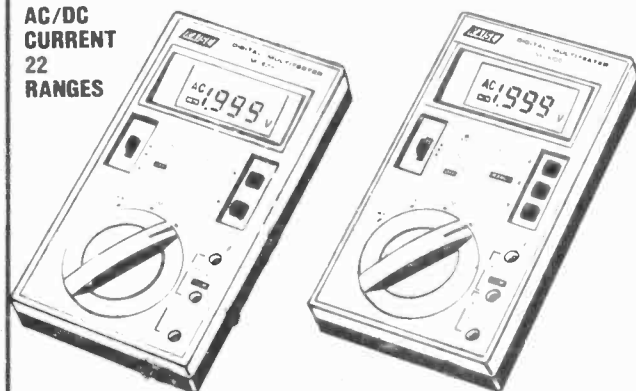
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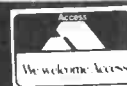
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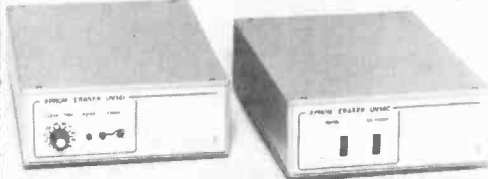


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4006	95p	4045	£2.63	4098	£1.92	4415V	£5.24	4536	£3.69
4007	18p	4046	£1.10	4099	£2.00	4422	£5.66	4537L	£26.10
4008	80p	4047	£1.71	4100	£1.92	4433	£12.30	4538	£1.20
4009	40p	4048	77p	4101	£1.69	4435V	£5.40	4539	97p
4010	50p	4049	45p	4102	£3.67	4450	£3.81	4541	£1.19
4011	25p	4050	49p	4103	£3.67	4451	£3.81	4543	£1.80
4012	18p	4051	80p	4104	£1.85	4461	£3.93	4549	£4.38
4013	50p	4052	80p	4105	£1.85	4462	£4.41	4552	£14.85
4014	84p	4053	80p	4106	92p	4469P	£14.20	4553	£4.30
4015	84p	4054	£2.18	4107	£1.28	4490P	£3.14	4554	£1.38
4016	45p	4055	£2.55	4108	£7.54	4500	£8.95	4555	78p
4017	80p	4056	£2.55	4109	£1.28	4501	29p	4556	72p
4018	89p	4059	£2.10	4110	£3.00	4502	£1.20	4557	£3.86
4019	45p	4060	£2.10	4111	£1.77	4503	70p	4558	£1.25
4020	99p	4062	£10.00	4112	£1.54	4505	£3.71	4559	£4.38
4021	£1.10	4063	£1.90	4113	£1.54	4506	50p	4560	£2.50
4022	£1.90	4066	55p	4114	£1.54	4507	55p	4561	81p
4023	27p	4067	£7.21	4115	£1.54	4508	£2.90	4562	£5.60
4024	78p	4068	27p	4116	£1.54	4509	£1.59	4566	£1.59
4025	27p	4069	27p	4117	£1.54	4510	£1.59	4568	£2.38
4026	£3.25	4070	30p	4118	£1.90	4512	80p	4569	£2.38
4027	50p	4071	25p	4119	£2.41	4514	£2.65	4572	40p
4028	84p	4072	25p	4120	£2.41	4515	£3.00	4580	£4.77
4029	99p	4073	25p	4121	£2.41	4516	£1.10	4581	£2.62
4030	74p	4075	25p	4122	£7.54	4517	£4.46	4582	£1.14
4031	£4.31	4076	£1.07	4123	£2.31	4518	£1.00	4583	90p
4032	£1.31	4077	29p	4124	98p	4519	80p	4584	90p
4033	£2.63	4078	29p	4125	98p	4520	£1.00	4585	£1.27
4034	£2.00	4081	27p	4126	98p	4521	£2.50	4597	£2.44
4035	£1.10	4082	27p	4127	98p	4522	£1.11	4598	£2.98
4037	£1.90	4085	£1.35	4128	98p	4526	£1.08	4599	£6.95
4038	£1.20	4086	£1.35	4129	98p	4527	£1.50	4700	£1.75
4039	£2.78	4089	£2.91	4130	98p	4528	£1.20		
4040	£1.00	4093	80p	4131	98p	4529	£1.30		
4041	£1.59	4094	£2.50	4132	98p	4530	70p		

### 74C

74C00	28p	74C76	57p	74C153	£1.15	74C903	57p	74C975	£5.01
74C02	28p	74C83	£1.34	74C154	£1.08	74C904	57p	74C976	£5.01
74C04	28p	74C85	£1.34	74C165	£1.08	74C905	£7.53	74C977	£5.01
74C08	28p	74C86	67p	74C173	93p	74C906	57p	74C978	£5.01
74C10	28p	74C88	£4.62	74C174	93p	74C907	57p	74C979	£17.90
74C12	28p	74C90	89p	74C175	93p	74C908	£1.00	74C980	£17.90
74C14	28p	74C93	89p	74C192	£1.15	74C909	£1.69		
74C16	28p	74C95	£1.08	74C193	£1.15	74C910	£7.45	80C95	85p
74C18	28p	74C97	£1.27	74C195	£1.08	74C911	£7.39	80C96	92p
74C20	28p	74C150	£3.81	74C200	£7.46	74C912	£7.39	80C97	85p
74C22	28p	74C151	£2.55	74C221	£1.41	74C914	£1.46	80C98	92p
74C24	28p	74C154	£3.81	74C245	£2.98	74C915	£1.15	82C19	£6.20
74C26	28p	74C157	£2.29	74C249	£1.79	74C918	£1.10	82C19	£6.20
74C28	28p	74C160	£1.49	74C274	£1.79	74C921	£17.07	82C30	£2.90
74C30	28p	74C161	£1.15	74C901	57p	74C922	£3.78		
74C32	28p	74C162	£1.15	74C902	79p	74C923	£3.86		

### MODULATORS

UM1111 E36 UHF Ch.36 Vision Modulator £2.50  
UM1231 UHF Ch.36 Vision Modulator wide bandwidth for computers etc £4.70  
UM1263 FM Sound Sub-carrier Modulator £2.50

### SWITCH MODE PSUs

AC 5221S 5V/10A £69.90  
AC 5221S 5V/5A, 12V/1A, -12V/1A, 5V/0.1A £86.80  
AC 5421S 5V/20A £99.20  
AC 5421S 5V/10A, 12V/2A, -12V/2A, 5V/0.1A £126.50

### MICROPROCESSORS

COMPUTER BOARDS		6800 MPU	\$6.55	INTERFACE	
114 x 233 mm fiberglas,		6802 MPU	\$9.95	81LS95 6/7/8	£1.40
gold plated edge connector,		6810 (128 x 8 RAM)	£3.25	75491 LED board	50p
Buttered SC/MP CPU £9.40		68A10 (128 x 8 RAM)	£3.75	75492	92p
SC/MP Preboard £3.40		6820, 6821 PIA	£3.96	2N425	£3.95
820 CPU card	£9.40	6820, 6824	£4.85	81726/81728	£2.84
VDU A* set	£9.40	MC68000	£2.64	IL74	£6.40
VDU B* of	£8.90				
VDU C* three	£8.90	6502	6502	CR Controller: Uarts	
EPROM Programmer	£9.40	6520 PIA	£7.95	Thompson CSF ST 9536A/E11.50	
12708A	£9.40	6522	£7.95	AY-5-1013 UART 16I02	£1.50
4k PROM board (S204A)	£9.40			AY-5-1013A	£4.70
8k PROM board (2708A)	£9.40	CARDOS		AY-5-1014A	£5.60
32k RAM board (2102A) 1k	£9.40	COSMAC COP 1802CE	£6.50	AY-5-1015	£5.60
8k	£9.40	COSMAC COP 1802E	£10.85	CHAR. GEN. KEYBOARD	
2k	£9.40	COP 1864	£7.25	ENCODER	
32k RAM board (2114A) 1k	£9.40	STATICS (Mostly 4550S)		WCM 56760	£9.75
8k	£8.90	2101-256 x 4	£1.20	MD 3-2513 [5V Upcassce]	£6.00
2M Interface	£9.40	2102-1K x 1	£2.25	DM 8578 CAB/8W/	£14.25
Keyboard Interface	£8.90	2111-256 x 4	£1.95	AY-5-2376	£9.75
PSU 5V +12V, -12V board	£8.90	2112-256 x 4	£2.25		
		2114, 4045-1K x 4	£4.25	FRMWARE	
PSU 5V, -12V board	£5.50	8 x 2114	£28.00	Z80K for Z80 (1 x Z80)	£14.95
ISBUS 11 x 13n 35 slot back-board	£11.50	2114A-1K x 4	£2.50	Z801 TRY BASIC for Z80 (2 x Z80)	£19.95
13" x 14 1/4" approx. Epoxy Glass. Unleaded		4118-1K x 8	£15.50	AK HBL for SC/MP (4 x Z80)	£49.95
Further details on request					
		DYNAMICS			
		MK 4115 15K 250S	£4.95	AK HBL-NIM for SC/MP (4 x Z80)	£49.95
		MK 4816 2K x 8	£30.52		



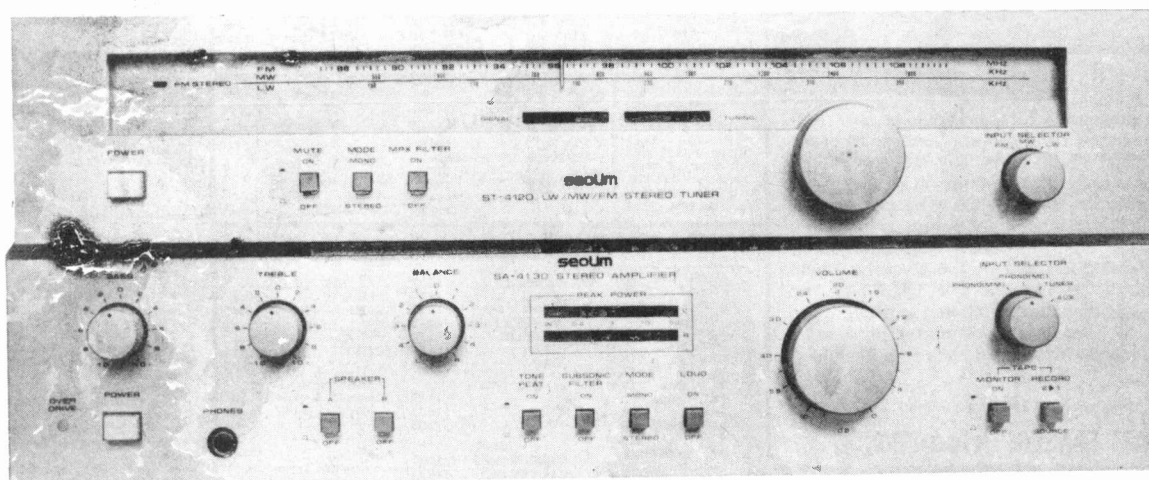
# HI-FI SYSTEM OFFER

This month we present the biggest and best ETI readers' offer ever — a complete hi-fi system. We've torn up its normal price tag of over £300 and slapped on our own — £279 including VAT and postage. Available only to ETI readers.

The system, imported by Videotone, bears a name unfamiliar to British Audiophiles — Seoum. The loudspeakers bear the familiar Videotone badge.

What do you get for your money? A slimline 30 W per channel stereo amplifier

with moving coil input, an AM/FM stereo tuner and matched cassette deck with Dolby NR (naturally) and selectable bias and equalisation. A pair of the excellent Videotone GB2 loudspeakers completes the system. Just look at the technical specifications.



## TUNER SPECIFICATION

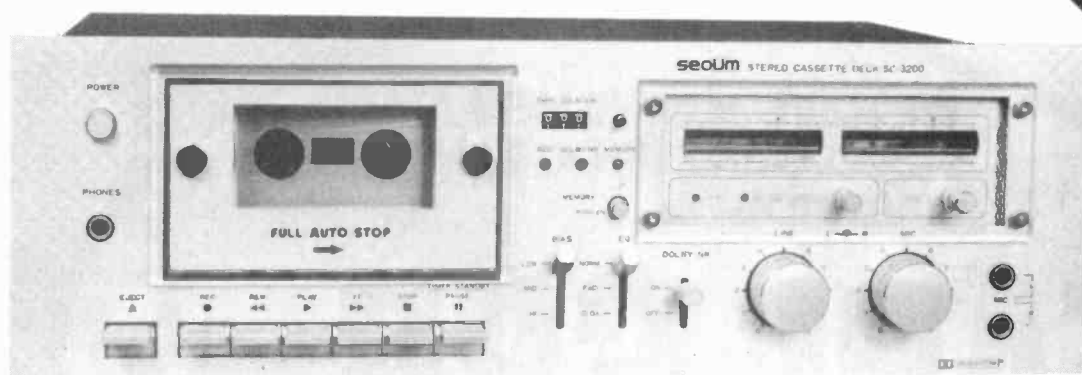
<b>FM Section — Tuning Range</b> 87.5-109 MHz	<b>Sensitivity</b> IHF/75R 0.8uV	<b>Selectivity</b> IHF/200 kHz 95 dB	<b>Capture Ratio</b> 1.2 dB
<b>T.H.D.</b> Mono 0.08% Stereo 0.15%	<b>S/N Ratio</b> Mono 85 dB Stereo 80 dB		
<b>AM Section — Tuning Range</b> 525-1650 kHz	<b>Sensitivity</b> IHF/75R 10uV	<b>Selectivity</b> IHF/75R 45 dB	<b>T.H.D.</b> 0.8%
<b>Dimensions</b> 430(W) x 285(D) x 184(H) mm			
<b>FEATURES:</b> 0.8uV (9.3 dBf) FM sensitivity; New MPX circuit with pilot signal cancelling improves FM frequency response up to 18 kHz within $\pm 1$ dB; New FM detector quadrates FM S/N			

## AMPLIFIER SPECIFICATION

<b>Audio Section — Output</b> Continuous RMS driven at 20-20,000 Hz 8R 30 + 30 W	<b>Peak Output</b> 100 W + 100 W	<b>T.H.D.</b> at rated output 20-20,000 Hz 0.03%
<b>Frequency Response</b> 8—60 kHz	<b>S/N Ratio</b> Phono 1 (MM) 82 dB	<b>IHF "A" Weighted</b>
Phono 2 (MC) 70 dB Aux 102 dB	<b>Input Sensitivity</b> Phono 1 (MM) 2.2mV/47k	Phono 2 (MC) 0.2mV/0.1 k
<b>Speaker Impedance</b> 4, 8, 16 R	Aux 125mV/50k	
<b>FEATURES</b> 30 W + 30 W Output power at 0.03% THD from 20Hz to 20kHz; Quickest electronic overload protection circuit with Green (normal) Red (protected) LED indicator; Super low noise EQ amp for moving coil and moving magnet cartridge; Tape dubbing facility · 12 dB/Oct subsonic filter.		



Under £300!



#### CASSETTE RECORDER SPECIFICATION

1. Frequency Response (Dolby NR OFF) Cr O<sub>2</sub> Tape 30—16,000 Hz FeCr Tape 30—16,000 Hz Normal Tape 30—15,000 Hz
2. S/N Ratio (From Dolby level) Normal Tape; Flat 52 dB Weighted NR OFF 53 dB Weighted NR ON 62 dB Fe Cr & Cr O<sub>2</sub> Tape; Flat 56 dB Weighted NR OFF 58 dB Weighted NR ON 67 dB
3. Harmonic Distortion (Normal Tape) 0.5%
4. Cross Talk 1 kHz 55dB
5. Erasure Effect 75 dB
6. Bias Frequency 100 kHz
7. Wow & Flutter Weighted 0.05 %
8. Fast Forward time (C-60) 75 S
9. Rewind time (C-60) 75 S
10. Input Sensitivity LINE 60 mV MIC 0.25 mV DIN 8.25 mV
11. Output level 0-1 V

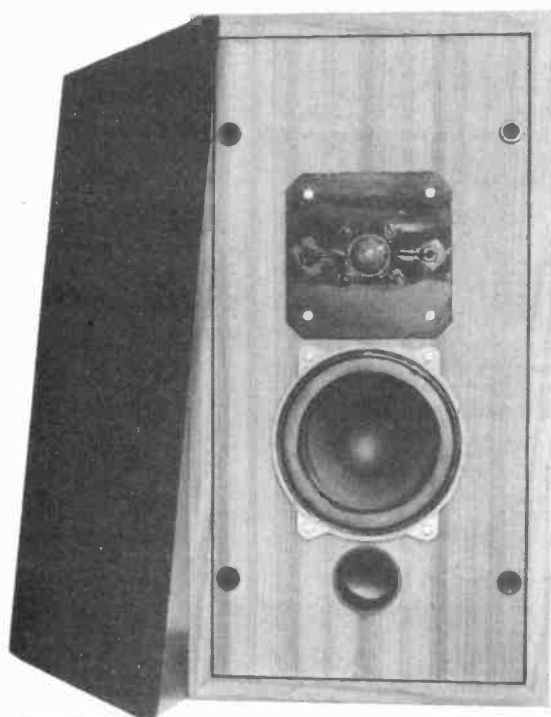
**EQ & BIAS SELECTOR** Equipped with EQ & Bias 3-position selector switch that can always keep the best recording and playing conditions for any tape used.

**PEAK INDICATOR** Generally a VU meter can't respond to transient sounds, so it can't indicate these sounds accurately. The peak indicator indicates them precisely, so preventing distortion and making an overall better recording.

**FEATURES:** Dolby system front loading stereo cassette deck; New LED VU meter indicating peak level; Selector checking recording & playback level and output level; Full auto-stop and memory function; Output level control volume; FET pre-amplification; 3-position selector of bias and E.Q.; Built-in Dolby NR circuits; Recording mixing facility; Low wow-flutter and distortion; Electronic timer stand by protecting pinch roller.

#### GB2 LOUDSPEAKERS SPECIFICATION

**Type:** Port loaded, two way, floorstanding/bookshelf model. **Recommended Amplifier power:** 15-40 W. In general they need between 10 and 15 W RMS per channel for every 1000 cu ft of room space. **Impedance:** 8 R nominal. **Frequency Response:** 50 Hz to 20 kHz  $\pm$  5 dB. **Efficiency:** 8V8 gives 90 dB. **Distortion:** Less than 1% 60 Hz to 20 kHz for 5 V input. **Finish:** Teak foil with black frets. **Size:** 19" high, 10" wide and 11" deep. **Weight:** 22 lbs each.



- Amp has moving coil input!
- Peak power delivery of over 75W per channel!
- Tuner has high sensitivity and selectivity
- Cassette deck uses accurate LED indication
- Guaranteed system compatibility for clear sound

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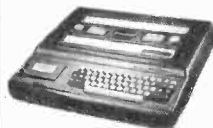
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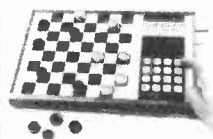
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- ★ Problem Mode
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- ★ Auto scorekeeping

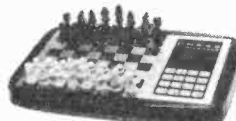
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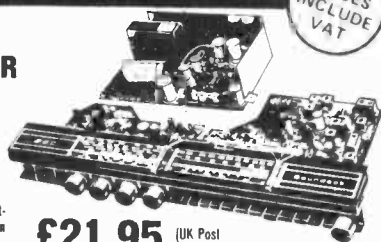
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## GEC STEREO TUNER/AMPLIFIER

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amplifier by GEC

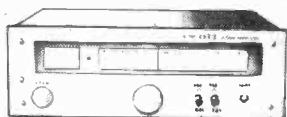
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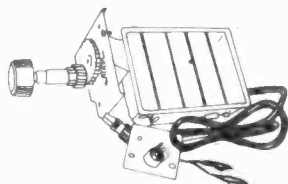


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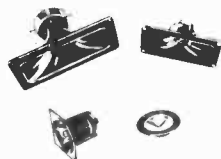
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**REJECT LED CALCULATORS** some repairable but excellent value for spares.  
Yields lots of parts. **£2.50** each. **LIQUID CRYSTAL CLOCK DISPLAY** nice style  
display gives black digits on grey background, could also be used for freq. meters,  
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**rotary knobs** satin finish black nylon knobs to fit standard 1/4" D shaped shafts.  
Coloured snap-in caps also have position indicator line. Cap colours available,  
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# ETIPRINTS

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

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

ETIPRINTS are made from our original artwork ensuring a neat and accurate board. We thought ETIPRINTS were such a good idea that we have patented the system (patent numbers 1445171 and 1445172).

## PARTS LIST

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

## HOW IT WORKS



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

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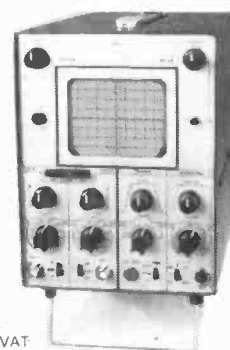
### SPECIFICATION FOR ALL MODELS

- ★ CH1, CH2: 5mV/div-20V/div in 9 col. steps
- ★ BANDWIDTH: 10MHz (DT-410), 12MHz (DT-412)
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- ★ TIME BASE: 0.5µs/div-200ms/div in 18 cal steps  
X5 Expansion to 100 ns/div  
X5 Multiplier to 1s/div
- ★ XY FACILITY: Matched Inputs X=CH1, Y=CH2

- ★ TRIGGER: Level Control, ± Slope  
Bright Line AUTO NORMAL, TV Triggering  
CH1, CH2 0.5div, EXT Trig. 100mv
- ★ Z Modulation
- ★ Graticule blue, ruled 8x10div (6.4x8cm<sup>2</sup>)
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DT-400 Series



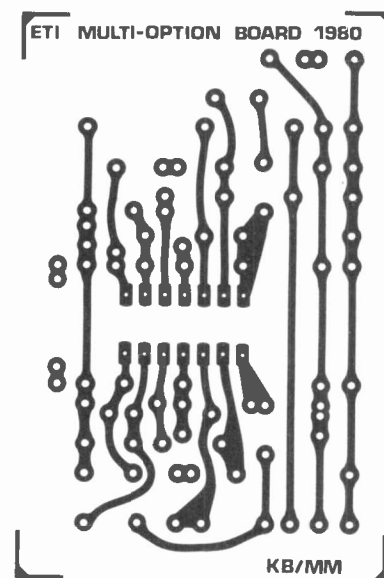
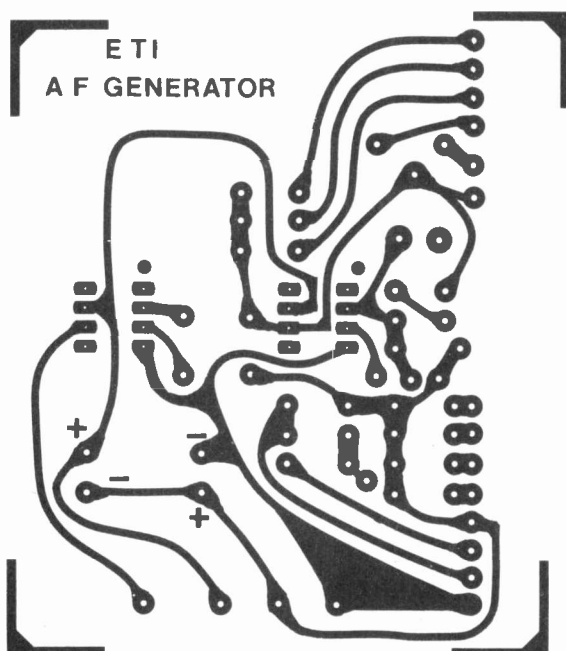
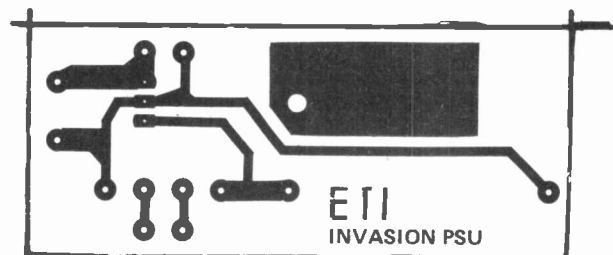
# PCB FOIL PATTERNS

The double sided main board (copyright Tangerine Computers Limited) is not shown. The sound effects board will be shown next month.

A heatsink as described in the Space Invasion article must be used with the project's power supply (foil pattern right) or the unit will overheat and cease operation.

Bottom right: The ETI Multi-Option Board can be used for all five projects.

Below: Audio Test Oscillator.





# FANCY A QUICK RUB-DOWN?

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### Principle:

The dosimeter is an ionisation chamber type using a quartz fibre electroscope as the indicating element. A microscope is used to project the image of the moving quartz fibre element on to a graticule scale. The quartz fibre is mounted on a wire electrode, which in turn is supported by a high quality insulator. When the instrument is charged, positive charges distribute themselves over the wire electrode and quartz fibre causing the fibre to bend away from the electrode. The fibre will take up a position depending on the amount of charge on the system.

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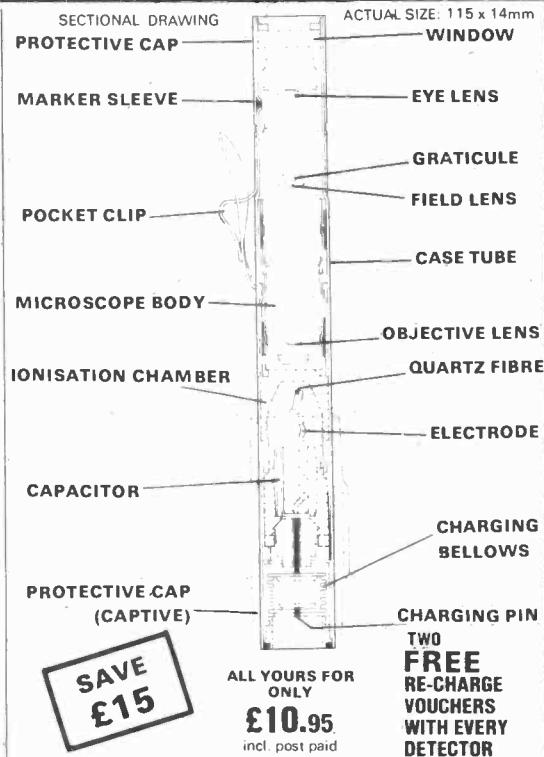
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BZ8813V	10p	IC7451	10p	74C10	20p	TIS92	10p	BFT60	5p
2N3006	5p	MC4001	15p	MC4049	35p	TIS93	10p	4013	30p
1N4305	5p	MC4012	15p	2N3704	8p	BC337	8p		
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BZ8813V	10p	IC7451	10p	74C10	20p	TIS92	10p	BFT60	5p
2N3006	5p	MC4001	15p	MC4049	35p	TIS93	10p	4013	30p
1N4305	5p	MC4012	15p	2N3704	8p	BC337	8p		
BZX79C12	10p	MC4020	75p	2N5447	5p	BC327	8p		

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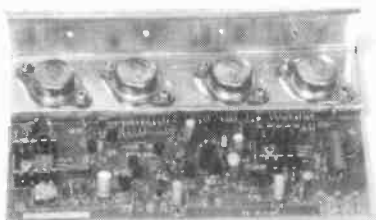
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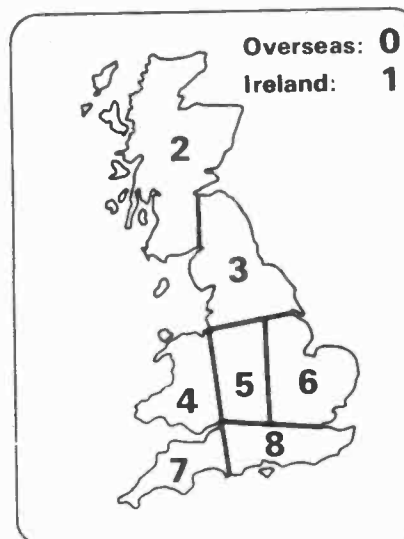
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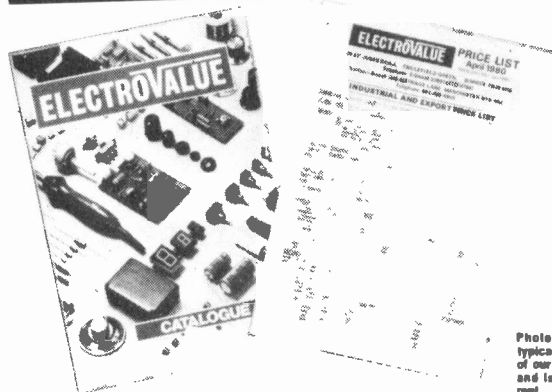


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## THE ZX80 COMPANION

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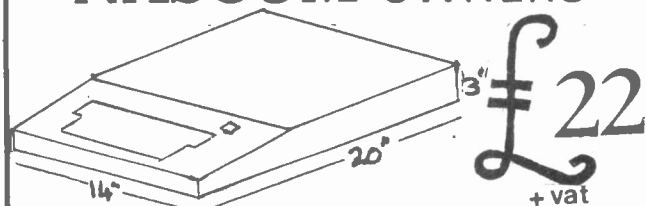
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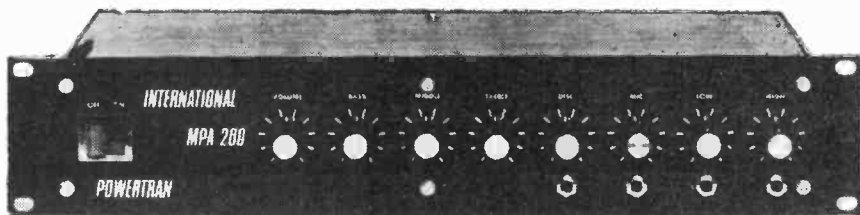
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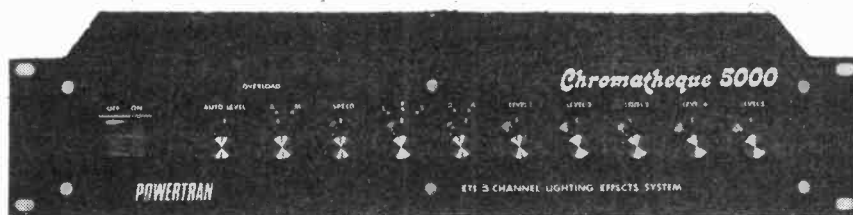
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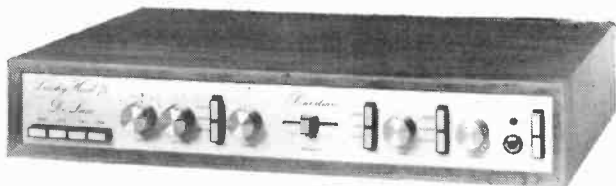
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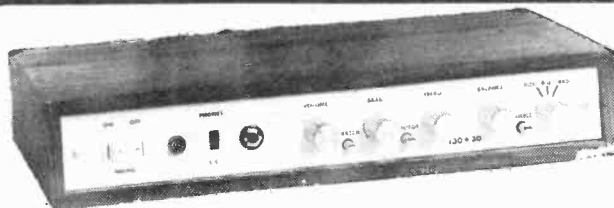
**SYNTHESIZER KITS ON PAGE 9. MORE KITS AND ORDERING INFORMATION ON INSIDE FRONT COVER.**



### 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 while distortion is less than 0.01%.

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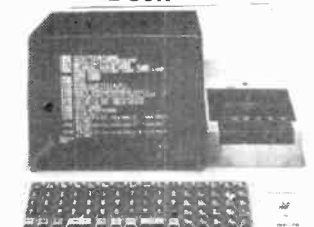
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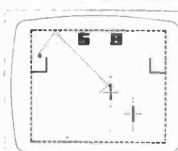
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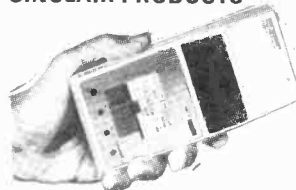
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4011	19p	555	21p	BC107	9p	BC328	14p	AD162	40p	W O 4	1 A
4012	18p	556	58p	BC108	9p	BC337	15p	TIP30	35p	400V	30p
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4017	69p				
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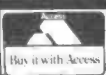
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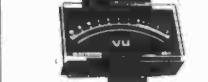
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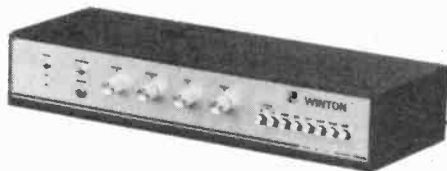
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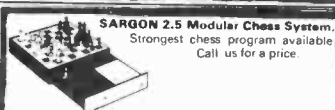
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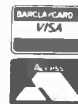
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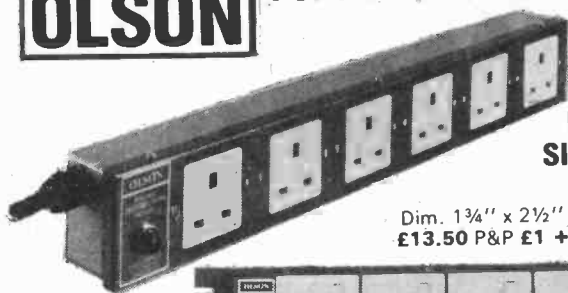
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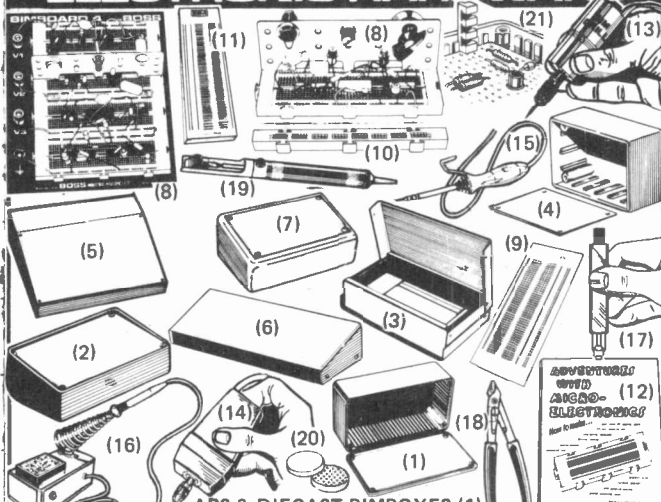
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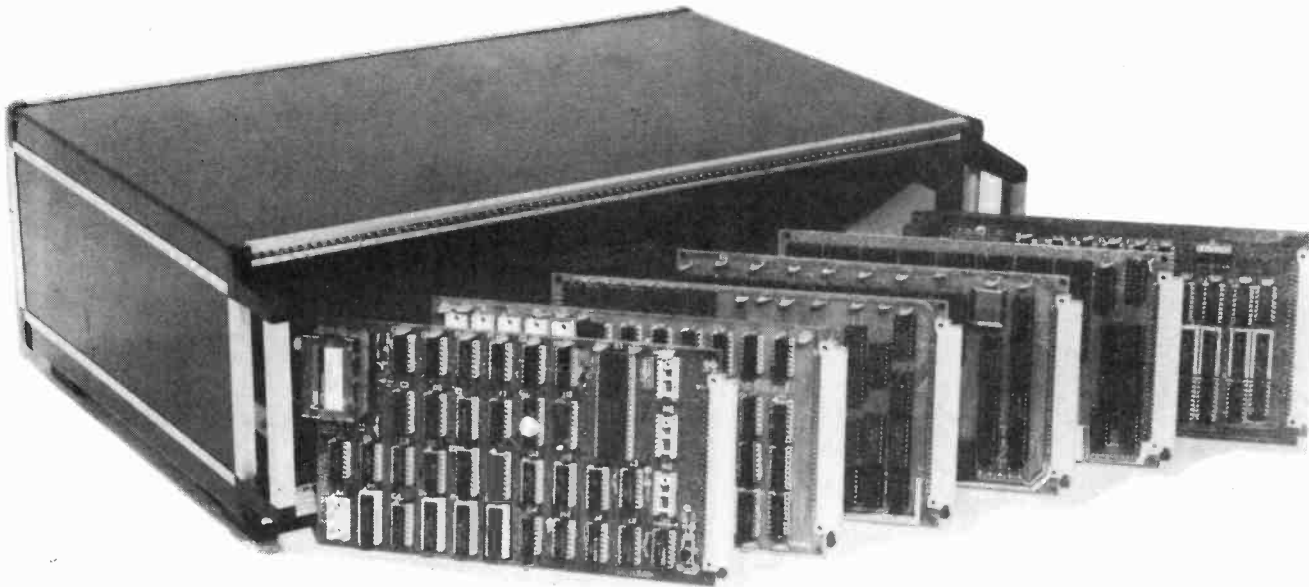
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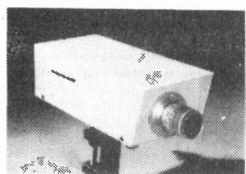
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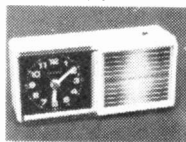
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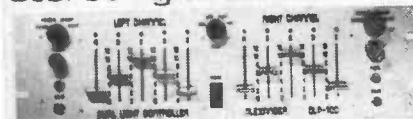
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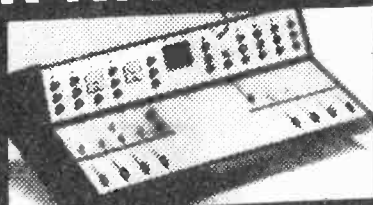
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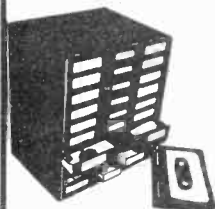
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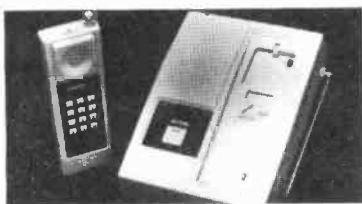
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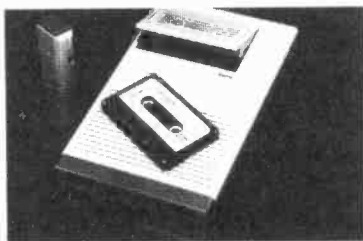
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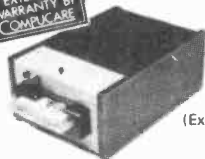
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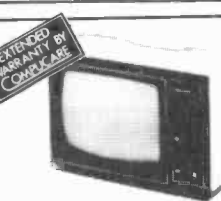


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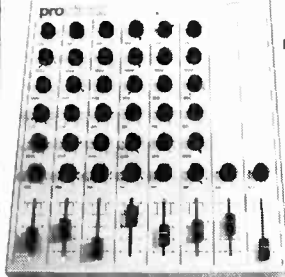


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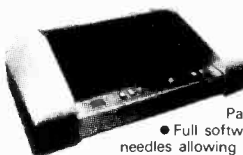
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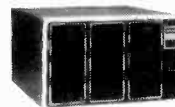
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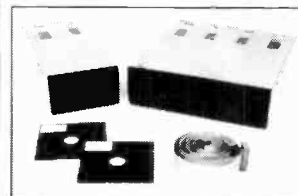
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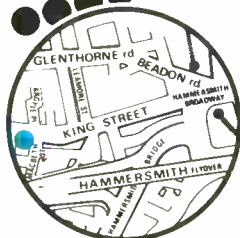




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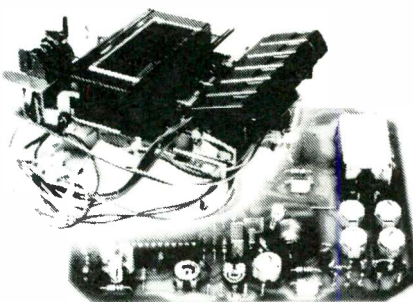
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