

electronics today

ISSN 0142-7329

MARCH 1980

60p

DISCRIMINATING METAL LOCATOR

Be choosy with this
VLF design



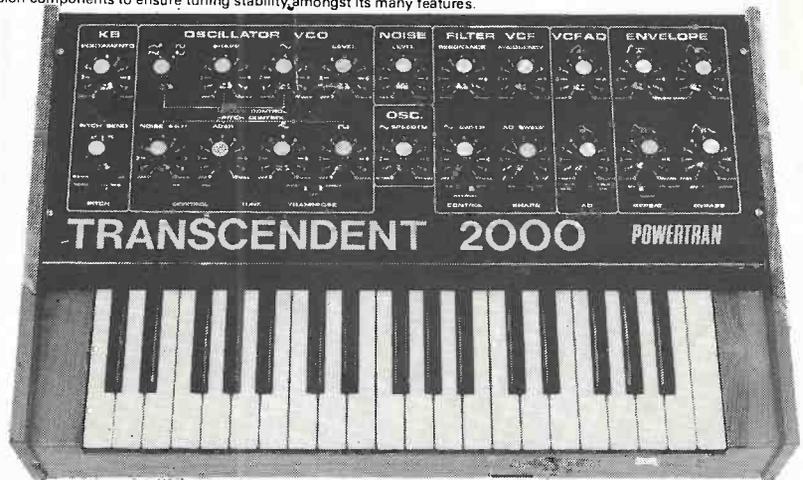
BLACK HOLES
The Whole Truth!

**VOLTAGE
CONTROLLED MIXER**
1537 VCA CIRCUITS
EXTRACTING TV HI-FI

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 affective 7 octave range. There is portamento, pitch bending, a VCO with shape and pitch modulation, a VCF with both low and high pass outputs and a separate dynamic sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features. The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or 1/2% metal trim!) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibreglass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready-built units selling for between £500 and £700!



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

**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!

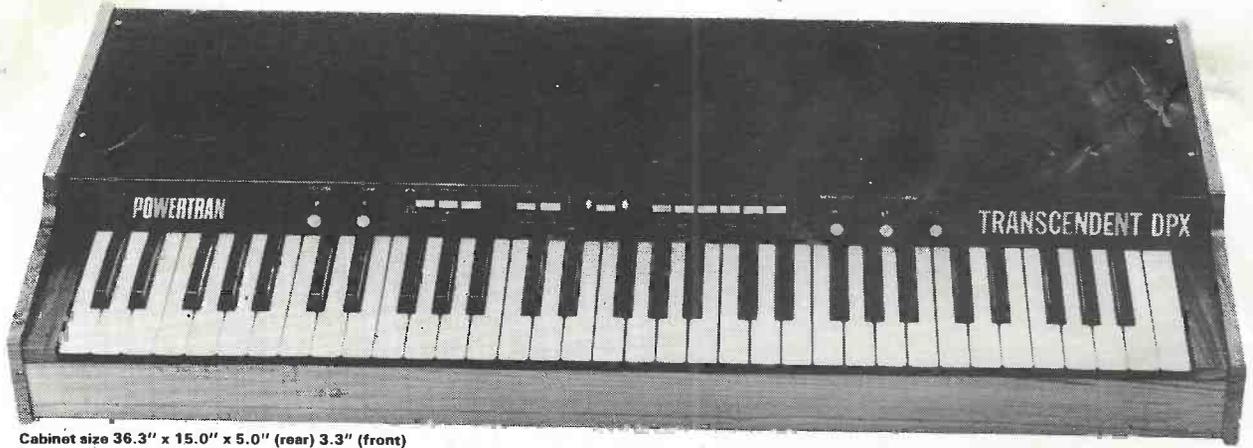
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**INCREASED CAPACITY AT OUR BIG NEW FACTORY
MEANS MANY PRICES DOWN! ALL OTHERS FROZEN!**

TRANSCENDENT DPX

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

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



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

COMPLETE KIT ONLY £299.00 + VAT!

To add interest to the sounds and make them more natural there is a chorus / ensemble unit which is a complex phasing system using CCD (charge coupled device) analogue delay lines. The overall effect of this is similar to that of several acoustic instruments playing the same piece of music. The ensemble circuitry can be switched in with either strong or mild effects.

As the system is based on digital circuitry digital data can be easily taken to and from a computer (for storing and playing back accompaniments with or without pitch or key change, computer composing etc., etc.) and an interface socket (25 way D type) is provided for this purpose.

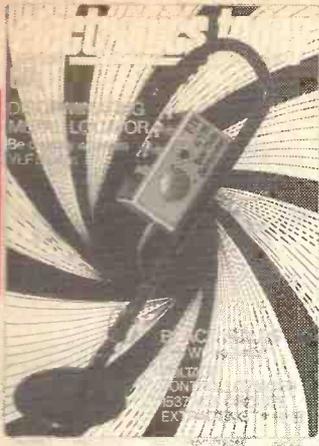
Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry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

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

POWERTRAN

**ORDERING INFORMATION
AND MORE KITS ON PAGE 8**

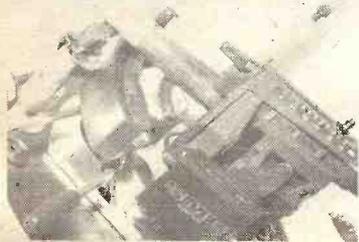
All kits also available as separate packs (e.g. P.C.B., component sets, hardware sets, etc.). Prices in FREE CATALOGUE.



hole truth p20



start digging here p.78



guess what p.51

electronics today

MARCH 1980 Vol 9, No 3 INTERNATIONAL

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Britain's first comp

A complete personal computer for a third of the price of a bare board.

Also available ready assembled for £99⁹⁵

The Sinclair ZX80.

Until now, building your own computer could easily cost around £300—and still leave you with only a bare board for your trouble.

The Sinclair ZX80 changes all that. For just £79.95 you get *everything* you need to build a personal computer at home...PCB, with IC sockets for all ICs; case; leads for direct connection to your own cassette recorder and television; everything!

And yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers on the market at several times the price. The ZX80 is programmed in BASIC, and you could use it to do quite literally anything from playing chess to running a power station.

The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. Once assembled, it immediately proves what a good job you've done. Connect it to your TV set...link it to an appropriate power source*...and you're ready to go.

Your ZX80 kit contains...

- Printed-circuit board, with IC sockets for all ICs.
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- New rugged Sinclair keyboard, touch-sensitive, wipe-clean.
- Ready-moulded case.
- Leads and plugs for connection to any portable cassette recorder (to store programs) and domestic TV (to act as VDU).
- FREE course in BASIC programming and user manual.

Optional extras

- Mains adaptor of 600 mA at 9 V DC nominal unregulated (available separately—see coupon).
- Additional memory expansion board plugs in to take up to 3K bytes extra RAM chips. (Chips also available—see coupon.)

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

Two unique and valuable components of the Sinclair ZX80.

The Sinclair ZX80 is not just another personal computer. Quite apart from its exceptionally low price, the ZX80 has two uniquely advanced components: the Sinclair BASIC interpreter; and the Sinclair teach-yourself BASIC manual.

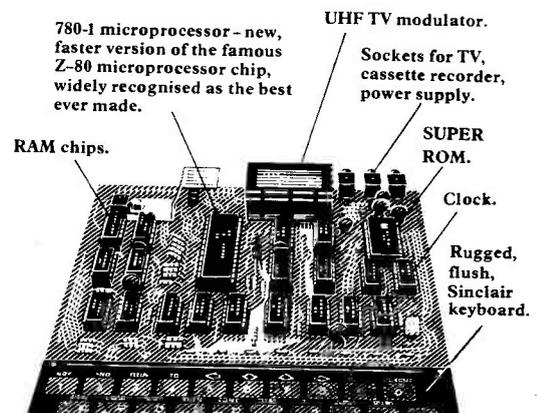
The unique Sinclair BASIC interpreter... offers remarkable programming advantages:

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

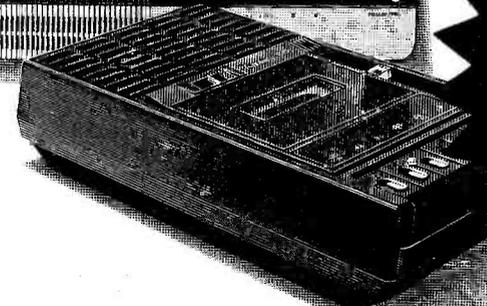
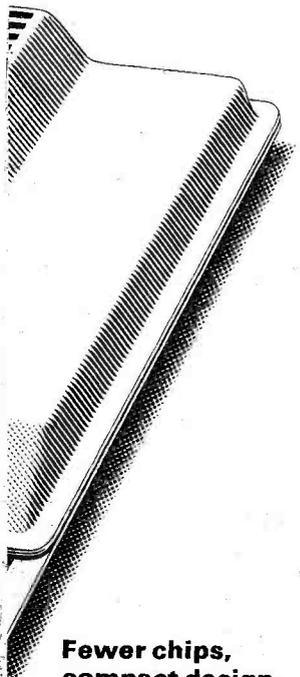
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

...and the Sinclair teach-yourself BASIC manual.

If the features of the Sinclair interpreter listed alongside mean little to you—don't worry. They're all explained in the specially-written 96-page book *free* with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming—from first principles to complex programs. (Available separately—purchase price refunded if you buy a ZX80 later.)



lete computer kit.



£79⁹⁵
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 Including all leads and components



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

The ZX80 owes its remarkable low price to its remarkable design: the whole system is packed onto fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the ZX80's 1K byte RAM is roughly equivalent to 4K bytes in a conventional computer, because the ZX80's brilliant design packs the RAM so much more tightly. (Key words, for instance, occupy just a single byte.)

To all that, add volume production – and you've that rare thing: a price breakthrough that really is a breakthrough.

The Sinclair ZX80. Kit: £79.95. Assembled: £99.95. Complete!

The ZX80 kit costs a mere £79.95. Can't wait to have a ZX80 up and running? No problem! It's also available, ready assembled, for only £99.95.

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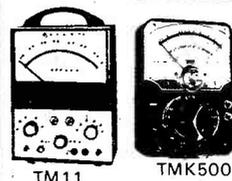
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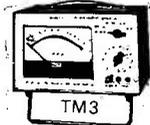
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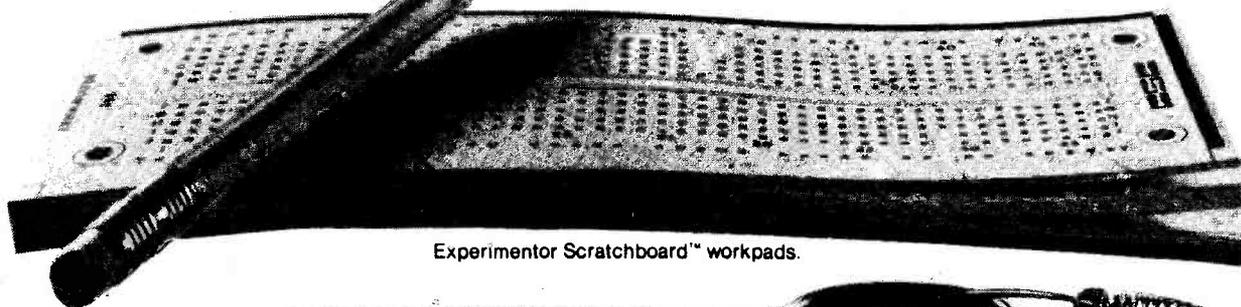
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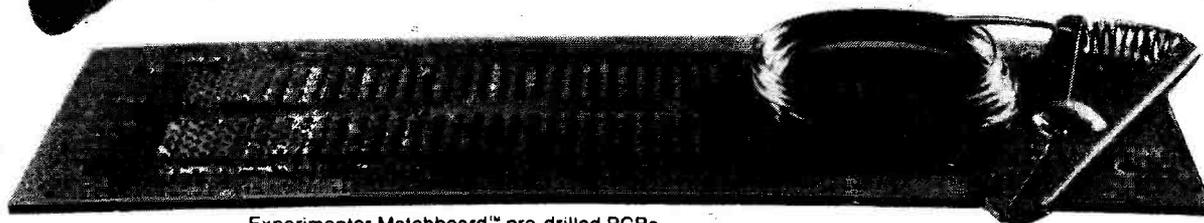
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CHROMATHEQUE 5000



Panel size 19.0" x 3.5". Depth 7.3"

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

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

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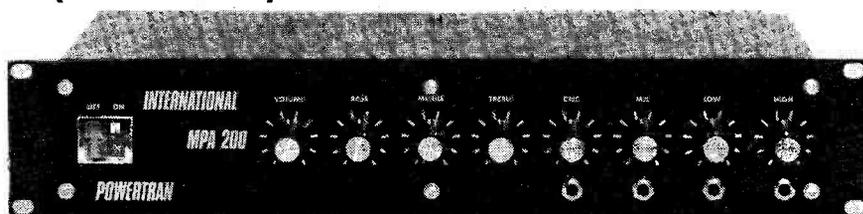
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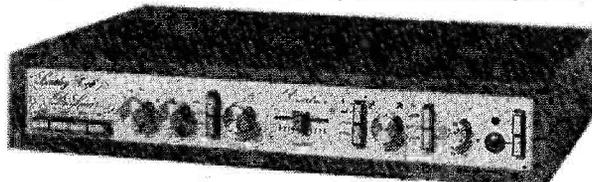
**MATCHES THE
CHROMATHEQUE 5000
PERFECTLY!**



Panel size 19.0" x 3.5". Depth 7.3"

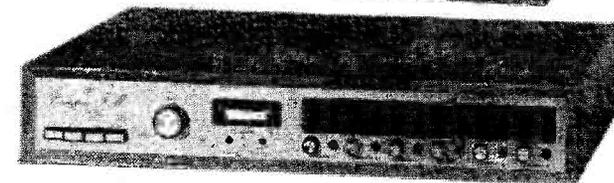
Featured as a constructional article in *ETI*, the MPA 200 is an exceptionally low priced — but professionally finished — general purpose high power amplifier. It features adaptable input mixer which accepts a wider range of sources such as microphone, guitar, etc. There are wide range tone controls and a master volume control. Mechanically the MPA 2000 is simplicity itself with minimal wiring needed making construction very straightforward.

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



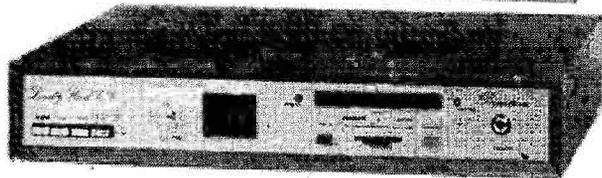
DE LUXE EASY TO BUILD LINSLEY HOOD 75W STEREO AMPLIFIER £99.30 + VAT

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 *H-Fi News and Record Review* and features include rumble filter, variable scratch filter, versatile tone controls and tape monitoring whilst distortion is less than 0.01%.



WIRELESS WORLD FM TUNER £70.20 + VAT

A pre-aligned front-end module makes this Wireless World published design very simple to construct and adjust without special instruments. Features include an excellent a.m. rejection push-button station selection as well as infinitely variable tuning and a phase locked loop stereo decoder, incorporating active filters for "birdy" suppression.



LINSLEY-HOOD CASSETTE DECK £79.60 + VAT

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

T20+20 20W STEREO AMPLIFIER £33.10 + VAT

This kit, based upon a design published in *Practical Wireless*, uses a single printed circuit board and offers at very low cost, ease of construction and all the normal facilities found on quality amplifiers. A 30 watt version of this kit (T30+30) is also available for **£38.40 + VAT**.

MATCHING TUNERS — SEE OUR FREE CATALOGUE!

COMPLETE KITS: Our complete kits really are complete. All of the projects shown on this page are supplied with fully finished metalwork, ready assembled high quality teak veneer cabinet (last 4 kits on this page), or professional quality rack mounting cabinet (first 2 kits on this page), cables, nuts, bolts, etc., and full instructions — in fact everything!

All of the kits shown on this page are available as separate packs for those customers who wish to spread their purchase or perhaps make their own cabinets or metalwork. Prices are given in our **FREE CATALOGUE**.

PRICE STABILITY: Order with confidence. Irrespective of any price changes we will honour all prices in this advertisement until April 30th, 1980, if this month's advertisement is mentioned with your order. Errors and VAT rate changes excluded.

EXPORT ORDERS: No VAT. Postage charged at actual cost plus 50p handling and documentation.

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

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

SALES COUNTER: If you prefer to collect kit from the factory, call at Sales Counter. Open 9 a.m.-4.30 p.m. Monday-Thursday.

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DIGEST



For Starters

The Dema System is a compact electronic ignition unit introduced by Maywood Technical Developments. Priced at £49.50 including VAT and postage, the unit is aimed at both the private motorist and the fleet operator.

The system incorporates a variable pulse width circuit to determine when the voltage stored on capacitors should be switched by thyristor to the HT coil and spark plugs. It monitors the revs and varies the duration of the spark to achieve as near as possible complete initiation of combustion.

The system can be installed by unskilled staff in about half an hour without having to make any alterations to the vehicle.

The Dema System is available from Maywood Technical Developments Ltd, Peake House 232 High Street, Harlington, Hayes, Middlesex UB3 5DS.

Tantless

It seems that there isn't a lot of tantalum ore about these days. Although it hasn't exactly been the first item on News at Ten, it means there's a shortage of tantalum powder, from which the capacitors are made. Supply and demand just isn't working in our favour. As demand keeps on rising, the known reserves are being exhausted. That inevitably means that tantalum capacitors are bound to increase in price rapidly over the next year or two.

Red Hot Radar

Under Chairman Brezhnev Soviet defence spending has increased from half to almost double that of America.

A Senate Subcommittee heard recently that the latest Soviet airborne tactical look-down/shoot-down radars are believed to be superior to any system now used by American forces.

Russian missile guidance systems can now match their American counterparts. Russia is also annually devoting several times America's spending on research into high energy laser research.

Radiation Hazard

Have you any old ex-government equipment with luminous dials or pointers? (They may not now be luminous because of phosphor degeneration).

Mr. Manning of Birmingham University has informed us of a radiation hazard that may exist from some ex-government equipment.

He was moved to write to us after examining a revolution counter, containing two large moving coil meters with edge-wise scales about 100 mm long,

scaled 6-14-18-22-26-30 and marked 'Engine Speed Hundreds of RPM'.

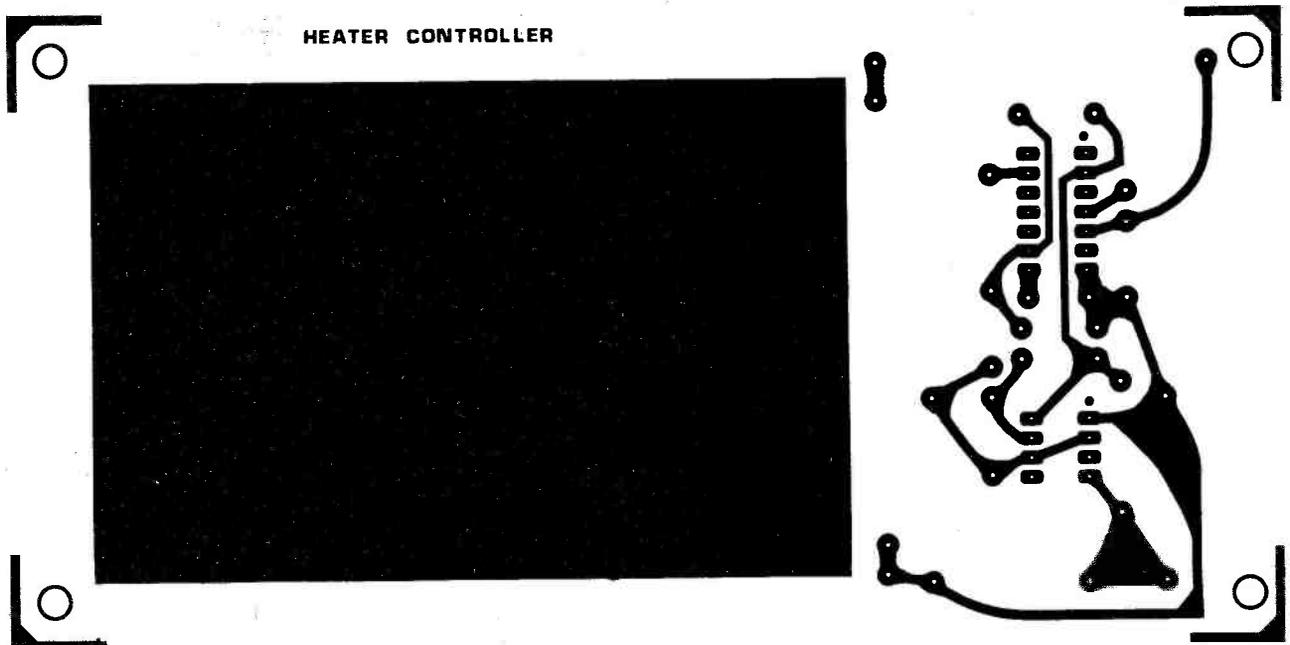
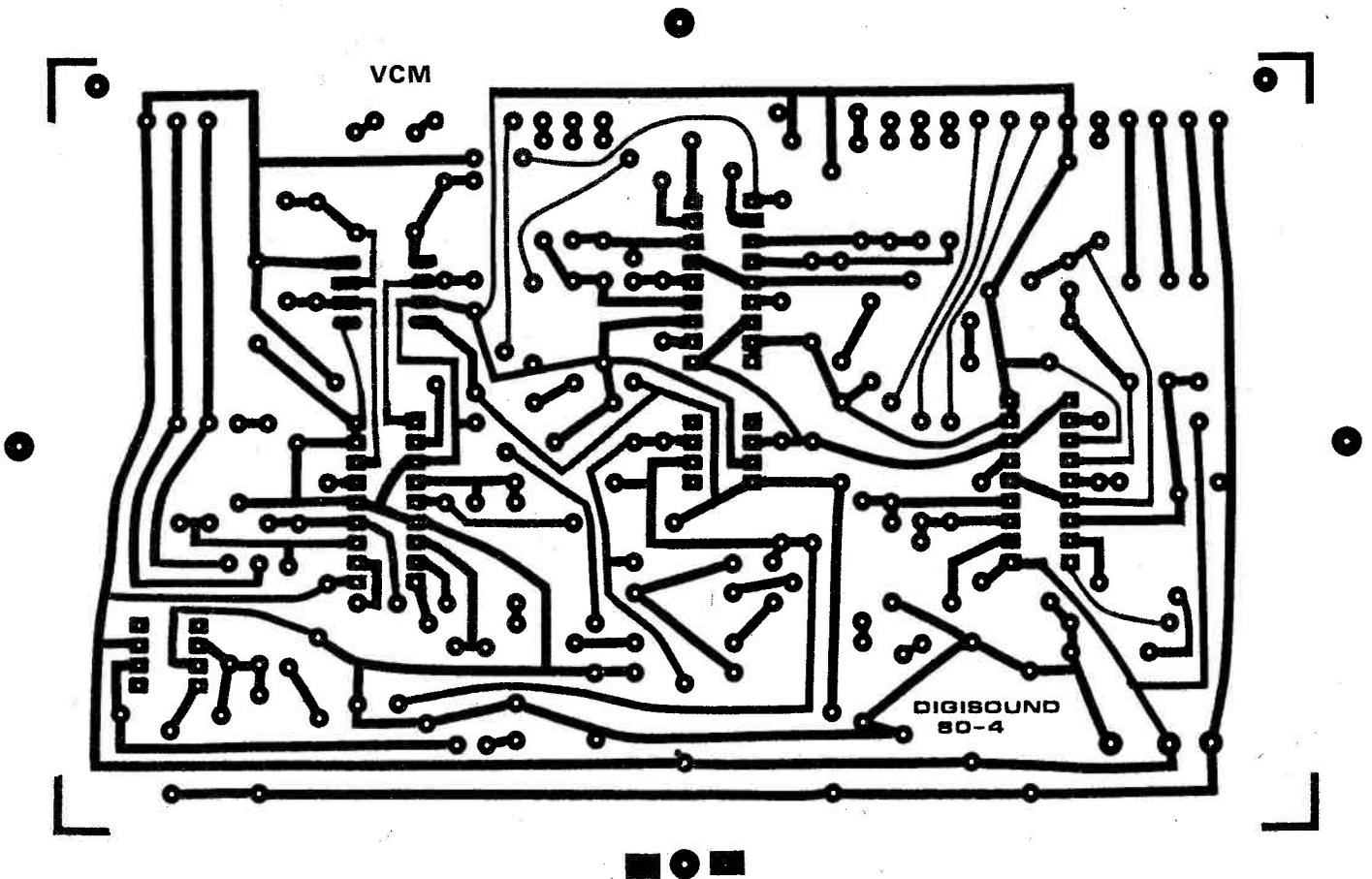
The graduations and numbers are filled with radium activated luminous paint, applied very thickly. At 10 cms from the scales a Geiger counter registered 1000 counts per second. With alpha and beta radiation blocked, the count rate was still 100 cps. As Geiger counters are only one or two per cent efficient for gamma rays, the true rate may be

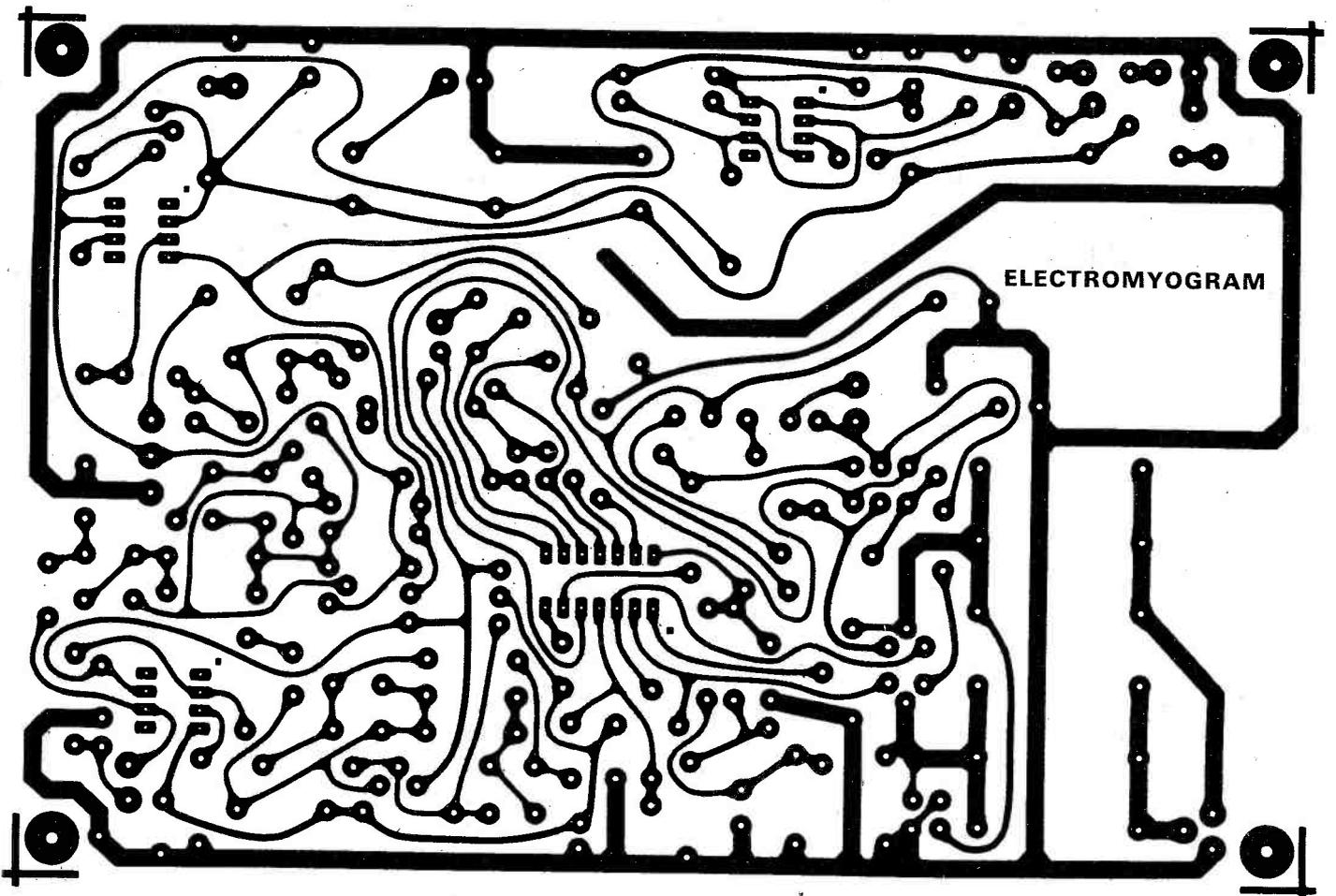
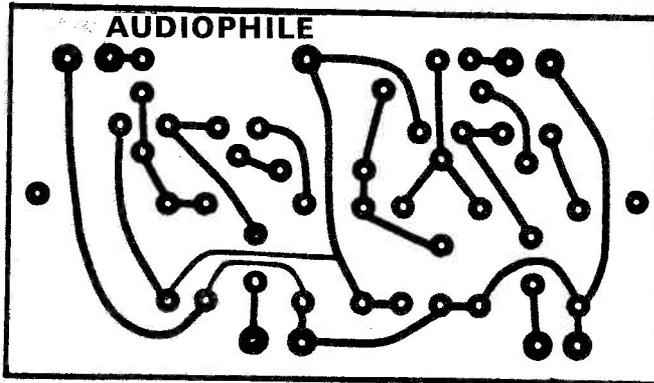
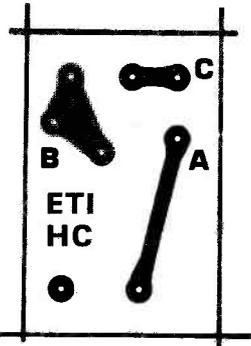
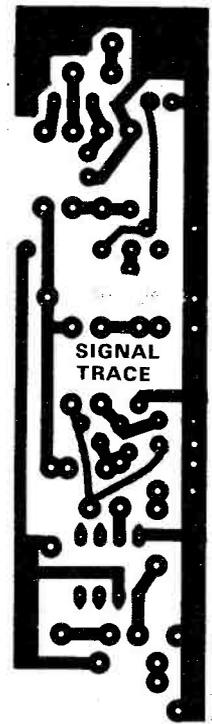
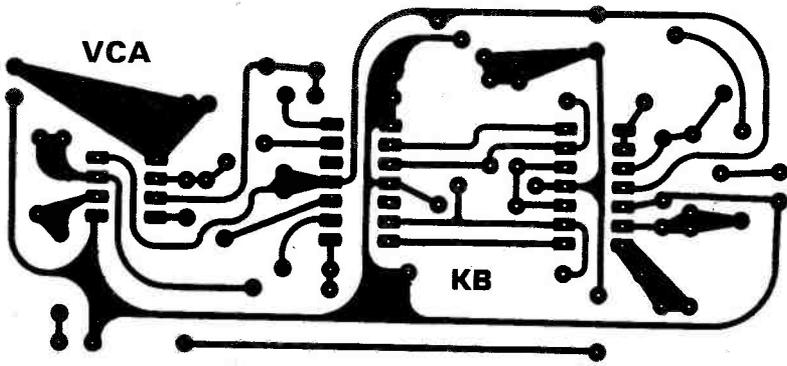
several thousand per second. In that event the radioactive paint used is such a strong source (several millicuries) that one would require a licence to use it for teaching purposes.

If you have any ex-government equipment with luminous dials or pointers — better safe than sorry, have it properly disposed of if you think it may be a radiation hazard. Warning — don't burn the equipment; that will simply spread the radium through the air.

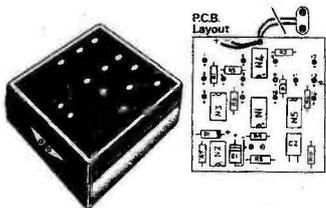
TTLs by TEXAS 7400 11p 74251 140p 4018 89p 7400 11p 74259 250p 4019 45p 7400 11p 74278 200p 4020 100p 7401 12p 74279 110p 4021 110p 7402 12p 74280 150p 4022 22p 7403 14p 74283 150p 4023 22p 7404 14p 74293 150p 4024 50p 7405 20p 74298 200p 4025 20p 7406 32p 74365 100p 4026 130p 7407 32p 74366 100p 4027 90p 7408 32p 74367 100p 4028 90p 7409 15p 74390 200p 4030 55p 7410 15p 74393 200p 4031 55p 7411 24p 74490 225p 4032 200p 7412 24p 74491 225p 4033 200p 7413 30p 74502 18p 4036 295p 7414 30p 74503 18p 4037 115p 7415 30p 74504 18p 4038 120p 7416 27p 74505 25p 4040 100p 7417 27p 74506 25p 4040 100p 7420 27p 74510 25p 4041 80p 7421 40p 74511 40p 4042 80p 7422 22p 74512 40p 4043 90p 7423 34p 74513 40p 4043 90p 7425 30p 74514 72p 4046 110p 7426 40p 74515 45p 4047 100p 7427 34p 74520 40p 4048 55p 7428 17p 74521 40p 4048 55p 7430 17p 74522 38p 4049 40p 7432 30p 74530 20p 4050 48p 7433 40p 74532 27p 4052 80p 7434 35p 74533 27p 4053 80p 7435 35p 74534 27p 4053 80p 7440 35p 74551 24p 4054 125p 7441 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PCB FOIL PATTERNS





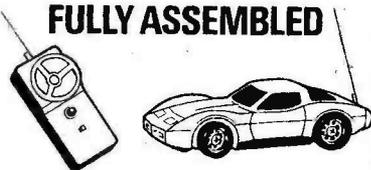
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Connectors (5) 4-Lead and 3-Lead and
Pads (6) DILS (7) BENDS 90° and 130°
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0.1 (11) Lines 0.02 (12) Bends 0.02 (13)
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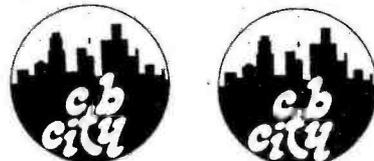
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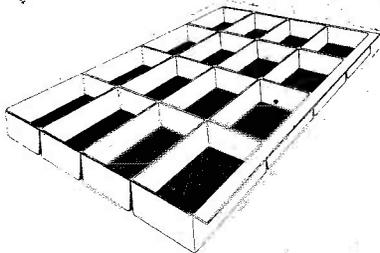
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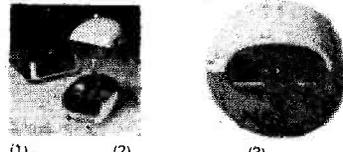
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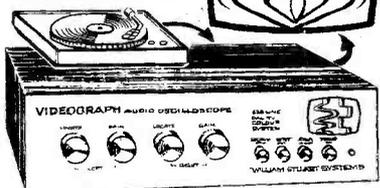
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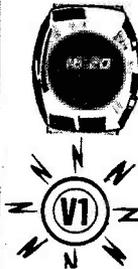
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video 100



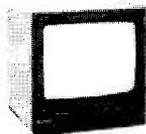
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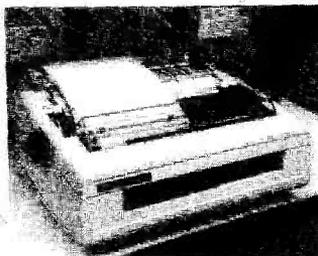
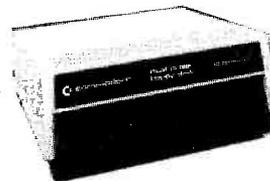


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NEC Spinwriter NEC's high quality printer uses a print "thimble" that has less diameter and inertia than a daisy wheel,

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NASCOM-2 MICRO-COMPUTER



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Microprocessors Z80A. 8 bit CPU. This will run at 4MHz but is selectable between 1/2/4 MHz. This CPU has now been generally accepted as the most powerful, 8 bit processor on the market.

INTERFACE

Keyboard New expanded 57 key Licon solid state keyboard especially built for Nascom. Uses standard Nascom, monitor controlled, decoding.

T.V. The tv peak to peak video signal can drive a monitor directly and is also fed to the on-board modulator to drive the domestic T.V.

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

The cassette interface is Kar'sas City standard at either 300 or 1200 baud. This is a link option on the NASCOM-2.

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

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

PIO There is also a totally uncommitted Parallel I/O (MK3881) giving 16, programmable, I/O lines. These are addressable as 2 x 8 bit ports with complete handshake controls.

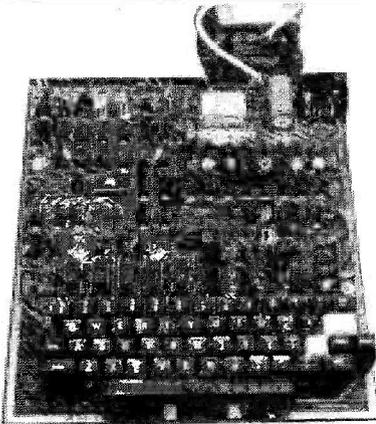
Documentation Full construction article is provided for those who buy a kit and an extensive software manual is provided for the monitor and Basic.

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

With free 16K RAM board.

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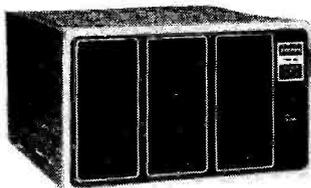
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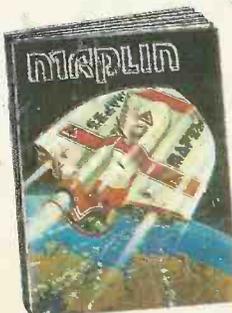
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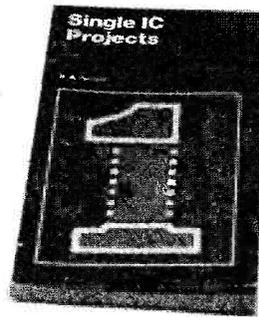
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New Babanis

Amaze your friends with the number of uses to which you can put a single IC. You won't be short of ideas with 'Single IC Projects' by R. A. Penfold. This 127 page volume from Bernard Babani is divided into five sections, covering low level audio circuits, audio power amplifiers, timers, operational amplifiers and miscellaneous circuits.

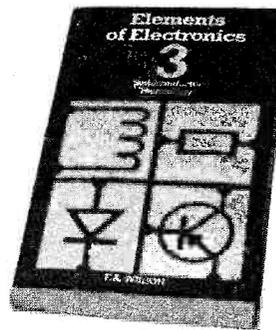
Each circuit suggestion begins with a brief description of the chip used, together with a table of its chief characteristics. In each case a circuit diagram, practical layout, constructional details and parts list is given. These twenty simple projects could be yours for £1.50.

Also from Babani is Book 3 in their Elements of Electronics series. Book 3 continues this introduction to electronics with sections on semiconductor physics and characteristics. Basic semiconductor applications are described, including



rectifiers, amplifiers, oscillators and switches. Book 3 of Elements of Electronics by F. A. Wilson (204 pages) is priced at £2.25.

If you have trouble getting these books they are available direct from the publisher, Bernard Babani (Publishing) Ltd,



The Grampians, Shepherds Bush Road, London W6 7NF. A complete catalogue of Radio and Electronics Books is also available from this address. Please send a stamped, addressed envelope. When ordering books, please send enough to cover postage.

Anti-Gravity Meter

You won't have a smashing time with this meter. The 3012 from Dorman Smith Instrumentation is a drop proof pocket tester giving DC volts (0V3 to 1000V), DC current (50 uA to 300 mA), AC volts (10V to 1000V) and resistance (10k to 1M ranges).

The meter will withstand being dropped from one metre — the height of the average workbench or jacket pocket. It incorporates a taut band movement and fuse protection. Power is from a size AA 1V5 battery.

The 3012 pocket test is available for £27 plus VAT including batteries, test leads, soft case and strap from Dorman Smith Instrumentation, Blackpool Road, Preston PR2 2DQ.

Tick Talk

If you have about a hundred dollars to spare you can invest it in the latest in alarm watches. The communicator, from Windert, uses a 64 kilobyte memory chip to carry its computer voice. It 'tells' you the time, talks you awake in the morning and nags you if you don't get up (makes the wife redundant).

The time, alarm and snooze messages are to be available in English, French, German and Spanish. In the not-so-distant future Windert have prophesied the development of programmable voice command watches and even the sci-fi cliché — watches with built-in TV screens and transmitters.

See-Thru Tops

Boss Industrial Mouldings have extended their BIM 2000 range of Bimboxes to include a new two part, deep profile version. Base and lid are available in black, grey, orange or blue, with the additional option of a clear lid. As with the rest of the Bimbox range, the new versions have 5.08 mm (0.2in) spaced slots on all sides of the base to support 1.5 mm PCBs.

The clear lid version is ideal for applications where viewing of, but not necessarily access to, internal components is required. The new Bimboxes, each 80.2x150.4x76 mm, are available from Boss Industrial Mouldings Ltd, 2 Herne Hill Road, London SE24 0AU.

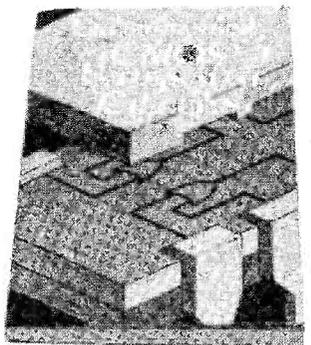
Sat 54 Where Are You?

Well, it was Satcom 3 actually, but the plot is reminiscent of that old, old American telly series. The Car 54 in this case, however, was an RCA communications satellite, last heard of in December, 22,000 miles above mother Earth.

If anyone finds a communications satellite answering to the name of Satcom 3, send it to RCA, nto us. Mind you, if it has gone up in a puff of smoke, it has probably burned up on its way back to Earth. NASA quick to assure us that it won't cause another Skylab incident. So, you needn't dust off your anti-Skylab umbrella, yet.

CMOS Class

Having trouble getting to grips with your CMOS? Understanding CMOS Integrated Circuits by Roger Melen and Harry Garland is an introduction to CMOS, covering everything from how the chips are made to a few simple practical CMOS circuits.



Almost half of the book is devoted to a summary of types of logic gates, semiconductor physics and CMOS fabrication techniques. The remainder gets down to the nitty gritty — CMOS circuit design, including waveform generators and information-processing circuits.

This 144 page American paperback is available in the UK from Prentice/Hall International, 66 Wood Lane End, Hemel Hempstead, Herts, HP2 4RG for £3.60.

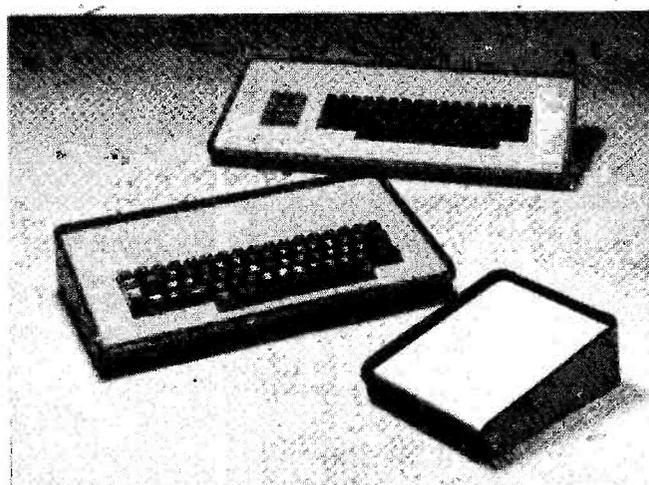
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JACKSONS VARIABLE CAPACITORS: Dielectric 100/300pF 175p; 500pF 205p; 6-1 Ball Drive 115p; 45/11/DAF 650p; Dial Drive 4103 61/36-1; Drum 54mm 40p; 0-1-365pF 245p; 0-2 365pF 275p.

RF CHOKES: 1µH, 4.7, 10, 22, 33, 47, 100, 200, 470, 750, 1mH, 2.5, 5, 10 30p each; 43mH 100 80p each.

VERO BOARD: 0.1, 0.15, 0.15 (copper clad) (plain) 46p 39p 24p; 2 1/2 x 3 1/2 55p 50p 31p; 2 1/2 x 3 3/4 55p 50p 31p; 3 1/2 x 5 75p 67p 43p; 2 1/2 x 1 7/8 189p 135p 82p; 3 1/4 x 1 7/8 218p 180p 120p; 4 1/4 x 1 7/8 280p 183p; Pkt of 36pins 20p DIP Board 268p; Spot face cutter 85p; VQ Board 90p; Pin insertion tool 120p; EURO BREADBOARD 530p; VERO BREADBOARD 340p.

FERRIC CHLORIDE: 1lb bag Anhydrous 95p + 35p P&P

DALGETT RESIST P&P: + spare trip 78p

COPPER CLAD BOARDS: Fibre Single-sided 9RP; Glass sided 5RP; 8" x 6" 75p; 8" x 12" 130p; Double-sided 8RP; 9.5" x 8.5" 80p.

SOLDERING PENS: 100 50p; 500 200p; 14pin 35p; 16pin 39p.

DIL SOCKETS (TAXES) Low Wire Prof. Wasp: 8pin 10p; 12pin 15p; 14pin 15p; 16pin 15p; 18pin 15p; 20pin 22p; 22pin 25p; 24pin 30p; 26pin 35p; 28pin 35p; 30pin 105p; 40pin 50p 109p.

EDGE CONNECTORS: 2-Dial type: 10pin .1 156p; 12pin .15 156p; 14pin .15 156p; 16pin .15 156p; 18pin .15 156p; 20pin .15 156p; 22pin .15 156p; 24pin .15 156p; 26pin .15 156p; 28pin .15 156p; 30pin .15 156p; 32pin .15 156p; 34pin .15 156p; 36pin .15 156p; 38pin .15 156p; 40pin .15 156p.

FERRIC CHLORIDE: 1lb bag Anhydrous 95p + 35p P&P

DALGETT RESIST P&P: + spare trip 78p

COPPER CLAD BOARDS: Fibre Single-sided 9RP; Glass sided 5RP; 8" x 6" 75p; 8" x 12" 130p; Double-sided 8RP; 9.5" x 8.5" 80p.

SOLDERING PENS: 100 50p; 500 200p; 14pin 35p; 16pin 39p.

DIL SOCKETS (TAXES) Low Wire Prof. Wasp: 8pin 10p; 12pin 15p; 14pin 15p; 16pin 15p; 18pin 15p; 20pin 22p; 22pin 25p; 24pin 30p; 26pin 35p; 28pin 35p; 30pin 105p; 40pin 50p 109p.

EDGE CONNECTORS: 2-Dial type: 10pin .1 156p; 12pin .15 156p; 14pin .15 156p; 16pin .15 156p; 18pin .15 156p; 20pin .15 156p; 22pin .15 156p; 24pin .15 156p; 26pin .15 156p; 28pin .15 156p; 30pin .15 156p; 32pin .15 156p; 34pin .15 156p; 36pin .15 156p; 38pin .15 156p; 40pin .15 156p.

FERRIC CHLORIDE: 1lb bag Anhydrous 95p + 35p P&P

DALGETT RESIST P&P: + spare trip 78p

COPPER CLAD BOARDS: Fibre Single-sided 9RP; Glass sided 5RP; 8" x 6" 75p; 8" x 12" 130p; Double-sided 8RP; 9.5" x 8.5" 80p.

SOLDERING PENS: 100 50p; 500 200p; 14pin 35p; 16pin 39p.

TRANSISTORS

AC125	35	BC214L	10	BFR81	24	TIP31A	38	2N1671B	120
AC126	25	BC307B	12	BFR88	105	TIP31C	43	2N2160	350
AC127	22	BC308	12	BFX81	46	TIP32A	58	2N2171	43
AC128	20	BC327	12	BFX84	28	TIP32C	58	2N218A	34
AC129	27	BC328	12	BFX85	28	TIP33C	70	2N219A	22
AC142	28	BC338	12	BFX87	28	TIP34	85	2N220A	23
AC176	25	BC441	27	BFY50	21	TIP34C	82	2N221A	23
AC177	60	BC461	27	BFY51	21	TIP35A	135	2N222A	20
AC178	60	BC467	27	BFY52	21	TIP35C	165	2N223A	23
AC198	60	BC477	35	BFY53	25	TIP36A	145	2N224A	20
AC200	60	BC516	38	BFY54	20	TIP36C	185	2N225A	23
AC211	60	BC517	10	BFY64	40	TIP41A	105	2N226A	20
AC221	40	BC547	40	BFY71	40	TIP41B	55	2N227A	23
AC222	60	BC548	10	BRY39	39	TIP42A	64	2N228A	25
AC228	60	BC549C	15	BSK20	20	TIP42B	82	2N270A	55
AC239	90	BC556	15	BSK26	15	TIP120	72	2N2905A	22
AC241	39	BC557	10	BSV95A	18	TIP121	70	2N2906	22
AD149	75	BC558	10	BU105	115	TIP142	125	2N2907	22
AD161	42	BC559	57	BU205	125	TIP147	145	2N2907	22
AD162	42	BCY30	80	BU208	215	TIP2955	60	2N2926G	10
AF114	60	BCY39	78	E421	75	TIP3055	48	2N3011	24
AF115	60	BCY40	48	MD9001	179	TIS43	43	2N3053	18
AF116	60	BCY41	14	MJ481	65	TIS44	45	2N3054	65
AF117	60	BCY70	14	MJ2955	105	TIS45	45	2N3055	45
AF118	75	BCY71	16	MJ2956	104	TIS46	45	2N3056	45
AF139	40	BCY72	25	MJE370	58	TIS88	35	2N3442	10
AF178	75	BC124	115	MJE371	54	TIS90	20	2N3663	14
AF186	50	BD031	42	MJE520	75	TIS91	24	2N3702	10
AF187	50	BD032	42	MJE521	74	ZTX107	11	2N3704	10
AG221	60	BD133	50	MJE2955	90	ZTX108	11	2N3705	10
BC107	10	BD135	30	MJE3065	70	ZTX109	11	2N3706	10
BC107B	10	BD136	30	MPP102	66	ZTX300	13	2N3707	10
BC108	10	BD137	30	MPP103	36	ZTX301	16	2N3708	11
BC108B	10	BD138	35	MPP104	36	ZTX302	20	2N3709	11
BC109	10	BD140	30	MPP105	36	ZTX303	17	2N3710	10
BC109B	12	BD144	188	MPSA05	15	ZTX304	24	2N3711	10
BC109C	12	BD145	175	MPSA06	16	ZTX314	24	2N3712	10
BC114	20	BD205	110	MPSA12	22	ZTX326	45	2N3772	185
BC115	60	BD245	70	MPSA12	22	ZTX341	20	2N3773	255
BC117	60	BD246	82	MPSA56	22	ZTX500	15	2N3819	40
BC119	28	BD434	70	MPSU02	58	ZTX502	17	2N3820	20
BC140	28	BD517	85	MPSU05	50	ZTX503	15	2N3823	70
BC142	26	BD695A	85	MPSU06	50	ZTX504	25	2N3836	90
BC143	26	BD696A	85	MPSU07	50	ZTX505	25	2N3837	90
BC147	9	BF115	25	MPSU08	50	ZTX506	25	2N3838	90
BC148	8	BF116	25	MPSU09	50	ZTX507	25	2N3839	90
BC148B	10	BF158	25	MPSU10	50	ZTX508	25	2N3840	90
BC149	9	BF173	25	MPSU11	50	ZTX509	25	2N3841	90
BC149C	9	BF177	25	MPSU12	50	ZTX510	25	2N3842	90
BC153	24	BF178	30	MPSU13	50	ZTX511	25	2N3843	90
BC154	13	BF179	38	MPSU14	50	ZTX512	25	2N3844	90
BC157	10	BF180	20	MPSU15	50	ZTX513	25	2N3845	90
BC158	10	BF194	11	MPSU16	50	ZTX514	25	2N3846	90
BC159	11	BF195	12	MPSU17	50	ZTX515	25	2N3847	90
BC160	28	BF196	12	MPSU18	50	ZTX516	25	2N3848	90
BC161	28	BF197	12	MPSU19	50	ZTX517	25	2N3849	90
BC161A	28	BF198	12	MPSU20	50	ZTX518	25	2N3850	90
BC161B	28	BF199	12	MPSU21	50	ZTX519	25	2N3851	90
BC161C	28	BF200	12	MPSU22	50	ZTX520	25	2N3852	90
BC161D	28	BF201	12	MPSU23	50	ZTX521	25	2N3853	90
BC161E	28	BF202	12	MPSU24	50	ZTX522	25	2N3854	90
BC161F	28	BF203	12	MPSU25	50	ZTX523	25	2N3855	90
BC161G	28	BF204	12	MPSU26	50	ZTX524	25	2N3856	90
BC161H	28	BF205	12	MPSU27	50	ZTX525	25	2N3857	90
BC161I	28	BF206	12	MPSU28	50	ZTX526	25	2N3858	90
BC161J	28	BF207	12	MPSU29	50	ZTX527	25	2N3859	90
BC161K	28	BF208	12	MPSU30	50	ZTX528	25	2N3860	90
BC161L	28	BF209	12	MPSU31	50	ZTX529	25	2N3861	90
BC161M	28	BF210	12	MPSU32	50	ZTX530	25	2N3862	90
BC161N	28	BF211	12	MPSU33	50	ZTX531	25	2N3863	90
BC161O	28	BF212	12	MPSU34	50	ZTX532	25	2N3864	90
BC161P	28	BF213	12	MPSU35	50	ZTX533	25	2N3865	90
BC161Q	28	BF214	12	MPSU36	50	ZTX534	25	2N3866	90
BC161R	28	BF215	12	MPSU37	50	ZTX535	25	2N3867	90
BC161S	28	BF216	12	MPSU38	50	ZTX536	25	2N3868	90
BC161T	28	BF217	12	MPSU39	50	ZTX537	25	2N3869	90
BC161U	28	BF218	12	MPSU40	50	ZTX538	25	2N3870	90
BC161V	28	BF219	12	MPSU41	50	ZTX539	25	2N3871	

WATFORD ELECTRONICS

THE DIGITAL FREQUENCY METER with a Difference



- 0-150MHz in 5 ranges.
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- Period and time interval facility.
- Unit counter up to 99,999,999
- 10MHz crystal timebase
- Hold and reset buttons plus built-in PSU.

All these features and more for less than half the price of an ordinary frequency meter. The DFM2000 has all its components including the displays, switches and transformer mounted on one double sided PC board. Assembly is simplicity itself especially since interwiring has been eliminated. This is a high quality design and will make a truly professional digital frequency meter that any constructor will be proud to own.

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Probes: Optional extra **£8.75**

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Only **£188.00**

Superboard II is supplied fully assembled and tested to British TV specification. Also included at no extra cost 4 manuals and a Cassette with programmes. Requires +5V or +3A and a Video Monitor or TV with RF converter to be up and running. (Data sheet supplied). We can also supply the RF Converter and Power Supply in Kit form or ready-built.

8K Microsoft BASIC in ROM. 4K Static RAM — on BOAPD expandable to 8K. Full 53 Key Keyboard with Upper Lower Case & User programmability and a lot more. See it for yourself. Continuous demonstration on at our retail shop.

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Specialty Designed Case **£25.00**
810 Expansion Board with 8K RAM **£188**
Assembler Editor plus Manual **£25**
Extended Monitor plus Manual **£10**
Basic Tutor Tapes **£27**

SWITCHES	SLIDE 250V:
TOGGLE: 2A, 250V 14p	1A DPDT 14p
SPST 25p	1A DPDT c/over 15p
DPST 34p	1/2A DPDT 13p
DPDT 38p	4 pole 2-way 24p
4 pole on/off 54p	
SUB-MIN TOGGLE	PUSH BUTTON
SP chopper 60p	Spring loaded 60p
SPST on/off 54p	SPST on/off 60p
SPST biased 85p	SPDT c/over 85p
DPDT 6 tags 70p	DPDT 6 Tag 85p
DPDT centre off 79p	
DPDT Biased 115p	

ROTARY: Make your own multiway Switch. Adjustable Stop Shafting Assembly Accommodate up to 6 Wafers **75p**
Mains Switch DPST to fit **34p**
Break Before Make Wafers. 1 pole/12 way. 2p/6 way. 3p/4 way. 4p/3 way. 6p/2 way. **47p**
Spacer and Screen **5p**
ROTARY: (Adjustable Stop)
1 pole/2 to 12 way, 2p/2 to 6 way, 3 pole/2 to 4 way, 4 pole/2 to 3 way **41p**
ROTARY: Mains 250V AC. 4 Amp **45p**

CRYSTALS

100kHz	323
455kHz	383
1MHz	323
1.036M	385
1.28MHz	382
1.6MHz	323
1.8MHz	323
1.6432MHz	382
2.4576MHz	382
3.2768M	323
3.57954M	195
4.000MHz	290
4.032MHz	323
4.433619M	135
5.0MHz	323
5.185M	323
6.9536M	200
7.680M	323
8.86723M	323
9.375M	323
10.0MHz	323
10.7MHz	323
12MHz	382
14.3181MHz	300
18MHz	323
17.432M	323
20.0MHz	323
27.648M	323
48.0MHz	323
100.000MHz	323

TRANSFORMERS (Mains Prim. 220-240V)

6-0-6V. 9-0-9V. 12-0-12V 100mA	95p
3VA: 0-6V-0.6V (PCB mounting)	150p
8VA: 6V-5A 6V-5A; 9V-4A 9V-4A; 12V-3A 12V-3A; 15V-2.5A 15V-2.5A	195p
12V: 4.5V-1.3A 4.5V-1.3A; 6V-1.2A 6V-1.2A; 12V-5A 12V-5A; 15V-4A 15V-4A; 20V-3A 20V-3A	220p (20p p&p)
24VA: 6V-1.5A 6V-1.5A; 9V-1.3A 9V-1.3A; 12V-1A 12V-1A; 15V-8A 15V-8A; 20V-6A 20V-6A	290p (45p p&p)
50VA: 6V-4A 6V-4A; 9V-2.5A 9V-2.5A; 12V-2A 12V-2A; 15V-1.5A 15V-1.5A; 20V-1.2A 20V-1.2A; 25V-1A 25V-1A; 30V-8A 30V-8A	350p (50p 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	850p (60p p&p). (N.B. p&p charge to be added above our normal postal charge.)

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4x2x4x1 1/2" 70
4x5x4x1 1/2" 88
4x2 1/2x2" 72
5x4x2" 98
6x4x2" 108
7x5x2 1/2" 145
8x6x3" 185
10x7x3" 210
10x4 1/2x3" 175
12x5x3" 215
12x8x3" 255

PANEL METERS

FSD	60x46x
	35mm
	0-50µA
	0-100µA
	0-500µA
	0-1mA
	0-5mA
	0-10mA
	0-50mA
	0-100mA
	0-500mA
	0-1A
	0-2A
	0-25V
	0-50V AC
	0-300V AC
"VU"	445p each

ETI Projects:

Parts available for: Click	
Eliminator	
DFM2000	
Frequency Meter	
DM900, Audiophile Amp, 60W Amplifier	
System. Send SAE plus 5p for list.	

VOLTAGE REGULATORS

1A TO3 +ve -ve	
5V 7805 145p	7905 220p
12V 7812 145p	7912 220p
15V 7815 145p	
18V 7818 145p	
1A TO220 Plastic Casing	
5V 7805 65p	7905 75p
12V 7812 65p	7912 75p
15V 7815 65p	7915 75p
18V 7818 65p	7918 75p
24V 7824 65p	
100mA TO92 Plastic Casing	
5V 78L05 30p	79L05 65p
6V 78L62 30p	
8V 78L82 30p	
12V 78L12 30p	79L12 65p
15V 78L15 30p	79L15 65p
LM300H 170p	LM327 270p
LM305H 140p	LM723 38p
LM309K 135p	TA8550 50p
LM317K 360p	TBA425B 95p
LM231K 550p	TDA1412 150p
LM325N 240p	78H05 +5/-5A 55p
LM326N 240p	78H6 +5 to +24 65p

OPTO ELECTRONICS

LEDs with Clips	13
TIL108 Red	17
TIL211 Grn.	17
TIL212 Yel.	18
TIL220 2" Red	14
2" Green, Yellow or Amber	18
Square LEDs, Red, Grn., Yel.	36
TIL32 Infra Red	58
TIL78	7
LS400	255
OCF71	120
ORP12	63
ORP61	85
2N5777	45
ISOLATORS	
IL74	48
TIL111/2	85
TIL114	95
TIL117	110
7 Segment Displays	
TIL307	675
TIL312 3" CA	105
TIL313 3" CC	105
TIL321 5" CA	115
TIL322 5" CC	115
DL704 3" CC	99
DL707 3" CA	99
DL747 3" CA	180
FD357 Red	180
3" Green CA	180
6" Green CA	225
LCD 3 1/2 Digit	875
LCD 4 Digit	975

326	284	4010	38	4048	58	4099	145	4516	120	4549	375
327	288	4011	28	4049	48	4180	109	4517	382	4553	398
347	148	4012	18	4050	48	4181	109	4518	102	4554	150
348	186	4013	42	4051	72	4182	109	4519	55	4555	65
352	228	4014	80	4052	73	4183	109	4520	108	4556	72
353	228	4015	82	4053	72	4174	110	4521	228	4557	451
365	65	4016	45	4054	110	4175	99	4522	149	4558	105
366	65	4017	82	4055	128	4194	108	4526	149	4559	375
367	65	4018	87	4056	135	4408	720	4527	162	4560	210
368	66	4019	38	4057	1650	4409	720	4528	99	4561	65
373	180	4020	99	4059	480	4410	720	4529	145	4562	533
374	180	4021	95	4060	115	4411	958	4530	85	4566	165
375	160	4022	85	4061	1200	4412F	1250	4531	135	4569	280
377	212	4023	22	4062	92	4412V	1050	4532	115	4572	26
378	184	4024	66	4063	110	4435	65	4534	675	4580	585
379	215	4025	19	4066	58	4415V	500	4536	365	4581	297
384	86	4026	180	4067	380	4419	280	4538	142	4582	130
390	230	4027	45	4068	22	4422	545	4539	105	4583	75
393	380	4028	81	4069	20	4433	895	4541	135	4584	63
395	218	4029	66	4070	32	4435	825	4543	155	4585	105
396	215	4030	58	4071	21	4440	1275				
398	276	4031	205	4072	21	4450	295				
399	230	4032	100	4073	21	4451	295				
445	150	4033	145	4075	23	4452					
447	144	4034	199	4076	85	4490F	695				
490	180	4035	111	4077	40	4490V	525				
668	182	4036	335	4078	21	4501	19				
669	182	4037	100	4081	20	4502	20				
670	248	4038	108	4082	21	4503	69				
		4039	320	4085	74	4506	51				
		4040	105	4086	52	4507	55				
		4041	85	4087	40	4508	25				
		4042	15	4093	150	4508	297				
		4043	94	4094	78	4510	99				
		4044	95	4095	105	4512	98				
		4045	145	4096	105	4513	208				
		4046	128	4097	372	4515	285				
		4047	87	4098	110	4515	298				

Direct Meter

Zycomm's combined VSWR and power meter offers direct reading of both functions without interpolation.

Autorangeing for power output covers 20 W to 2 kW in three ranges. VSWR can be measured from 1:1 to infinity.

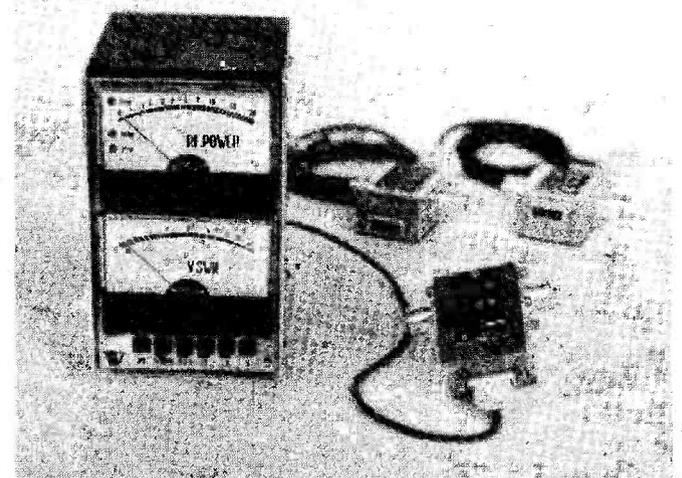
Separate sensing heads, supplied to cover each frequency range, can be connected at any position in the feed line. Forward and reverse power can be displayed as either peak or rms

readings.

The electronic comparator included in the meter allows constant readout of VSWR regardless of power variation. It gives a true indication during speech on SSB.

You'll need a 240 V 50 Hz supply to operate the meter.

The combined VSWR and power meter is available from ZycommElectronics Ltd, 47-51 Pentrich Road, Ripley, Derbyshire DE5 3DS.



End of Chess

If you saw our survey of Chess Machines in December, you will have gathered that the idea is to play a game from start to finish against the computer. The latest chess machine is a little different in that it only plays end games.

C/E, S (score), P (peek?) and R (response). On top of all that there is a four digit LCD display.

With the mini mind you get seven booklets, each containing fifty different problems. More booklets will be printed to catch up with the Chess Master's memory of several thousand problems. Each booklet represents a different level of play.

It's a mini machine, measuring only 105 x 63 x 8 mm — not much bigger than a credit card calculator. It looks a bit like a calculator, too. On the front panel there are eight buttons numbered one to eight (for listing moves) and five instruction buttons — E (to enter move),

Li and Fung Trading are making a thousand Chess Masters everyday in Hong Kong. More on the mini mind when we can get one to play with.

Vee Needen Sie

With a bit of luck we will once again be amazed, astounded and generally boggled by the versatility of ETI readers. This time, we'd like to hear from anyone who can translate technical German (ideally Dutch, too) into English for us.

the odd page of unpronounceable tutonic text and turning it into the equally odd page of English, why not drop us a line or two or three.

We could employ the services of professional agencies in the field, but we'd prefer to get an ETI reader in on the act. So, if you think you're up to taking

Although we moved offices a few months ago, a lot of our mail is still being sent to our old address, so make sure you send the account of your terrific translational talents to us at 145 Charing Cross Road, WC2 (full address on the contents page.)

Great 1980 Sale

SUPER SOUND SAVING! DINDY LOW NOISE CASSETTES

SJ30	10 C30	15 min per side	£2.00
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SJ31	10 C90	45 min per side	£3.50
SJ32	10 C120	40 min per side	£4.50

ALL REDUCED! CAPACITOR PAKS

16201	18 electrolytics	4.7u-10u	£4.36
16202	18 electrolytics	10u-100u	£4.36
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ALL 3 at SPECIAL PRICE of £1.30			
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16162	24 ceramic caps	470p-3300p	£1.74
16163	24 ceramic caps	4700p-0.047p	£1.74
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RESISTOR PAKS

16213	60 1/2w resistors	100ohm-B20ohm	£1.50
16214	60 1/2w resistors	1K-8.2K	£1.50
16215	60 1/2w resistors	100K-820K	£1.50
16216	60 1/2w resistors	100K-820K	£1.50
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SJ59	6 5K lin 40mm slider pots		£0.50
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Greenweld 1980

We've just received our copy of Greenweld's 1980 component and equipment catalogue.

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Why should you buy the latest edition, if you have last year's? Well, if you don't send off for the 1980 edition, you'll miss out on all the new lines appearing in the catalogue AND somehow Greenweld have managed to reduce some of their prices. You'll also miss out on a copy of the latest bargain list (sent with every catalogue). As soon as the new Vero catalogue is available, that will be included too.

You can get all this for 40p plus 20p postage from Greenweld Electronics, 443 Millbrook Road, Southampton SO10HX.

Sci-Fi Easter

If you're into sci-fi, don't make any plans for Easter. Write 100 times in your gold embossed, leather-bound, page-a-day desk diary (or the nearest cigarette packet) — Albacon 80, the 31st UK Science Fiction Convention will be held in Glasgow over the Easter weekend.

From 4-7 April 1980 at the Albany Hotel, Glasgow, you can drift off into another world of sci-fi movies, lectures, discussions, a banquet and even a fancy dress do. You can join Albacon by sending off your £7 to the membership secretary Gerry Gillin, 9 Dunnotar Street Ruchazie, Glasgow G33.

Synthesiser (Feb)

There were a couple of minor errors in the Synthesiser project last month. The circuit diagram of the Power Supply on page 65 of the February issue shows C3 and C8 as 2n2. The correct value is, as shown in the Parts List, 2u2 25V tantalum. Now have a look at Fig 4 on page 69. C1-4 should go to ground. Also, PR3 should go to ground.

Now the bad news for anyone who uses the foil patterns published in ETI. The synthesiser foil patterns somehow got turned round the wrong way.

Audiophile AMP (Oct)

Some readers have experienced problems with RF oscillation in the power amp modules. If you're having trouble with this, place a 1000 p capacitor across each output transistors base/collector leads.

Super Index

In January we published an index to our 1979 projects and features. Thank goodness indexing only comes round once a year. We recently received a copy of a monster catalogue, listing projects published during 1978 in sixteen popular electronics and hi-fi magazines, including ETI, Hobby Electronics and Computing Today.

The projects are listed under 36 subject headings, from aeriels to time-keeping. Also included are dates of publication of alterations and amendments to projects published up to August 1979, together with additions to the 1972-77 index. Unlike our own index this one includes ETI Tech Tips features.

The 1978 volume of the Electronics Projects Index is available for £1.30, including post and packing, from its compiler (obviously a very patient man) Mr M L Scaife, Central Library, Northumberland Square, North Shields, Tyne & Wear, NE30 1QU.

Vero Cat

Last month, we gave you details of the new Vero packaging catalogue, Vero Electronics have asked us to point out that this catalogue is only available to the electronics trade. Their press release was sent to us in error. However, the good news is that Vero's new catalogue for the hobbyist will be available at the beginning of March.

Pet Chip

This should appeal to those of you who spent your hard-earned pennies on a 'pet rock,' when they were all the rage.

We recently received a letter from an anonymous dad who made an apparently trivial Christmas presi for his daughter. However, since then he has been inundated with orders.

Mr A. Nonymous painted a face on one end of an IC (pet IC, you see) and made a matchstick cage for it complete with watch battery feeding bowl.

The chip should quickly LATCH on to its new OHM. As for feeding, a few BITS of CURRENTS a day should be AMPle. Just let it NOR away to its heart's content. You can teach it tricks. In time it will learn to CHARGE and FLIP-FLOP, or even VOLT small objects.

Ta, Mr Nonymous. We haven't had a good groan in ages.

Electronic Circuit Design No. 1

Selected Reprints from **electronics today**

Introduction

Since ETI was originally launched in Britain in April 1972 we have published nearly 5000 pages of editorial matter; much of this has been devoted to electronic projects of course. In our history we have republished the best of these projects in Top Projects No 1-No 7, we have also reprinted the Tech-Tips and other circuits in Circuits Book No 1 and No 2 and our beginners series Electronics-It's Easy is now on its third reprint.

We have not however, until now, brought together the best features dealing with electronic design. Nearly

1500 pages have been devoted to this in recent years and this special is the first of a series of three which will bring together the best 250-300 of these.

Although some features are from quite early issues they have only been included because we feel that 'age' has not withered them.

We hope that the contents help the reader understand at least some of the aspects of electronic circuit design.

Halvor Moorshead
Editorial Director — ETI

Contents

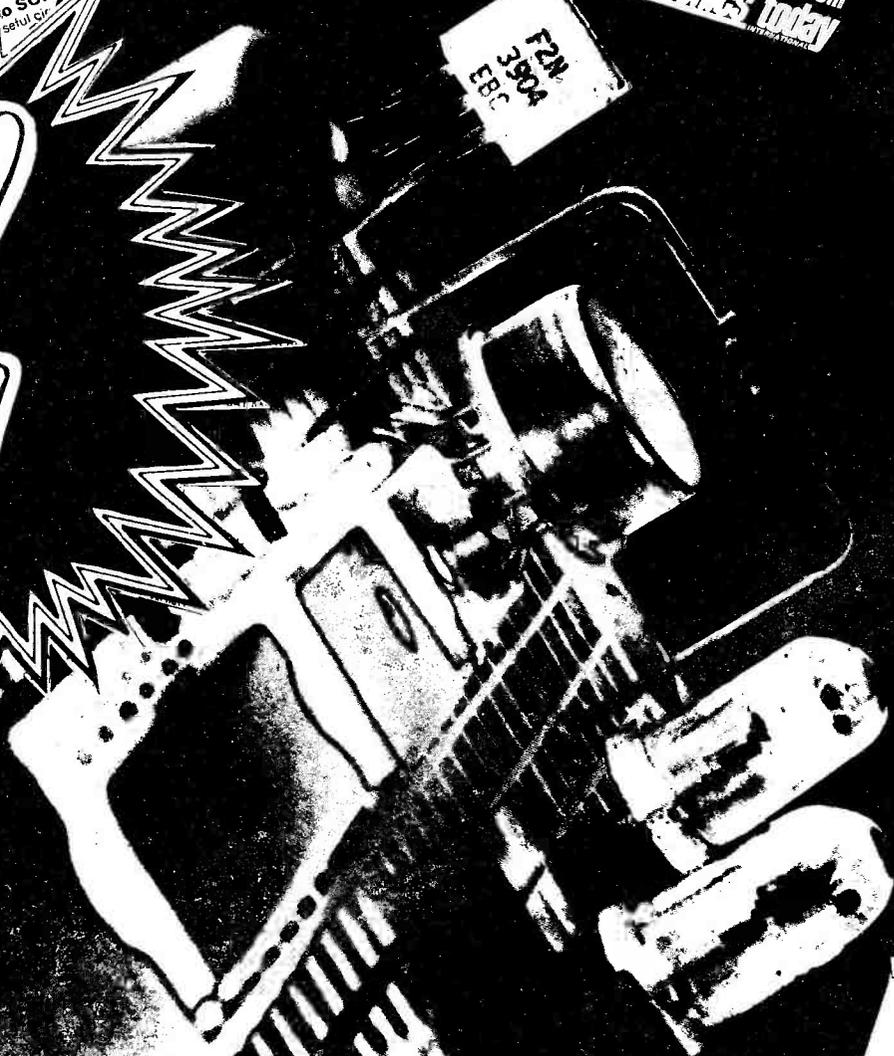
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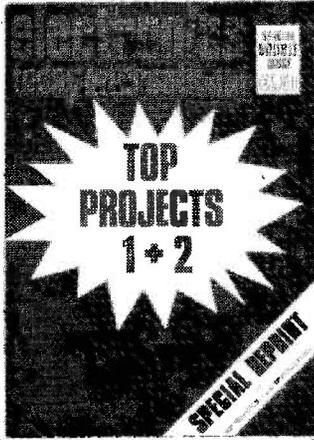


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Each volume contains over 150 circuits, mainly drawn from the best of our Tech-Tips. The circuits are indexed for rapid selection and an additional section is included which gives transistor specs, and plenty of other useful data.

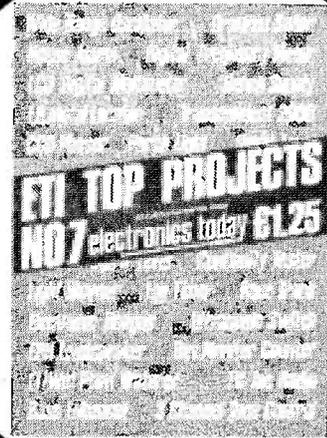
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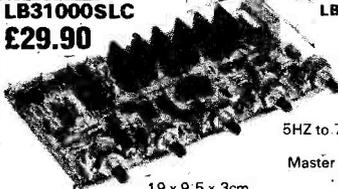
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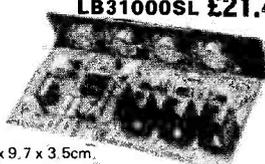
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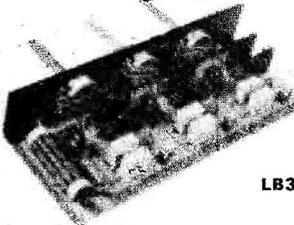
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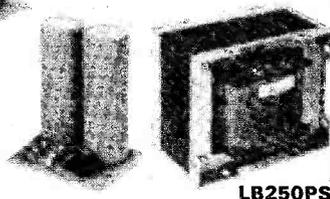
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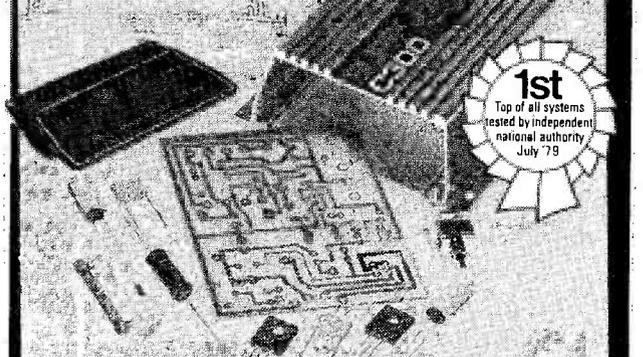
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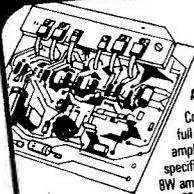
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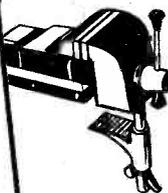
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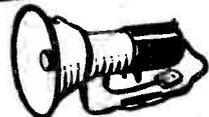
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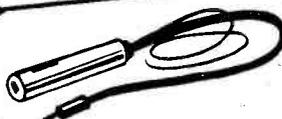
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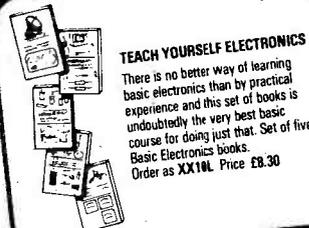
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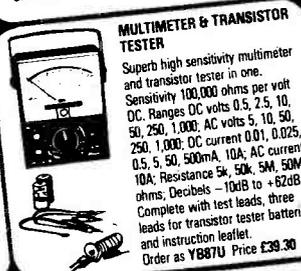
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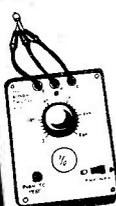
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BLACK HOLE THEORY

**You've read the book and seen the film, now hear the gospel
on Black Holes according to Ian Graham**

To understand what a black hole is and how it is formed, let's first have a look at the life of a star, for, under the right conditions, the death of a star may herald the birth of a black hole. The birthplace of stars is within the clouds of material between the stars. These clouds collapse under their own gravitational fields. Local regions of increased density form condensation nuclei whose gravitational fields grow gradually stronger as more and more material is attracted towards them. As these embryonic stars (protostars) continue to contract their temperature begins to rise, producing internal heating and emitting radiation into the surrounding space. When the temperature is high enough for hydrogen fusion to begin, contraction ceases.

The greater part of the star's life-time is then occupied with burning its hydrogen fuel, forming helium, which sinks deep into the core. Eventually, when the hydrogen is almost exhausted, the star's temperature begins to fall and the core begins to contract. We must now look at the star, not as a homogeneous ball of burning gas, but as a relatively heavy core surrounded by a lighter envelope. There is a constant battle between thermal forces, trying to blow the star apart and gravitational forces trying to crush it. Contraction of the core causes a rise in temperature, temporarily halting contraction and causing an expansion of the envelope ie the star appears to be growing larger. The remaining hydrogen is burnt off in the outer layers, sending more helium to the core. Eventually the core collapses under the immense pressure of the upper layers and this is accompanied by an enormous expansion of the envelope, forming a red giant.

Great Balls Of Fire

The final episode in the star's life depends on its mass. Let's take the route that will take us to a black hole. The core continues contracting, helium fusing to form carbon and successively heavier elements. Eventually it collapses rapidly, blowing off the envelope in a supernova explosion during which the single star may outshine an entire galaxy.

The explosion may destroy the core completely or it may leave a small core. However, if the star was more than two or three times as massive as our own Sun, the core surviving a supernova will rapidly collapse. Theorists predict that the collapse will continue until the core radius reaches zero. This hugely massive, but dimensionless point in space is called a singularity.

No Escape

The singularity has such a strong gravitational field that light itself cannot escape ie the escape velocity of the body is greater than the speed of light. The further we are from the black hole, the lower is the escape velocity (the gravitational force decreases with the square of our distance from the body). At a particular distance from the singularity, the Schwarzschild radius, the escape velocity equals the speed of light. Within this event horizon, nothing escapes.

For a body of mass (M), the Schwarzschild radius (R_s) is given by:

$$R_s = \frac{2GM}{c^2}$$

(G is Newton's gravitational constant and c is the speed of light).

If we let M be the mass of our own Sun, R_s turns out to be 3 kms. So, why isn't the Sun a black hole? Its radius is much larger than 3 kms, so beyond this event horizon the Sun's hydrogen fusion reactor can radiate its energy out into space, but if the Sun's mass was to be compressed to a diameter of less than 3 kms, it would become a black hole.

If we look at our own Earth and the bodies around us in the solar system and even the Milky Way galaxy as a whole, we find that they all rotate ie they all have angular momentum.

The angular momentum (L) of a rotating body of mass (m), radius (r) at an angular velocity of ω is given by:

$$L = m\omega r^2$$

If a rotating body such as the remnant of an exploded star, begins to contract ie r gets smaller, the angular velocity (ω) must increase in order that angular momentum may be conserved. Depending on its mass a black hole may rotate at about 1000 times a second. A black hole is such a dense body that one the size of a proton would weigh in at about ten thousand million tonnes!

Just as the Earth bulges slightly at the equator and is flattened at the poles due to centrifugal force, the much greater rotation of a black hole results in a much more severe deformation. The equations predict that a black hole is not a sphere at all. It may be similar in profile to a spiral galaxy (like the Milky Way) ie a disc with a bulge at its centre.

All this speculation on the formation and structure of a black hole may seem to be purely academic. After all, how do you go about finding a black hole to prove that it exists and verify its structure and behaviour? Even if you knew where to look, how would you observe something from which no light can escape?

Stellar Striptease

You may not be able to see the black hole itself, but it should be possible to observe what it does to any matter near it. The best candidate for detection would be a black hole and a star orbiting each other — a binary system. Material should be stripped from the star and wind its way round the black hole, forming a disc, finally disappearing beyond the Schwarzschild radius like water funnelling down your bath plug-hole. As the matter crowds together for its last dive to oblivion, its temperature rises until it is hot enough to radiate at X-ray wavelengths.

The search for X-ray sources could not begin until the space age because radiation in the X-ray region of the spectrum cannot penetrate the Earth's atmosphere. One of the earliest X-ray sources discovered by orbiting telescopes was Cygnus X-1, in the constellation of Cygnus. The X-ray source accompanies a visible blue giant star. The visible star's speed was found to be varying along a sine wave, so it must have an invisible companion around which it is orbiting.

Most of the light emitted by the system appears to arise, not from the visible blue star, but from helium gas sucked from it and circulating around its invisible companion. The companion's mass has been calculated as more than the critical three solar masses, so it is likely to be a black hole.

Another system likely to become a household name among black hole hunters is V861 Scorpii (the V indicates that its brightness appears to vary). This variation over a period of about eight days is due to a dark body orbiting

(and eclipsing) a blue supergiant. Like Cygnus X-1, V861 Scorpil is a binary system.

Dark Star

In both these cases, the dark star could be either a black hole or a neutron star. A neutron star is a body where the matter from a collapsed star core is compressed so tightly that electrons and protons are pushed together to form neutrons. Again, mass is the determining factor. If the mass is less than about three Suns, the body will be a neutron star. If it is above the critical mass, it should be a black hole.

Shaking The Edifice

Life was much simpler for scientists in Victorian times. Through classical Newtonian physics, everything under the Sun (and beyond it) seemed describable and predictable. It was just a matter of time before the scientists achieved a comprehensive understanding of the universe and determined the physical laws to describe all the processes therein, from the subatomic level upwards. Then along came trouble-makers like Planck and Einstein, who showed that an electromagnetic wave could behave like a stream of particles. In classical physics a wave is not the same as a particle and never the twain shall meet. Not content with shaking the foundations of prevailing physics, Einstein (leader of the popular front for the liberation of physics) went on to predict the effects of very dense bodies on time itself.

Space and time are inextricably intertwined. Close to a black hole space is curved so severely that time itself loses its meaning. Stephen Hawking and Roger Penrose working at Cambridge saw the possibility that any object (including a spacecraft) falling towards a rotating black hole may not fall into the murderous singularity, but may miss it, to reappear elsewhere in our universe (or another universe) an instant later. Einstein's theories predicted the possibility of bridges between the warped planes of space. However, black holes were then believed to be non-rotating bodies, so that any matter falling over the event horizon could not help but hit the singularity.

Instant Travel

If only a small fraction of the matter falling into a rotating black hole misses the singularity, what becomes of it? It must reappear at the other end of the tunnel an instant later, maybe light years away from where it disappears. So, there must be points in space where matter appears to be spewing forth from nowhere — white holes. Now, if black holes are almost undetectable because of their blackness,

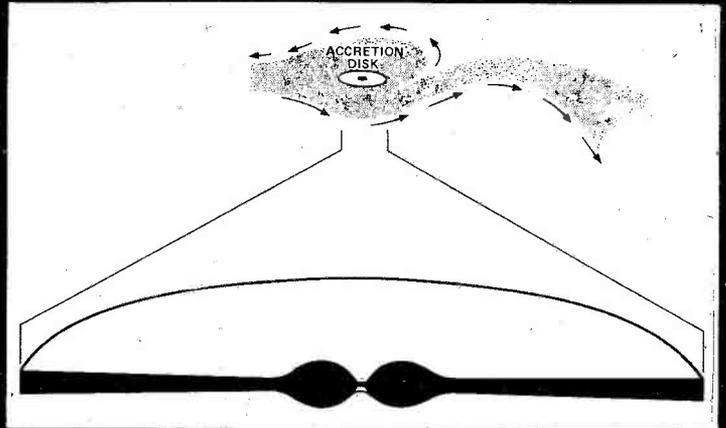


Fig. 2. As matter is sucked from the giant star towards the black hole, it builds up an accretion disc around the event horizon.

the detection of white holes should be simplicity itself. Indeed there are galaxies, known as Seyferts (after the man who identified them in 1943) which resemble galaxies like the Milky Way, but for one characteristic. The centre of a Seyfert is very bright and smaller than usual, and it emits radiation at frequencies which the Milky Way absorbs. The galactic nucleus seems to be an exploding ball of matter and energy — possibly a white hole.

Sci-Fi

The black hole may seem to be a futuristic concept. In fact, Laplace realised that if a body was massive enough, its escape velocity would exceed that of light, as far back as 1798. That black holes might make possible travel across light years of space in an instant (or even time travel) sounds more like science fiction.

Before we can verify the theories and check out the equations we will have to get the hang of interstellar travel, or find a black hole in the solar system. Cygnus X-1 is about 600 light years away. As for black holes in the solar system — it's not as crazy as you might at first imagine. The Big Bang, from which the universe is believed to have begun, would have produced the magnitude of pressures necessary to produce black holes in their millions. Our galaxy could be sprinkled with these tiny Big Bang black holes. When a study of the Sun, looking for neutrinos produced in nuclear reactions at its centre, found none, one researcher suggested that a small black hole in the Sun itself may satisfy the findings.

It may sound like science fiction . . . but for how much longer?

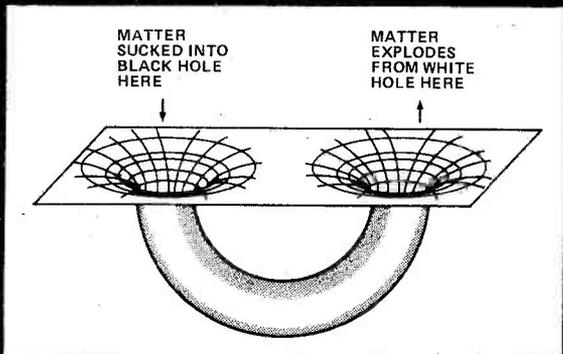


Fig. 1. If all the matter disappears into a black hole, it must appear somewhere else at a White Hole.

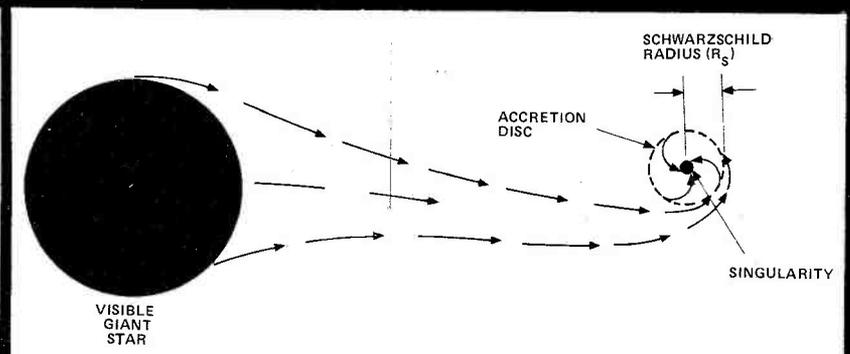


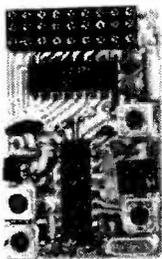
Fig. 3. The black hole and its giant companion star orbit one another, as the hole strips material from the star.

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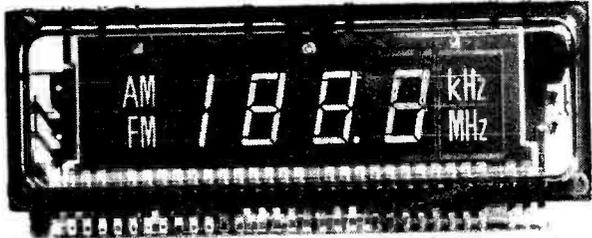
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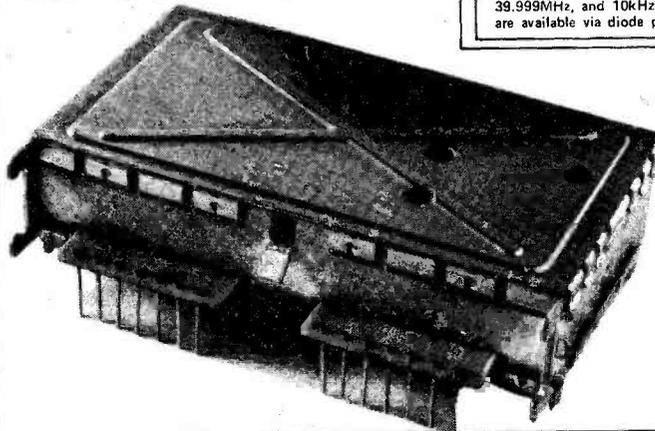
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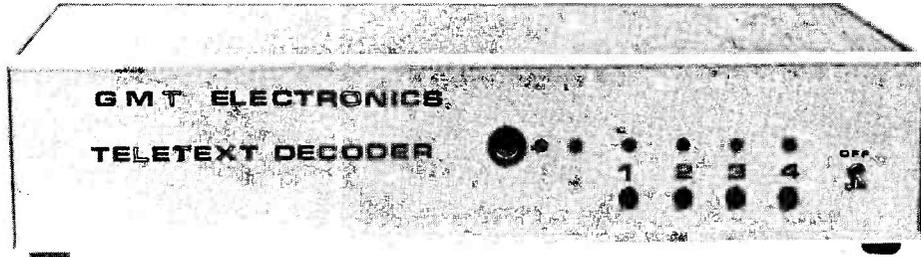
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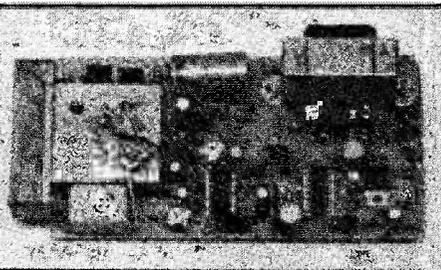
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DOPPLER RADAR ALARM

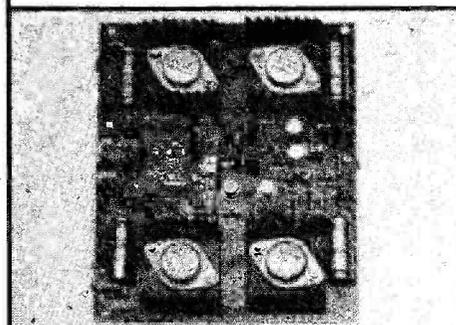


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The unit provides a 12 volt output, normally high (low on alarm), to supply an external remote relay, which is not supplied. The unit has an integral buzzer to give an indication when the unit is being armed, and when triggering is complete. The unit comes complete with a suitable case.

DOPPLER RADAR ALARM **£39.50**

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Bring your Hi-Fi up to date. Available now is a 100 watt audio amplifier using POWER MOSFETS. The POWER MOSFET has several advantages over bipolar transistors. It has good frequency response, no carrier storage delay, thermal stability, no secondary breakdown, and high input impedance. The MOSFET Amplifier has been designed to deliver a continuous power output of 100 watts with full heatsinking into 8 ohms from 5 Hz to 100 kHz with no more than 0.01% total harmonic distortion, which is about a tenfold improvement on ordinary bipolar techniques. The high output impedance and thermal stability of the MOSFET reduces the size of the total circuit by about 30%. The kit does not include a case.

reduction
POWER MOSFET AMPLIFIER MODULE **£27.50**

SIGNAL TRACER

eti signal tracer

10M 10pF signal probe detects audio, mains fields and amplitude modulated RF.

HOW IT WORKS

It has been said that a signal tracer is just an amplifier with a diode at the front. In fact, for many applications, just such an arrangement is all that is required. This design fulfills the above description and then some!

Boasting a high input impedance and good sensitivity, the unit drives a small loudspeaker or personal earphone with good volume. Power may be derived from the equipment under test or a separate nine volt supply may be used. Use of the specified case ensures a neat and attractive project. The case is identical to that used in the CSC logic probe kit and comes complete with detachable probe, power supply leads and a small piece of perforated board (not needed here). Its place is taken by the PCB. The case comes complete with cut-outs for three indicator LEDs. Only one is used in this design to accommodate the power indicator LED and the other two may be blanked off or simply left vacant.

Construction

Use of the PCB is really essential. Quite apart from the problem of fitting all the bits in the case, layout is critical to avoid stray feedback and spurious oscillation. Owing to the limited space available in the case, the physical size of the components is important and the smallest available components should be used. Note that C3 lies over R3, 4 and capacitors C5, 9 need to lie on their sides. A flying lead link should be taken from R2 (Q1 drain) to C2. This may be done on the underside of the board and should be as short and direct as possible. LED 1 is mounted on the board and is self-supporting.

In use, the unit should be connected to a nine volt supply and a loudspeaker plugged into SK1; use screened cable to avoid stray feedback. As a simple test, hold the probe within a couple of centi-

PARTS LIST

Resistors

R1	10M
R2,12	1k0
R3,10	1k5
R4	2k7
R5	150k
R6	18k
R7	10k
R8	470R
R9	2
R11	10R

Capacitors

C1	10p ceramic
C2,4,6	10n ceramic
C3	6u8 tantalum
C5,9	47n tantalum
C7	220u electrolytic
C8	2u2 tantalum
C10	47n ceramic
C11	100u tantalum

Semiconductors

IC1	LM386
Q1	2N3819
Q2	BC109
LED 1	any 0.125" LED
D1	1N4004

Miscellaneous

case, socket, 8 ohm earphone or loudspeaker

To provide high input impedance with good sensitivity a FET input stage is used. Q1 is connected as a common source amplifier, decoupled to AC by C3, with the output taken across R2. This stage is coupled to Q2 by C4. Q2 operates as an AM detector and audio amplifier. The output is taken across R7 and is decoupled to RF by C5. The power supply to this section of the circuit is provided via R10 smoothed by C7. A small integrated audio amplifier forms the output stage. IC1 provides its own input bias and the output automatically centres at half the supply voltage. C10 and R11 prevent instability. The output is coupled via C11 to an eight ohm personal earphone or loudspeaker. Shielded cable should be used to prevent stray feedback to the input stage. Overall power is supplied via D1 which protects against accidental reversal of the supply leads. Power is indicated by LED 1. As this component is sited near the input stage its power supply is decoupled by C9 to prevent instability due to stray feedback. When used with 9 volt battery equipment, power may be derived from the circuit under test. When a separate supply is used to power the probe, a connection should be made from 0 V to the earth of the equipment under test. Bear in mind the voltage rating of C1; for a small ceramic capacitor, this may be only fifty volts or so.

BUYLINES

The LM386 is available from Watford Electronics. The remaining components are unexceptional and should be readily available. The case is manufactured by Continental Specialties Corporation, type CTP-1. Continental Specialties Corporation, Shire Hill Industrial Estate, Saffron Walden, Essex CB11 3AQ.

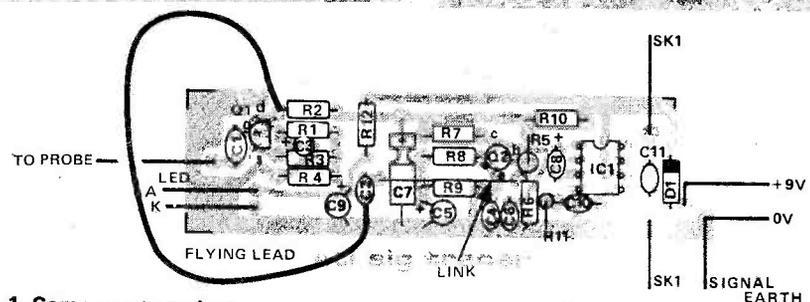
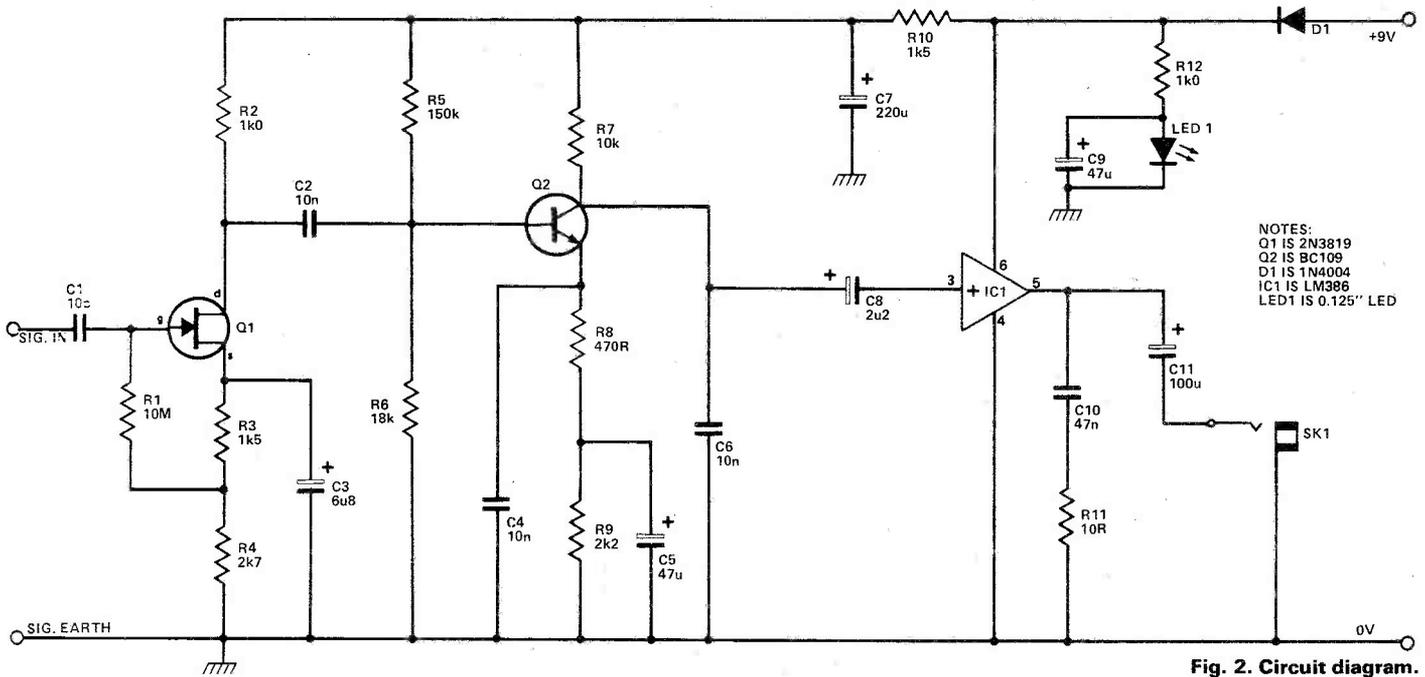


Fig. 1. Component overlay.



NOTES:
 Q1 IS 2N3819
 Q2 IS BC109
 D1 IS 1N4004
 IC1 IS LM386
 LED1 IS 0.125" LED

Fig. 2. Circuit diagram.

metres of a live mains lead. A loud hum or buzz should be heard. When using the tracer with a separate power supply from the equipment under test a wire should be taken from 0 V to the equipment's earth to provide a signal return

path. Remember that the input capacitor C1 may only be rated at about fifty volts if you are thinking of working with high voltage equipment. As well as detecting low level audio, the probe may also be used to detect radio-

frequency signals at frequencies up to and above 10 MHz. Sensitivity is quite adequate to make the unit useful with TRF receivers and signals are easily detected in conventional medium-long wave superhets. **ETI**

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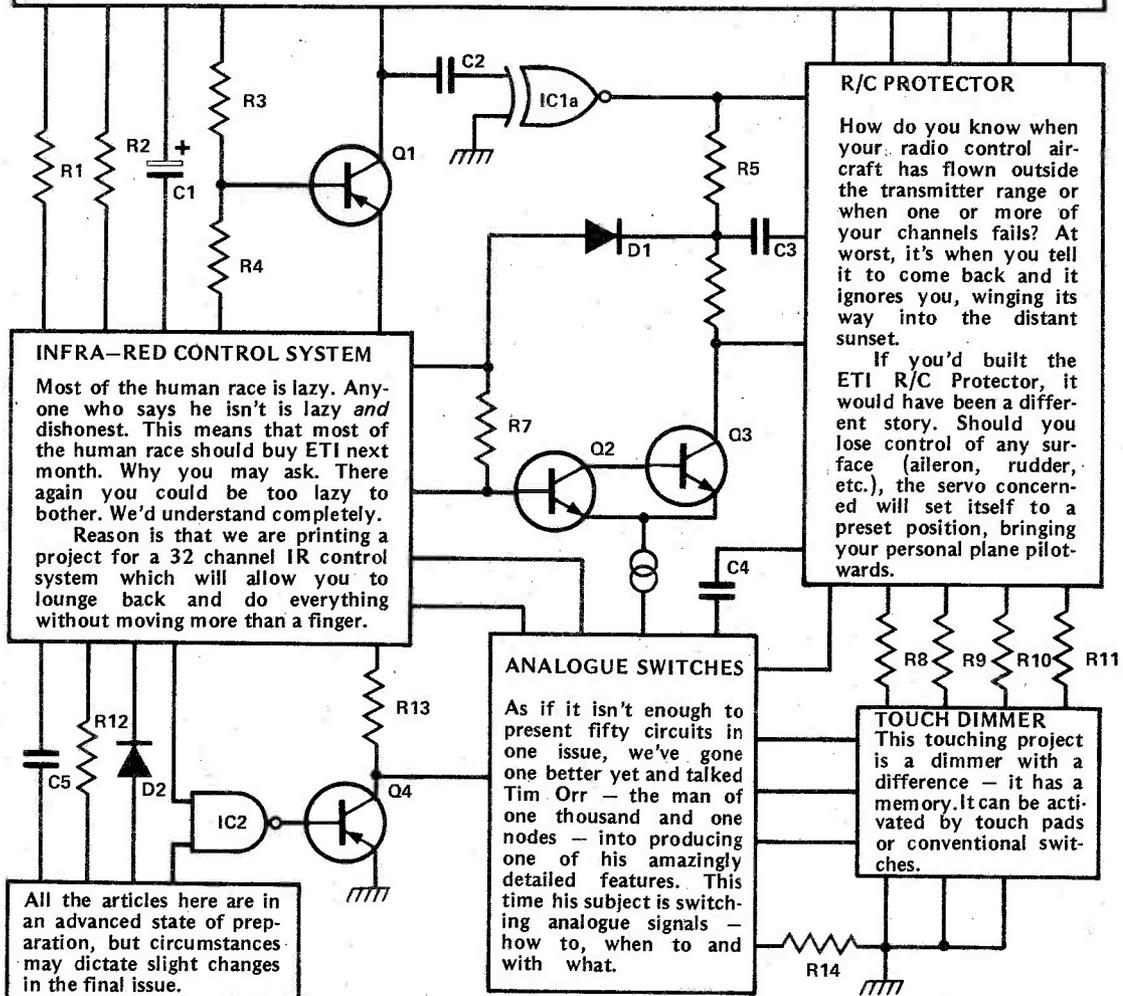
What to look for in the April issue: on sale March 7th

CIRCUIT SUPPLEMENT

Next month's ETI carries something really special — a SIXTEEN PAGE circuit supplement for the experimenter. All the circuits have been tried and tested by us, making this the most reliable reference yet. If there is anything you need a circuit for or any circuits you need something for this is the place to find it. No less than 50 in all. Half a hundred of the best you'll find anywhere.

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50 TESTED
CIRCUITS
TO BUILD



THE 1537 VCA

Keith Brindley brings you up to date with the latest offspring of the silicon chip family - complete with practical applications.

There is always a great deal of excitement generated in electronics on the arrival or introduction of a new circuit, concept or chip, particularly if the system is potentially a field leader. The 1537A chip is just that! The specifications which the device can offer in situ are well above those of any similar preceding systems. Table 1 gives a listing of specifications, which can be obtained in the correct applications.

Parameter	Specification
Bandwidth	DC-200kHz
T.H.D., 20Hz-20kHz	0.004%
I.M.D. (SMPTE TEST)	0.03%
Noise	-90dBv, ± 1 dB (worst case, unity gain)
Overshoot and Ringing	None
Slew Rate	> 10v/usec, symmetrical & constant
Input Impedance	20K Ω
Maximum Input Level	+20dBv
Gain	0dB (Unity)
Maximum Attenuation	>94dB
Control Voltage	0 to +10V
DC shift vs. Attenuation	≤ 5 mV
Power Requirements	Regulated ± 15 V at +25, -33mA

Table 1. The maximum possible specifications available from a 1537A system.

With harmonic distortion of 0.004% and a signal/noise ratio of over 90 dB the system is of course well suited to studio applications, although use in this environment is by no means its only area of involvement. The IC itself seems at first glance, somewhat highly priced at around £6, but nevertheless, it requires few extra components to produce a VCA system of the superb quality (suggested in the specifications of Table 1) and overall represents good value for money to the amateur and professional engineer alike.

Amplifier Or Attenuator

The term VCA is normally used as an abbreviation of the phrase Voltage Controlled Amplifier, but in its simpler modes the 1537A is, strictly speaking, a voltage controlled attenuator ie with a maximum gain of unity. The inventors, do, however, stress that connection of the 1537A into the feedback loop of an amplifier (such as an op amp) produces a voltage controlled amplifier. The applications section of this article show how this can be achieved.

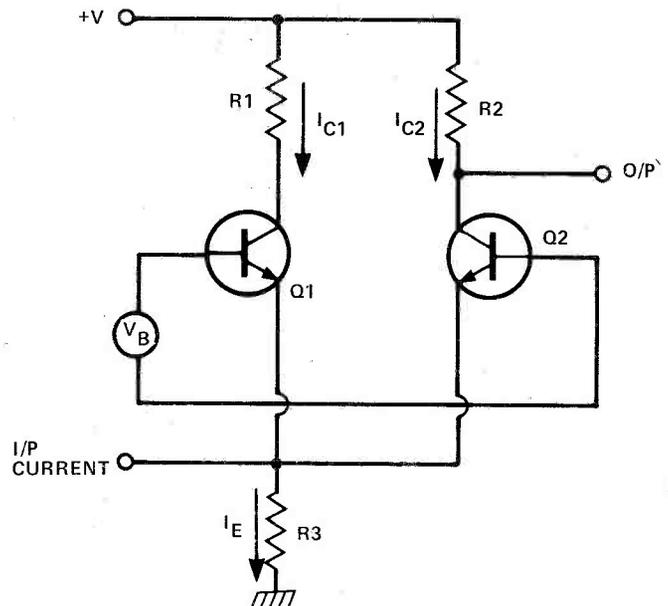


Fig. 1. A differential pair of transistors — the basis of a VCA.

The operation of the 1537A VCA depends upon the gain control function of a differential pair of transistors as in Fig. 1. The transistors in Fig. 1 are connected at their emitters. The current through R3 (I_E) is, therefore, approximately equal to the sum of their two collector currents I_{C1} and I_{C2} through R1 and R2 respectively. The relative bias voltage, V_B , between the two bases determines the relative collector currents. If we now apply an input signal current to the joined emitters we obtain output signal currents through R1 and R2, the sizes of which are determined by the bias voltages. In other words, by altering this bias voltage we alter the size of the output signals.

Figure 2 shows a simplified internal circuit of the 1537A chip giving pin numbers and external load and emitter resistors necessary for operation. There are two basic gain control circuits within the chip, similar to that in Fig. 1 (built around Q1, 2 and Q5, 6) except for three main differences: — the diode connection of the transistor pair not used for signal output ie Q1 and Q6, which reduces the distortion due to transistor gain differences. — the addition of buffers around Q4 and Q8 to reduce loading of the output collectors of the gain transistors, in turn allowing idealised characteristics over the full gain range. — the use of transistors Q3 and Q7 as voltage to current converters enabling the input to be applied as a voltage rather than as a current.

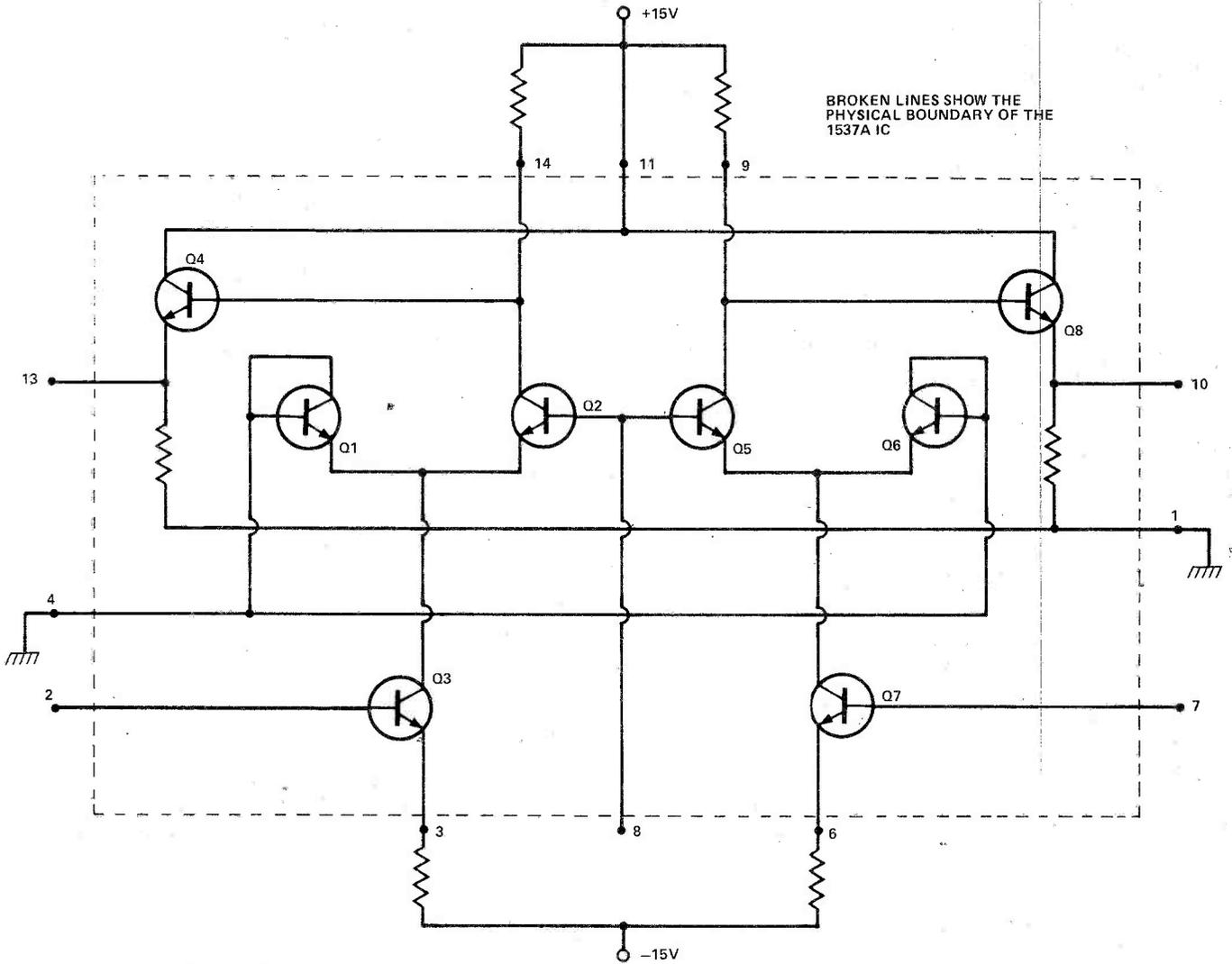


Fig. 2. A much simplified internal circuit of the 1537A IC, showing external load and emitter resistors.

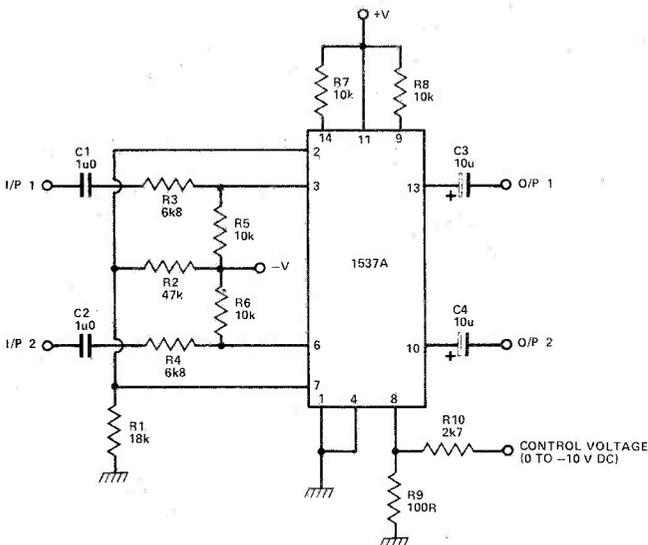


Fig. 3. The simplest mode of operation of the 1537A — a low input impedance stereo VCA with a negative going control voltage.

There is, however, a much more subtle difference, on top of this and that is the use of large geometry transistors. The effect of larger geometry transistors can improve second order intermodulation by as much as ten times for a tenfold increase in transistor size. Noise can also be reduced by about 10 dB for a similar increase in geometry.

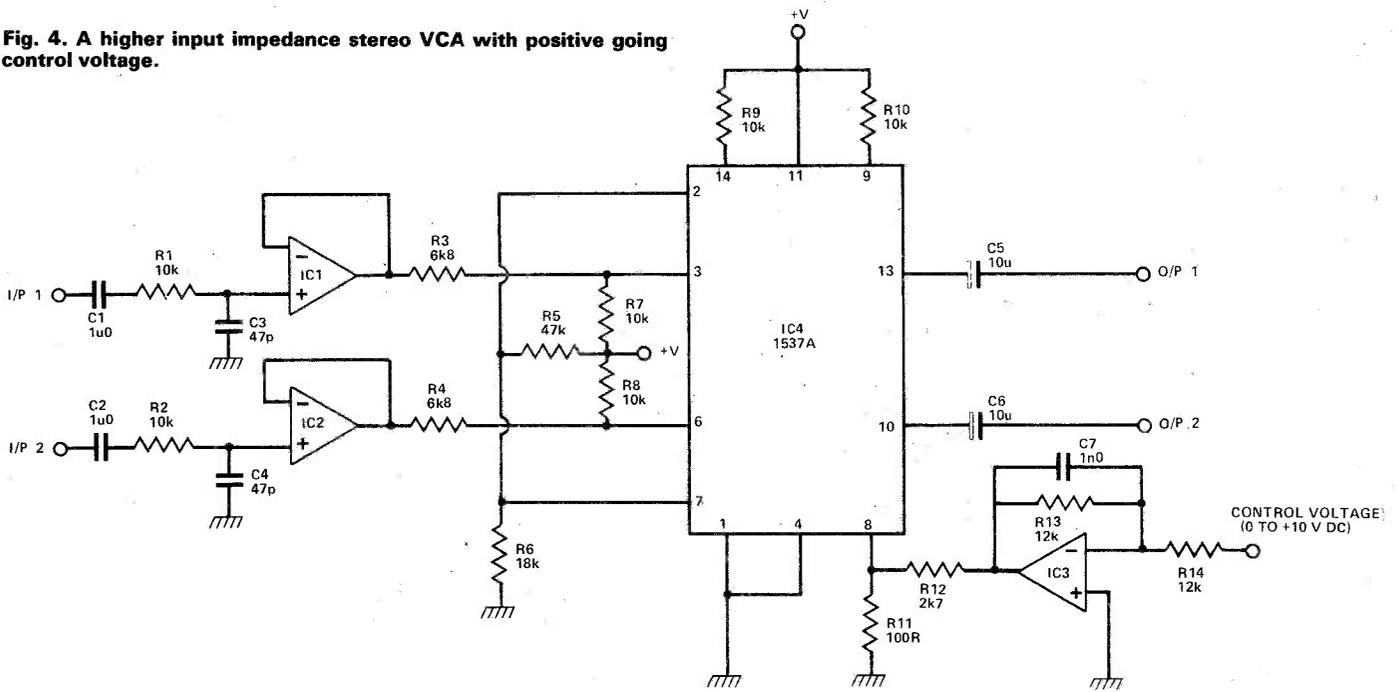
This leads us now to the simplest mode of operation of the 1537A using each gain control circuit individually, although the control voltage affects the gain of each circuit simultaneously (Fig. 3).

The ratio of R9 and R10 is calculated to allow a control voltage range of 10 volts (ie 0 to minus 10 V), altering the gain of the system from 0 dB to about -90 dB. The input impedance of the circuit to applied signal is low and ideally buffers should be placed before this circuit. Although this circuit does not give studio quality specifications it will, however, still produce results in the "high fidelity" range, providing impedance matches are considered.

Figure 4 shows a circuit application which gives a higher impedance input. Also included is an inverting stage in the control voltage link which allows a voltage of 0 to + 10 volts to be used for controlling attenuation.

Although any operational amplifier could be used for ICs 1, 2 and 3 in the previous circuit, it should be fairly ►

Fig. 4. A higher input impedance stereo VCA with positive going control voltage.



apparent that the noise, distortion and bandwidth specs of the circuit are limited to those of the op amps used.

Either of the two circuits of Figs. 1 and 2 can be adopted as the voltage controlled gain heart of a stereo system. Their outputs are about 10 dB down on the inputs so necessary amplification should be given before or after the attenuator.

Coming Up To Scratch

Now, three more developments to the circuitry can be undertaken to improve the specifications to those of Table 1. Figure 5 shows the circuit of the ideal system capable of these high specs.

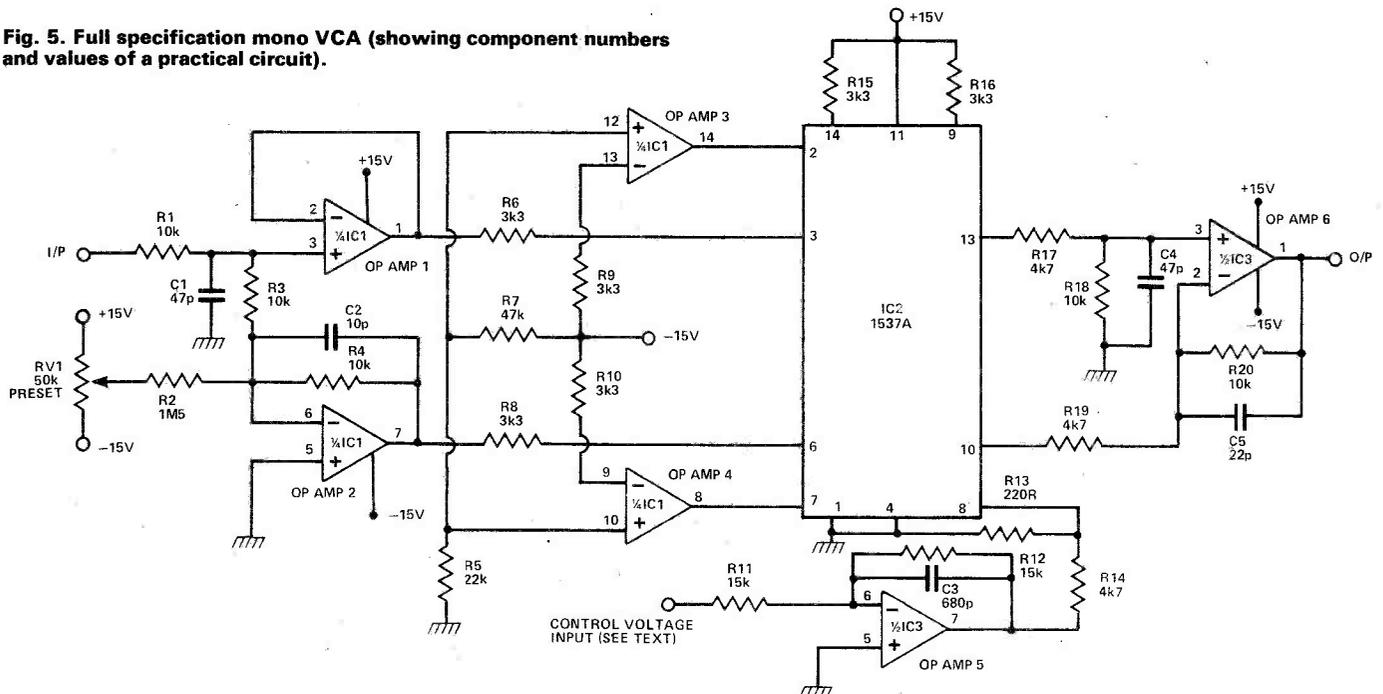
Firstly, actively linearised voltage to current sources (op amp 3 and 4 in Fig 5) improve distortion figures when

using a wide range of input signal voltages.

Secondly, paralleling of the two individual gain control circuits (ie the same input signal is fed to both devices at their inputs and mixed at their outputs) gives a 3 dB improvement in S/N ratio.

Finally, a technique is utilised which is complementary to the previous development of parallel devices, whereby the same input is applied to both gain control devices but 180 degrees out of phase. The two outputs are combined in a differential amplifier to give a single ended output. The differential amp is formed around op amp 6. This technique has the effect of reducing DC shift caused by bias and control voltages and with careful adjustment of RV1, the minimal DC shift now left at the output can be reduced even.

Fig. 5. Full specification mono VCA (showing component numbers and values of a practical circuit).



further to near (if not actually) zero. The prototype circuit shown, upon testing, actually gave no DC shift at all (or at least none measureable on our test equipment).

The complete circuit can be used as an exceptionally high quality VCA whose signal input can be anything from a few millivolts through to about 20 volts pk to pk without distortion. The lack of DC blocking capacitors at the input and output means that the system can be used to control a DC voltage applied to the input. AC signals up to well over 200 kHz are easily catered for, due to the system's wide bandwidth.

The overlay in figure 6 shows the component layout on printed circuit board of the circuit. The PC design is given in the Foil Pattern section of this issue and will enable interested readers to build the system and get first hand experience of it. As far as we know this article is the first of its kind to present a circuit in a form where "experimenters" can benefit easily and directly from the written text whilst simultaneously using the device in a tried and tested form.

Construction

If the circuit board layout is followed then there should

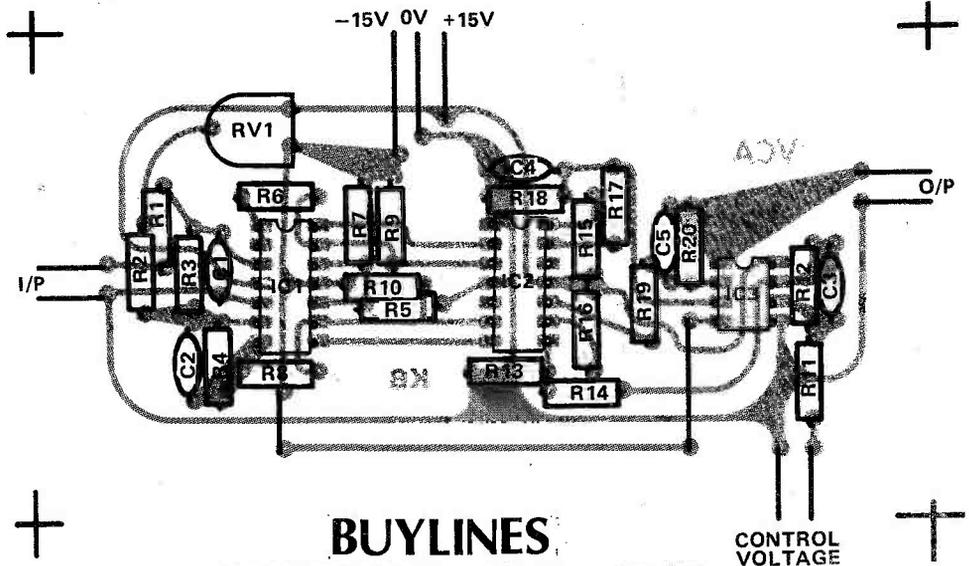
be no problems. IC holders are advisable though by no means necessary. RV1 should be a good quality type (cermet), to assist in setting up the output offset shift to zero, cheaper quality presets can sometimes be tricky to adjust in low voltage DC applications of this nature. Op amps 1 to 4 in the circuit are combined in IC1 and can be of a wide range of types from a quad 741 type (3403) upwards. Obviously, if you wish to obtain the best specs the quality of the op amps are critical. LF 347 or TL 074 will give the best results.

Similarly op amps 5 and 6 are included in IC3 and LF 353 or TL 072 are of optimal quality.

Setting Up

The system should work without any adjustment for an AC signal and varying the control voltage from 0 to 10 volts should give total control over the output amplitude. Some setting up will be required if the input is to be DC, though. This is best achieved by earthing the input. Measure the output voltage using a high impedance voltmeter (it should only be the order of a few millivolts). Adjust RV1 until a complete sweep of control voltage ie from 0 to 10 volts produces only minimal change in DC output voltage. The

Fig. 6. Overlay of PCB of the 1537A VCA module.



PARTS LIST

RESISTORS All kW, 5%	
R1,3,4,18,	10k
20	
R2	1M5
R5	22k
R6,8,9,10,	3k3
15,16	
R7	47k
R11,12	15k
R13	220R
R14,17,19	4k7
PRESET	
RV1	50k min horiz cermet
CAPACITORS	
C1,4	47p polystyrene
C2	10p polystyrene
C3	680p polystyrene
C5	22p polystyrene
SEMICONDUCTORS	
IC1	TL074, LF347 etc.
IC2	1537A
IC3	TL072, LF353 etc.
MISCELLANEOUS	
IC Holders	
PCB	

BUYLINES

Most of the larger mail order companies will be able to help with the quad and dual op amps if you experience any difficulty in obtaining them.

The 1537, however, is presently obtainable only from Apex Audio Systems Ltd. Their address is 35 Britannia Row, London N1 8QH. They have kindly agreed to offer the IC to ETI readers at the reduced rate of £5.00 each including VAT, which is 15% off the normal price. However, this is dependent on small quantity CWO orders and the special code 'ETI APHEX 101' must be quoted with your order.

All other components should be easily obtainable.

circuit is now completely set up to accept an input signal in the frequency range DC to 200 kHz. At minimum attenuation the system operates as a unity-gain wide range, high quality buffer, with a reasonably high input impedance and low output impedance. Variation of the DC control voltage over the range 0 to 10 volts will produce over 90 dB of attenuation of the output signal.

If an overall gain is required in the circuit, resistors R18 and R20 can be changed as in Table 2.

GAIN	R18 & R20
0dB	10k
6dB	22k
10dB	33k
15dB	56k

Table 2. The values of R18 and R20 to give the required overall gain in the VCA system of Fig. 5.

The control voltage range of 10 volts can be altered as required simply by changing the ratio of resistors R13 and R14 to suit.

To our knowledge, there is no officially recognised standard symbol for a VCA and rather than redraw the whole circuit of figure 5 upon every reference to the circuit we thought it better to invent a symbol for the purposes of this article. A horizontal trapezoid shape appeared to be the ideal symbol, as shown in Fig. 7. It symbolizes the system as a modular buffer amplifier, whose output (symbolized by the top line), decreases as the control voltage (the bottom line), increases. We shall use the modular symbol of a VCA whenever reference is made to the circuit of Fig. 5, although any VCA module of another design should function in the applications which we give.

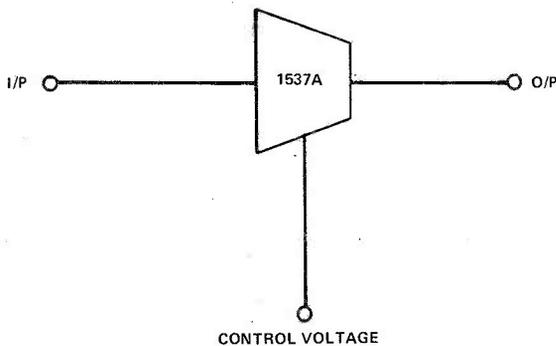


Fig. 7. The ETI symbol of a VCA module.

Use of the 1537A system module as a DC controlled analogue gate can produce many effects. Amplitude modulation of the signal occurs and the usual associated effects are observed. For instance, in Fig. 8 we can see a simple but high quality tremelo unit. Transistors Q1 and Q2 are connected as a phase shift oscillator and buffer, with speed and depth controls whose varying DC output is connected directly to the control port of the 1537A module. The frequency range of the oscillator is approximately 2 to 5 Hz. Altering the values of all three capacitors will change the main frequency, though that stated will give the best results.

The control voltage in the last application was varied as a sine wave of course, but there is no reason why other waveforms eg square, could not be used for control purposes. Figure 9 shows a 555 operating in the astable

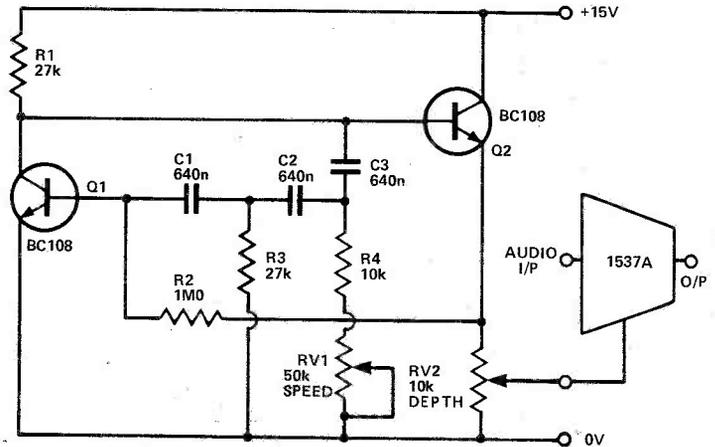


Fig. 8. A simple tremolo circuit.

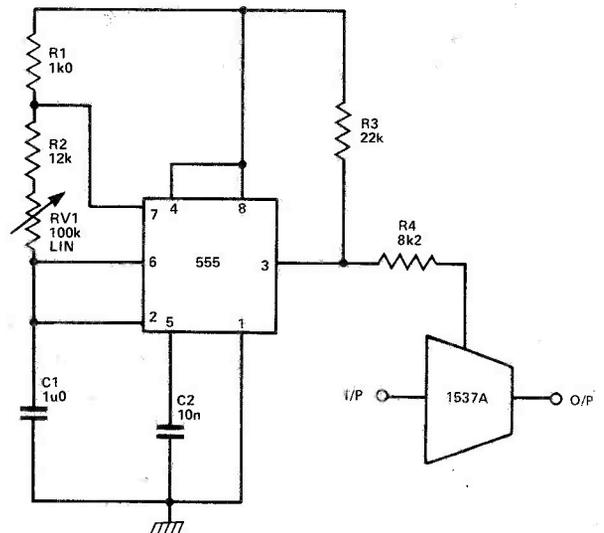


Fig. 9. A Dalek type sound generator.

mode with a frequency range of approximately 5-50 Hz. The output signal will be modulated with the square wave and the overall product is a Dalek type sound if a vocal signal is applied to the 1537A module.

This square wave control can be taken one stage further if the control voltage is the output from a monostable as in Fig. 10. A tone burst generator can be very easily constructed with this mode of operation. In a tone burst

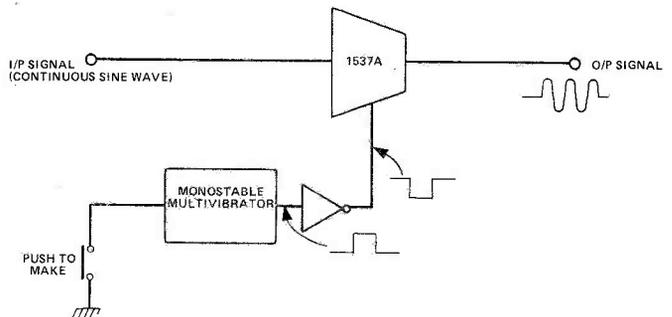


Fig. 10. A simple system enabling the construction of a tone burst generator.

generator, a rectangular envelope 50-500 μ s long is formed around a single sine wave frequency of normally 1 kHz. Tone burst generators are useful for testing the transient response of speakers. A push to make switch is used to provide the trigger to fire the multivibrator, producing the correct length pulse which in turn is inverted to form the control voltage pulse, applied to the control port of the 1537A.

The previous applications have all used automatic waveform control of the applied signal to produce the required attenuation characteristics, but this is not a necessary trait. The control voltage can be simply tapped off a variable resistor having the maximum control voltage range (ie 10 volts) across it. In this way, altering the position of the wiper alters the attenuation of the applied signal. The pot acts quite simply as a volume or level control. Ordinary non-DC volume controls can suffer from pick-up problems because the signal itself is being rotated through the pot. As only DC is applied to the pot in this application no pick-up can occur and the control can be remotely mounted from the module with no screened cable being necessary. Figure 11 shows such a volume control.

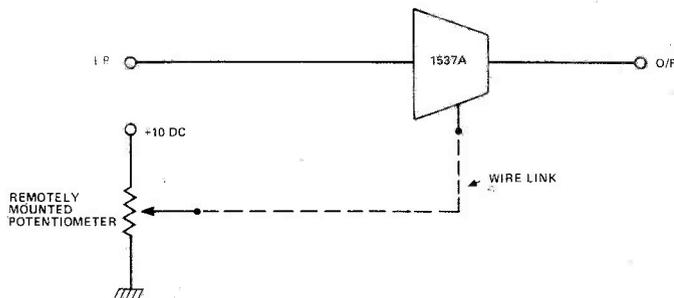


Fig. 11. Remotely (wire-linked) controlled volume control.

This remote control facility can be utilised in an audio mixer which includes remote faders for each channel. Figure 12 shows the general idea of such a circuit. An op amp is used as a summing amplifier into which the output of each channel's VCA is fed and mixed. The mix is relative to the control voltage applied from the remote faders to each VCA. The circuit allows for up to N inputs, where N to practical limits will probably be a maximum of about 12, but with careful layout techniques, there is no reason why this cannot be increased further.

Figure 13, shows an interesting outline to enable digital control of the VCA, say from a computer link. In order that the computer can operate in real-time, ie control of the VCA is not just its only job, it is necessary for the interface to provide a latch for the digital word. The output of this latch is changed to a linear DC voltage by the D/A (digital to analogue) convertor whose output is taken to the control port of the VCA.

The digital latch, once set by a strobe pulse, provides the facility that after the volume required has been found, the computer is free to perform other tasks. When the volume is to be altered, the latch is reset to the new digital input.

The last six applications of the 1537A VCA system have simply shown methods of providing a control voltage (automatically, manually or digitally) to control the module in its function as an analogue gate. The following section begins with the assumption that the control voltage is already present, perhaps by one of the previous methods.

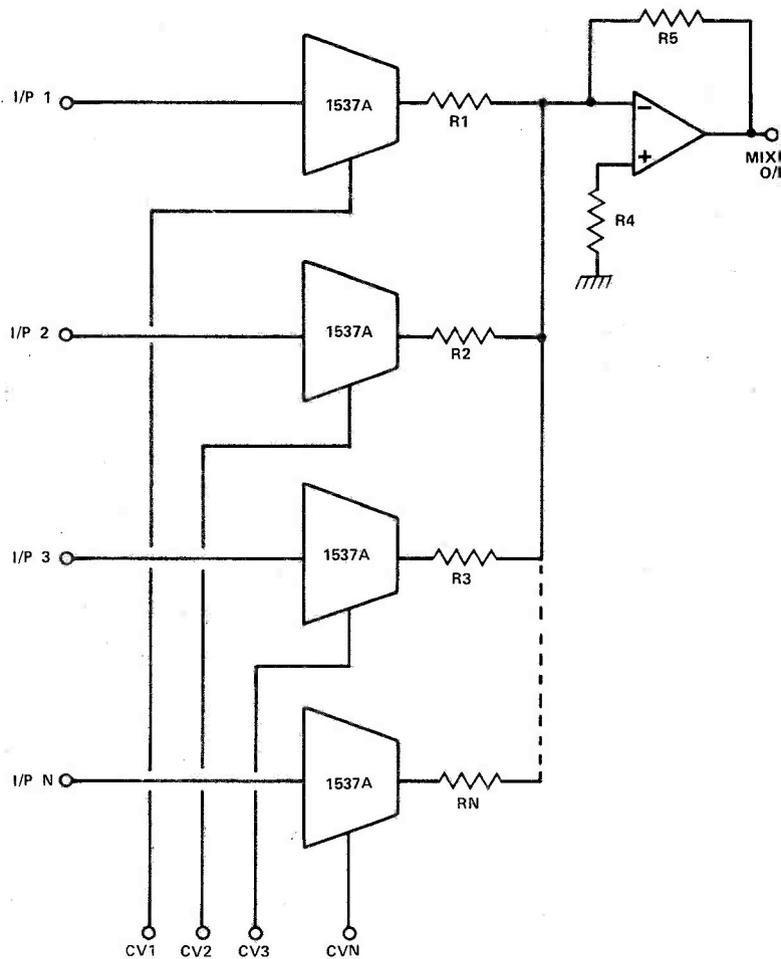


Fig. 12. High quality, remote fader controlled mixer.

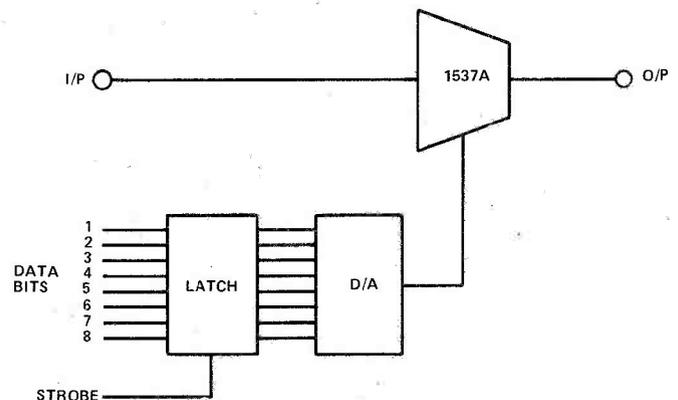


Fig. 13. Main components of a digitally controlled attenuator.

Applications

Consequently the next few circuits show the system in a much more versatile role — not just as an analogue gate, but one in where the system itself becomes part of a larger system. Figures 14 and 15 give details of circuit in which the 1537A module is used in the feedback loop of conventional operational amplifiers to allow voltage controlled ►

amplifiers to be constructed. The resistance values used give gains of approximately 1 to 100 over the VCA control voltage range and an inverting VCamp and a non-inverting VCamp can be easily built as shown.

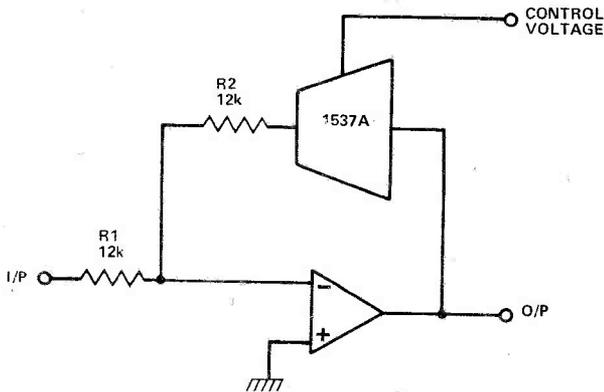


Fig. 14. A non-inverting controlled attenuator.

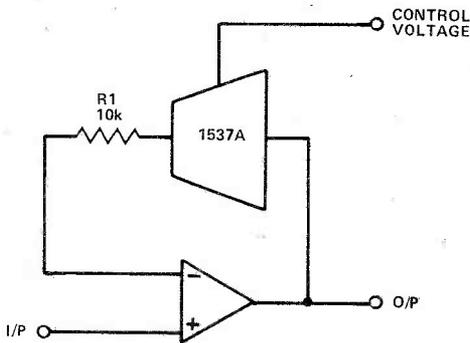


Fig. 15. An inverting voltage controlled amplifier.

A voltage controlled resistor is shown in the application of figure 16. The apparent resistance, R_1 , is given approximately by the formula

$$\frac{R_1}{1 - A}$$

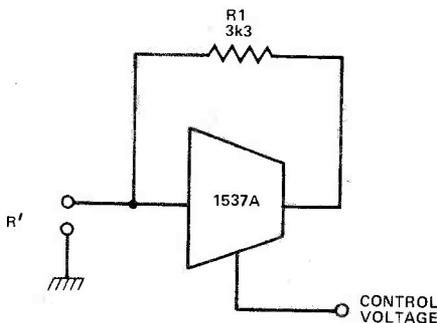


Fig. 16. A voltage controlled variable resistor.

where A is the gain of the VCA module (remembering that it has a maximum gain of unity). The value of R_1 shown gives an apparent voltage controlled resistance of 7 k to 100 k over the ten volt control voltage range.

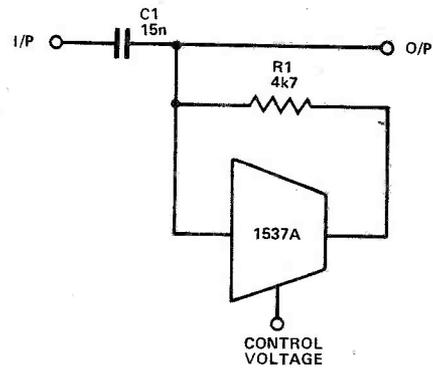


Fig. 17. A voltage controlled High Pass Filter.

The effect of a VCR (voltage controlled resistor) is used in the final two applications as the control element in filter circuits. Figure 17 shows a simple voltage controlled high pass filter. The component values shown filter out all frequencies below the variable limit of 1-2 kHz. Adjustment of the control voltage alters the lower cutoff point.

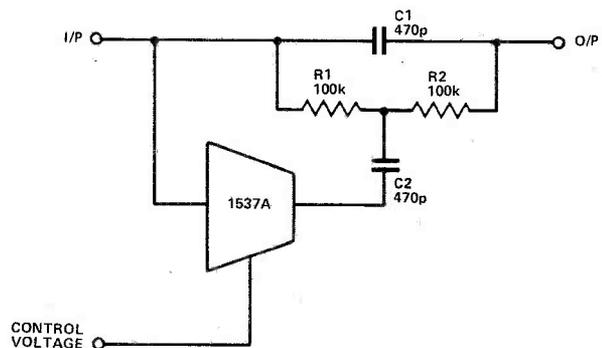


Fig. 18. A voltage controlled Band Reject (Notch) Filter.

Figure 18 consists of the circuit of a voltage controlled band reject or notch filter whose depth of notch is adjusted by the control voltage. The component values shown set the frequency at about 300 Hz and depth of notch is variable from 0 dB to about -15 dB.

Conclusions

The applications given in this article show the 1537A chip to be a very versatile device. It is remarkably easy to work with, a fact which is borne out by the quality (in technical terms) of the circuitry in the breadboarded fashion of our experimental design work, let alone in the modular fashion allowed by the use of our PCB layout. We can foresee many more applications of this device to come in the future. Thanks go to Aphex Audio Systems UK Ltd for their help in obtaining data on the 1537A. They are at present the only suppliers of the chip in this country and have kindly offered a 15% reduction in price to ETI readers quoting the code given in Buylines.

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		4044	50p
		4049	25p
		4050	25p
		4060	80p
		4066	30p
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7432	18p	74122	35p
7442	38p	74123	38p
7447	45p	74125	35p
7448	50p	74126	35p
7454	12p	74132	45p
		74141	55p
		74145	55p
		74148	90p
		74150	55p
		74151	40p
		74154	65p
		74157	40p
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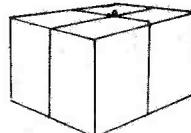
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BC108	8p	BFY51	15p
BC108C	10p	BFY52	15p
BC109	8p	MJ2955	98p
BC109C	10p	MPSA06	20p
BC147	7p	MPSA56	20p
BC148	7p	TIP29C	60p
BC177	14p	TIP30C	70p
BC178	14p	TIP31C	65p
BC179	14p	TIP32C	80p
BC182	10p	TIP32C	80p
BC182L	10p	TIP2955	65p
BC184	10p	TIP3055	55p
BC184L	10p	ZTX107	14p
BC212	10p	ZTX108	14p
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BC214L	10p		
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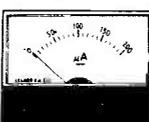
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DESIGNER'S NOTEBOOK

ETI's chief design engineer, Ray Marston, discusses the use of CMOS counter/divider ICs.

A common task facing the electronics design engineer is that of producing simple digital counter/divider networks, which produce an output frequency or count rate that is some fixed fraction of the original input frequency or count rate. This month's "Notebook" discusses the use of CMOS ICs in such applications.

4013 and 4027 Flip Flops.

The two most basic counter/divider ICs in the CMOS range are the 4013 dual D-type flip-flop and the 4027 dual J-K flip-flop. Figure 1 shows the outlines and pin notations of these two devices, which each contain two independent flip-flop stages sharing common supply connections. Each of these packages can be used to give division ratios of 2, 3 or 4.

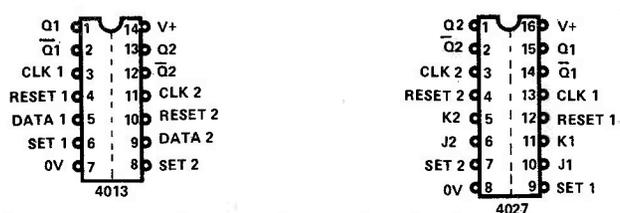


Fig. 1. Outlines and pin notations of the 4013 dual D and the 4027 dual J-K CMOS flip-flops.

A single 4013 'D' stage can be made to act as a divide-by-two counter by grounding its SET and RESET pins and coupling its DATA pin to its Q output, as shown in Fig. 2a. A single 4027 J-K stage can be made to act as a divide-by-two counter by grounding its SET and RESET pins and connecting its J and K pins to the positive supply rail, as shown in Fig. 2b. Both of these circuits change state on the positive-going transition of the input clock signal, which must have rise and fall times of less than 5 uS. The 4013 is very fussy about the shape of its input clock signals and tends to be rather temperamental in operation. The 4027 is not too fussy about its clock signals and is very easy to work with.

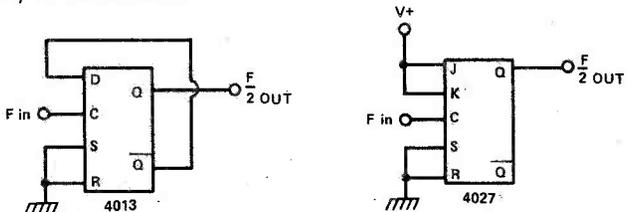


Fig. 2. Divide-by-two counters made from D-type (left) and J-K (right) flip-flop stages.

Ripple Counters

Figure 3 shows how two divide-by-two 'D' or J-K flip-flop stages can be wired in series to give an overall division ratio of four (2²). Fig. 4 shows how three such stages can be

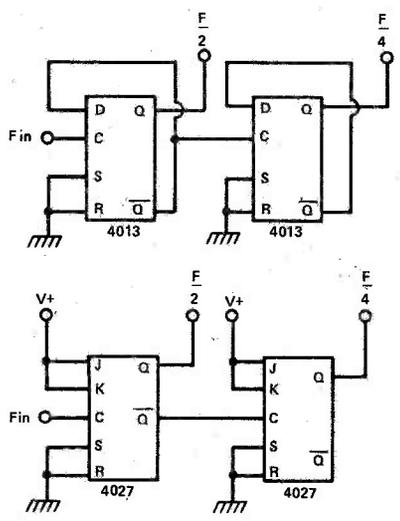


Fig. 3. D and J-K versions of divide-by-four ripple counters.

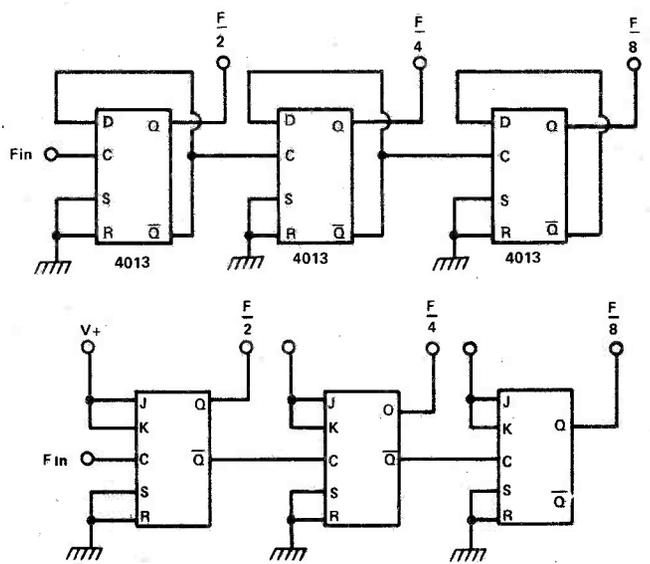


Fig. 4. D and J-K versions of divide by eight ripple counters. ▶

wired in series to give a division ratio of eight (2^3). Note that each counter stage is clocked at precisely half the rate of (an octave below) the preceding stage, so that the clock signal seems to 'ripple' through the counter chain. Also note that, as is made clear in Fig. 5, the final division ratio is equal to 2^n , where 'N' is the number of counter stages. Thus, four stages give a ratio of $2^4=16$, five stages give $2^5=32$, six give $2^6=64$, seven = 128 and so on.

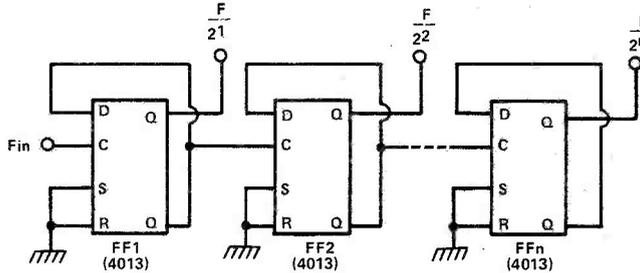


Fig. 5. D version of divide-by- 2^n ripple counter.

A detail not made clear in the above diagram is that, since the counters of a 'ripple' circuit are effectively wired in series, the propagation delays of the individual stages in the counting chain add together to give a fairly long total delay at the end of the chain. If each stage has a delay of 100 nS and there are ten stages, the total propagation delay is 1 μ S. Consequently, the final output signal will not change state until 1 μ S after the arrival of the original input clock signal that initiates that change of state. The counter states of the 'ripple' type of counter are thus not in perfect synchrony with the original clock signal and this type of circuit is consequently known as an asynchronous counter.

4013 and 4027 counters can be cascaded to give any desired number of ripple stages. When more than two stages are required it is usually economic, however, to use a special-purpose MSI ripple-carry binary counter/divider IC. Figure 6 shows the outlines and functional diagrams of three popular ICs of this type.

The 4024 is a seven-stage ripple unit with all seven outputs externally accessible: it gives a maximum division ratio of 128. The 4040 is a twelve-stage unit with all twelve outputs accessible: it gives a maximum division ratio of

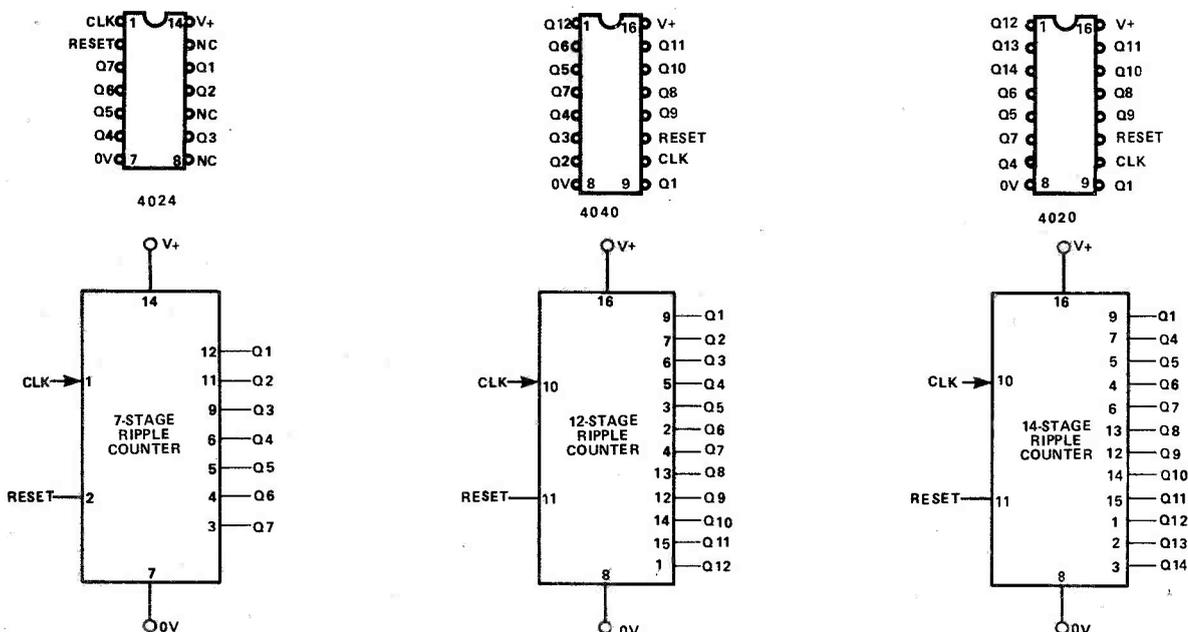


Fig. 6. Outlines (above) and functional diagrams (below) of three popular CMOS multi-stage ripple counters.

4096. The 4020 is a fourteen-stage unit with all outputs except 2 and 3 externally accessible: it gives a maximum division ratio of 16 384.

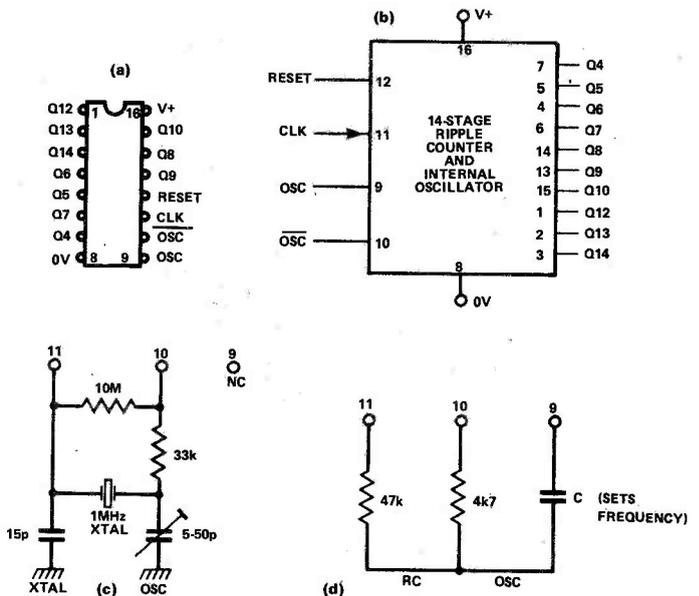


Fig. 7. Outline (a), functional diagram (b), and alternative oscillator connections (c and d) of the 4060 fourteen-stage ripple counter.

Fig. 7 shows the outline and functional diagram of a special-purpose ripple-carry unit, the 4060. This is another fourteen-stage unit, but does not have outputs 1, 2, 3 or 11 externally accessible. The special feature of the 4060 is that it incorporates a built-in clock oscillator circuit. The diagram shows the connections for using the internal circuit as either a crystal or an RC oscillator.

The 4020, 4024, 4040 and 4060 ICs are all provided with Schmitt trigger action on their input terminals and trigger on the negative transition of each input pulse. All counters can be set to zero by applying a high level on the RESET line.

'Walking Ring' or 'Johnson' Counters

An alternative to the ripple type of counter is the so-called 'walking ring' or 'Johnson' counter. In these counters, all counter stages are clocked in parallel and the stages are cross-coupled so that the response of one stage to a clock pulse depends on the states of the other stages. Fig. 8 shows the connections for making a divide-by-three counter from two J-K stages and Fig. 9 shows the connections for making a divide-by-five counter.

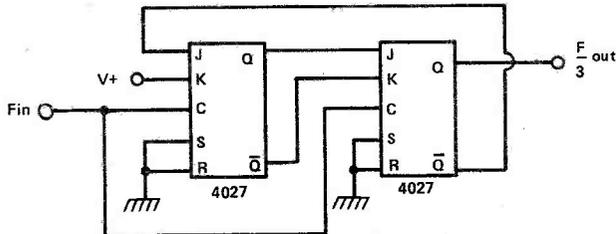


Fig. 8. J-K version of a divide-by-three 'walking ring' or 'Johnson' counter.

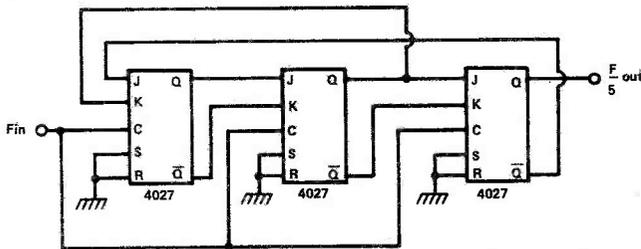


Fig. 9. J-K version of a divide-by-five 'walking ring' or 'Johnson' counter.

A major advantage of the 'walking ring' or 'Johnson' counter is that, since all stages are clocked in parallel, the outputs of the completed counter are subjected to only a single stage of propagation delay. Consequently, the system gives synchronous operation and outputs give glitch-free decoding.

4018 Divide-by-N Counter

When count numbers greater than four are required, it is economic to use MSI ICs such as the 4018, rather than the 4013 or 4027. The 4018 is a five-stage 'Johnson' counter that can be made to divide by 2, 3, 4, 5, 6, 7, 8, 9 or 10 by merely cross-coupling its terminals in suitable ways. The IC features a Schmitt trigger on its clock input line and clocks on the positive transition of the input signal.

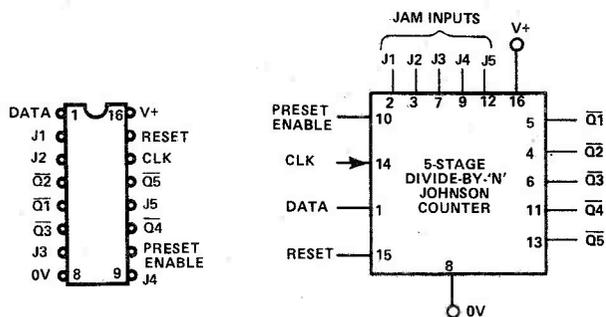
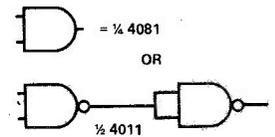
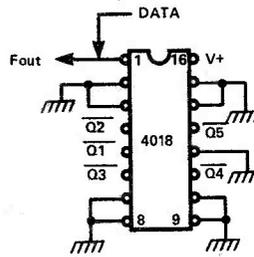


Fig. 10. Outline and functional diagram of the 4018 presetable divide-by-N counter.

Figure 10 shows the outline and functional diagram of the 4018. Fig. 11 gives methods of cross-coupling the IC to give division ratios from two to ten. On even division,

ratios, no additional components are needed. On odd ratios, a two-input AND gate is required in the feedback network. This gate can be a single 4081 AND stage, or can be made from two 4011 NAND stages.

- DIVIDE-BY-2 = $\overline{Q1}$ TO DATA
- DIVIDE-BY-3 = $\overline{Q1} \overline{Q2}$ TO DATA
- DIVIDE-BY-4 = $\overline{Q2}$ TO DATA
- DIVIDE-BY-5 = $\overline{Q2} \overline{Q3}$ TO DATA
- DIVIDE-BY-6 = $\overline{Q3}$ TO DATA
- DIVIDE-BY-7 = $\overline{Q3} \overline{Q4}$ TO DATA
- DIVIDE-BY-8 = $\overline{Q4}$ TO DATA
- DIVIDE-BY-9 = $\overline{Q4} \overline{Q3}$ TO DATA
- DIVIDE-BY-10 = $\overline{Q5}$ TO DATA



CONNECTIONS FOR DIVIDE-BY-N OPERATION

Fig. 11. Methods of connecting the 4018 for divide-by-two to divide-by-ten operation.

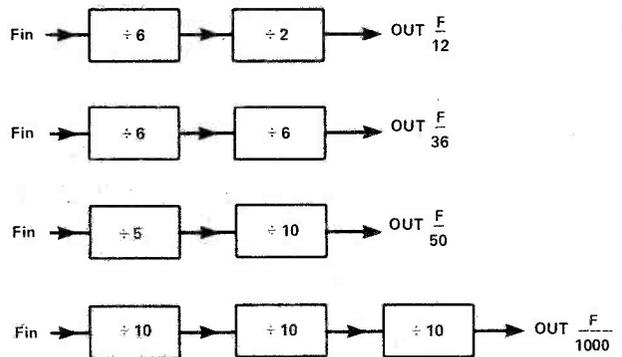


Fig. 12. Typical examples of division by numbers greater than ten.

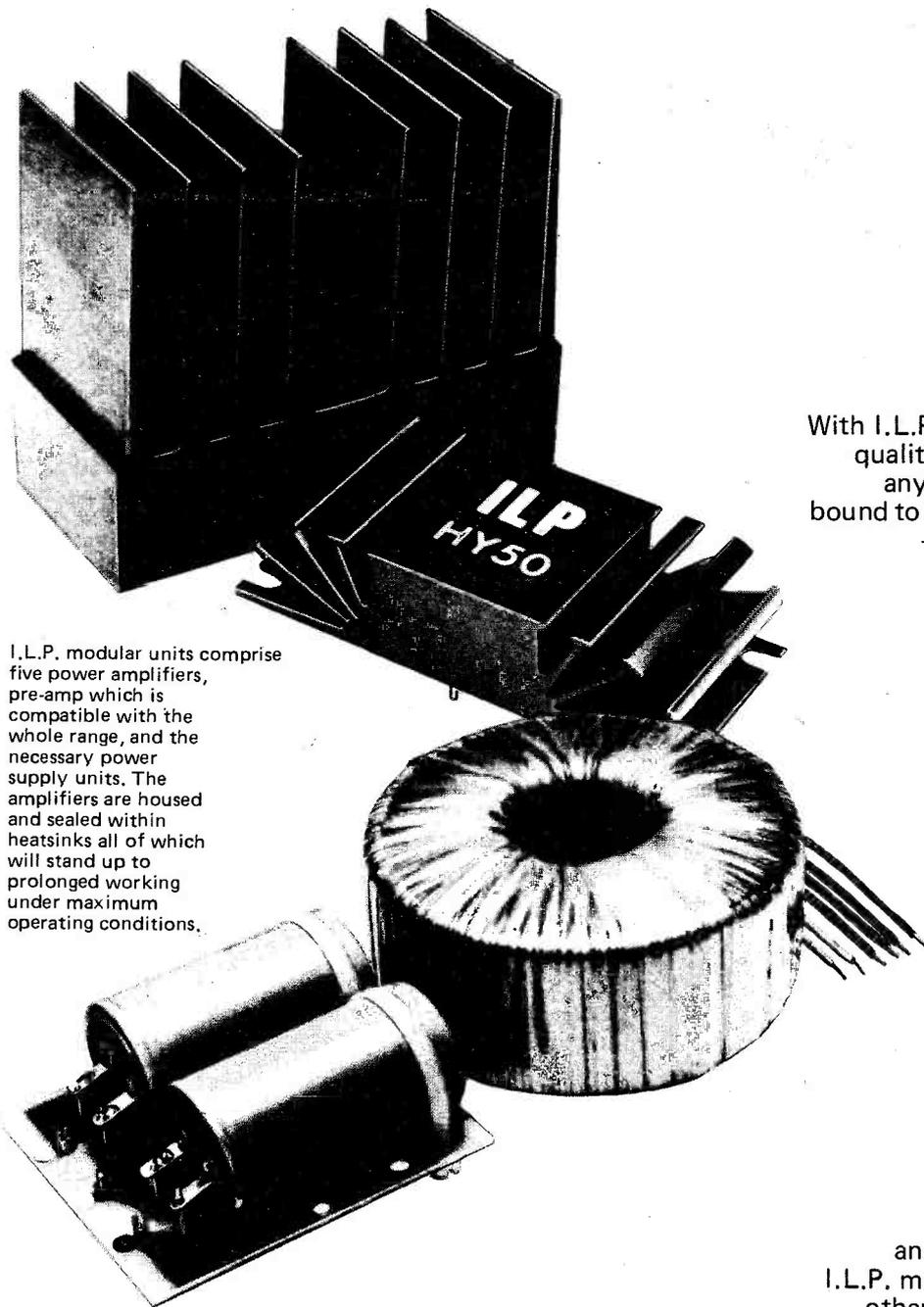
Greater-Than-Ten Division

Even division ratios greater than ten can usually be obtained by simply cascading suitably scaled counter stages, as show in Fig. 12. Thus, a divide-by-two and a divide-by-six stage give a ratio of twelve, a divide-by-six and a divide-by-six give a ratio of 36 and so on. Non-standard and uneven division ratios can be obtained by using standard counters such as the 4018 and decoding their outputs to generate suitable counter-reset pulses on completion of the desired count.

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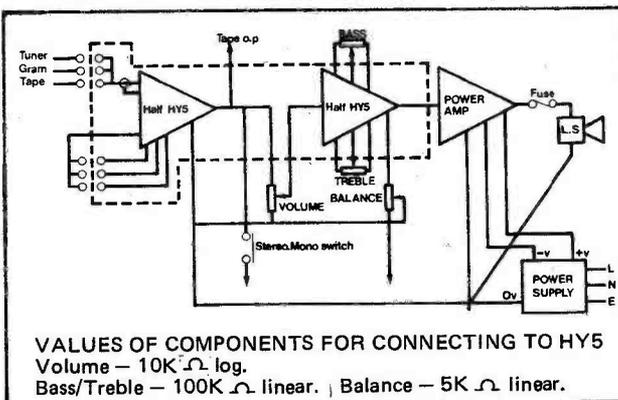
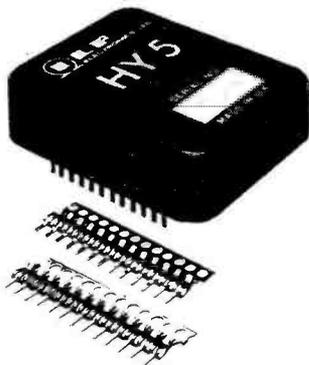
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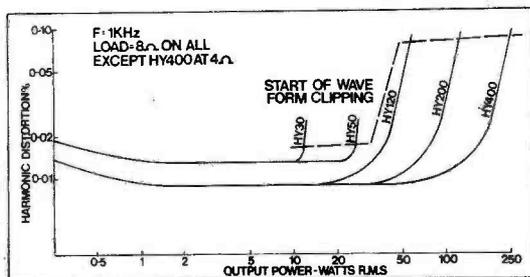
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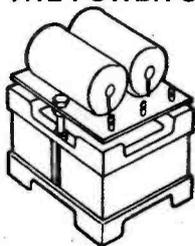
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HY50	30 W into 8 Ω	0.02%	90dB	-25 -0 +25	105x50x25	155	£7.24 + £1.09
HY120	60 W into 8 Ω	0.01%	100dB	-35 -0 +35	114x50x85	575	£15.20 + £2.28
HY200	120 W into 8 Ω	0.01%	100dB	-45 -0 +45	114x50x85	575	£18.44 + £2.77
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RAVEN ON...

Dave Raven looks at the High Street discount war and suggests how you can spend £2500

High street discounting is not a topic we normally discuss in the annals of a high technology magazine.

However, it does have a special relevance to ETI, since we are not against a bit of discount, but more important, the discounting of electronic goods is directly related to the subject of high technology. With 17% inflation, in what other field can you predict with confidence that prices of certain manufactured goods will fall. This ironic contradiction of market forces is brought about by the rapid development of micro-chip technology. Products which contained two components are quickly reduced to one, assembly operations are halved producing double the output, which effectively reduces the price.

This is clearly very confusing to consumers of these goods, but conserve your energy worrying about it, since the customer is on a winner. The man to spare a thought for is your local High Street retailer of electrical goods and, of course, the local jeweller. Cast your mind back to 1964 before the end of retail price maintenance. For years it was simple to place an order with a firm of reputable wholesalers who promptly deliver a mixed variety of stock items which are marked up with the usual standard profit margin and proudly displayed in the window, end of selling job. Customers came streaming in, picked up the goods and paid him his profit, thank you kindly. No point in the customer shopping around, since everything costs the same in all the shops.

Then, at a stroke, Mr Heath removed retail price maintenance, making it illegal for a manufacturer to dictate at what price his goods must be sold. In addition, our membership of the common market introduced further legislation forbidding any form of price rigging by a manufacturer. This resulted in one recent case where a company was fined nearly £200,000 by the EEC for its part in a breach of these regulations.

The effect of discounting on small traders was severe. However, they were afforded some protection by manufacturers who have blatantly broken the laws, but now, in addition to the normal type of discounting which usually works by operating on a smaller profit margin, cutting out the wholesale operation and going for a high turnover, we have the introduction of a fast moving technology which causes discounting of a new kind. This threat protects no one including the large multiple suppliers, as it takes them so long to select a product and

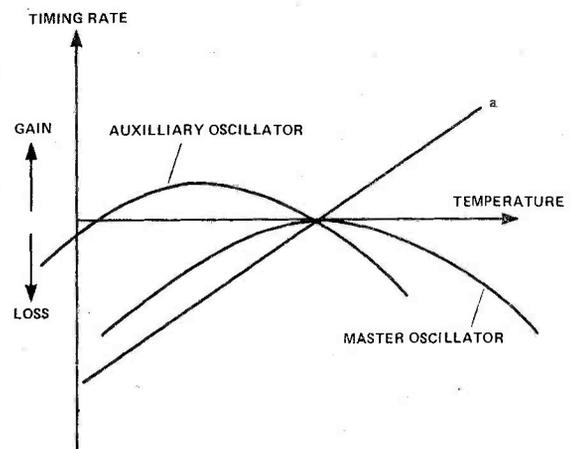


Fig. 1. The difference in oscillating frequency between the master oscillator and auxiliary oscillator is computed line (a).

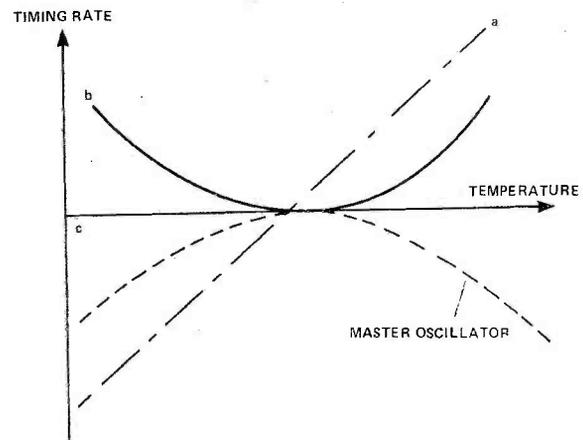


Fig. 2. The straight line (a) obtained by computation is squared and compensated for through a microprocessor in the circuit curve (b). The sum of curve (b) and the characteristic curve for the master oscillator is computed to form a straight line, which is not affected by temperature change.

promote it. Also, their buyers are not up to date with the technological changes. We now have a situation whereby the large chain stores who have grown to fame on the bulk purchase of items which are then distributed throughout their retail outlets, suddenly find that the electronic clock, watch, TV game, etc. selected for promotion in May or June is out of date and over priced by Christmas.

The effect of this during Christmas 1979 was clear to see. Apart from brand leaders such as Casio in the watch field there was little choice in the multiple stores. The shops that I did see selling unknown brands of electronic watches were grossly over priced and the product was out of date. It is obvious that buyers have been very cautious in their purchases of electronic products, probably hoping that soon there will be some sort of price stability.

The future for the small retailer in all of this looks very bleak. First he suffers a loss of trade due to discounting and now he suffers further losses because his wholesaler supplies him with out of date products at too high a price. The only way around this one, I am afraid, is for him to get his jacket off and run round to the wholesaler/importer and see what is going on. Probably he should travel wider for his purchases (even to Hong Kong if necessary).

For the big retail chain more misery is on the horizon, since the price rigging and cartel type operations which have been in existence are soon to crumble. The relevant government department has already invited companies which practice discounting such as Argos, Comet and Tesco to submit evidence of manufacturers that are refusing to supply them, because they discount. With an impending retail trade depression it seems certain that big battles lie ahead in the High Street and of course Mr. Consumer is smiling all the way to the Bank.

The loss of small local dealers for consumer electronic goods is obviously not to be welcomed, since their small size and flexibility usually provides an efficient after-sales service. In the case of jewellers selling quartz watches I think they have already shown that these are not suitable places from which to buy. Their profit margins are much too high for a product which thrives on low profit margin and a fast turnover. The servicing is minimum and a central service centre can service a large group of stores very efficiently and batteries, etc. can always be fitted at local level.

To try and forecast the future for the retail trade in consumer electronics is not easy, but it looks certain that the large multiple stores will have to look closely at their buying methods and probably work closer with the very companies that are setting the price structure for micro-chip goods in the UK.

One company I know, whose name I would not divulge even if you inserted hot watch batteries up my nails, has increased its turnover by 20 times in three years and is all set to start discounting on the discount, so watch out Woolies.

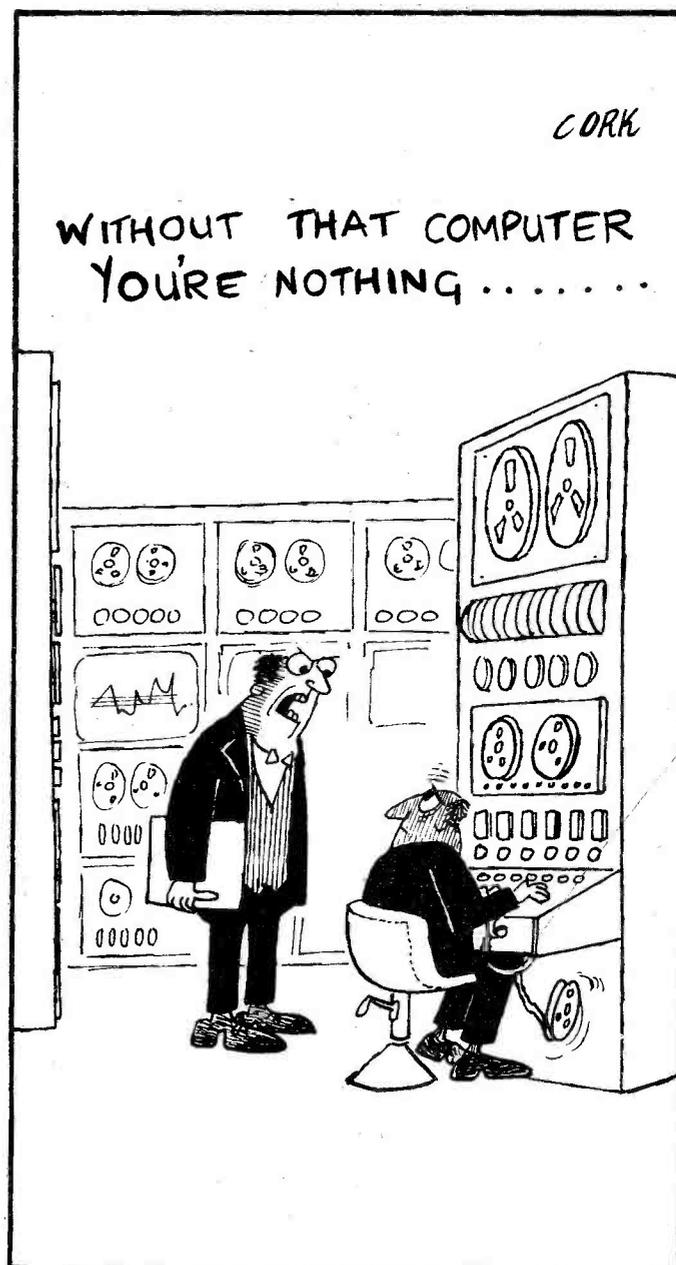
Slimming Time

If you are not worried by the news that the Japanese are predicted to be big in making aero engines then you should be, since that is about the last major piece of technology we are still any good at. In addition to this, the sight of the latest Seiko version of an electronic watch is enough to make you give up and go home if you happen to be a watch designer. Styled in their usual superb way, these latest slimline models are as thin as some watch bracelets, which makes them look almost tasty enough to eat, let alone wear

on your wrist. The 18 carat gold digital man's watch measures a total of 1.79mm in thickness overall. The watch module is a mere 1.38mm thick including battery.

The analogue version is 18 carat gold and also only 1.79mm thick overall. The price for both models is slightly thicker than average, a real snip at £2500 each. Accuracy of Seiko watches has been improved using a traditional electronic technique of twin quartz oscillators for a temperature compensating circuit. The pair of crystal oscillators have different temperature characteristics and each of the crystal oscillators are oscillating independently. The temperature change is detected and this is then compensated for using a microprocessor which in turn corrects the watch accuracy, thus achieving an approximate accuracy of plus or minus 10 seconds a year.

ETI



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**Next
Month**

Hobby Electronics

MOBILE MICROELECTRONICS



We have managed to "persuade" one of the country's leading motoring journalists into writing a feature for us. He will be taking a look at the impact electronics has been making on the world of automotive engineering and some of the advances we can expect in the next few years.

Already we have cars (if you can afford them) like the Aston Martin Lagonda that are almost completely computer controlled, is this the shape of cars to come? We think so, find out all about it next month.

SHORT WAVE RADIO

Have you ever wondered why there are so few designs around for really simple SW radios? We think it's because most designers are a bit afraid of RF circuitry. After all digital equipment is so easy to design, most of the hard work has already been done by the IC designer.

So, we at HE have girded the loins, put our noses to the grindstone and come up with a really first-class design for a SW radio. We won't promise it'll cover 27 MHz (after all, there's not much to listen to, is there?) on the other hand it just might. Miss next month's copy and you will never know.

PETTING IT TOGETHER



Rick Maybury's latest report from the west coast of America comes from the Commodore factory in Silicon Valley California where the famous PET computer is assembled. The PET is probably the best known of all the minicomputer systems and Commodore have lost no time in carving out for themselves a very large slice of the market, find out why next month.

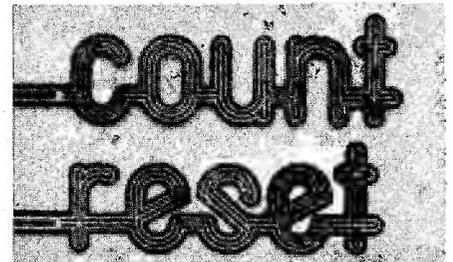
25 WATT MODULE

Here we have Keith Brindley putting the finishing touches to the prototype of the 25 Watt modular Amplifier for next month's HE. The final design will be built on a PCB and should set a new standard in medium power amplifiers. This project should be ideal for use in a home-built stereo system. Although we haven't published a purpose-built pre-amp it will happily work alongside the Tantrum pre-amp and virtually any other design, depending of course how far you want to go.

By using readily available components it should cost appreciably less than the commercial modules on the market.

To save you the trouble of finding a suitable PSU design we are publishing one designed for the job.

TOUCH SWITCH

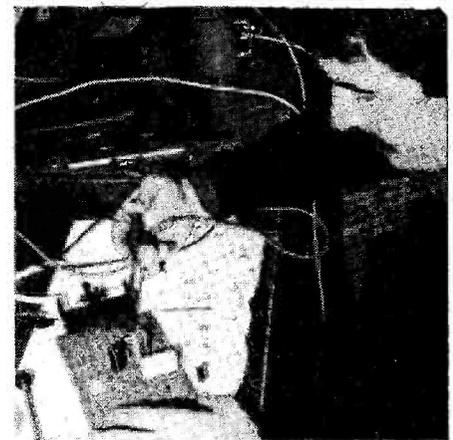


How would the world of amateur electronics exist without the ubiquitous touch switch? How have we got the nerve to publish another? Simple, they are easy to build and are a really great introduction to electronics.

Add a touch of class to your projects with next month's super design. Featuring novel circuitry and using only two inexpensive ICs with genuine capacitive operation we feel sure this one is going to be a winner. Ten channels are available and any one may be selected under fingertip control. Full constructional details next month. We know that you won't want to miss it.

PSU MODULE

To complement the 25 watt power amplifier module we have designed a purpose-built PSU. The power supply to be described next month will happily drive two 25 watt modules (with some to spare) and will still be relatively cheap and easy to build.



The March issue will be on sale February 8th

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



AUDIOPHILE

Ron Harris brandishes his safety raiser at a dust bug and has news for Audiophile Amp fiddlers

Tis a strange thing but the higher quality record deck you have, the more attention needs to be lavished upon it to keep it happy and operating. Not for the *real* hi-fi enthusiast the arm that raises itself from the groove after a hard side's tracking, thus liberating the ear from the repetitive click with which all composers, modern or baroque, somehow seemed to end every recorded piece. Oh no, it's not that easy.

It is only, apparently, upon the semi or totally automatic machines which populate the foothills surrounding peak-fi that such cantilever bending mechanisms are to be found. To be sure in the past couple of years' operation has moved ever more toward a gentleness suitable for the most compliant of stylus carriers.

Alas, though, noses still head rapidly skyward at a sniff of automation.

Not that there have not been devices marketed to add a refined touch of convenience to the first division decks before. There have. Never successfully enough, though. Anyway, wanting both my cake and digestion of it, I purchased myself the latest of this line, the Audio Technica "Safety Raiser".

Before we go ANY further, I absolutely refuse to make so much as a single pun around that name. Whatever blade at AT thought it up can keep his giggles to himself! I will simply applaud the sharp edge of his wit.

With anything resembling justice this beautifully engineered little device would sell a million. It looks superb and the action is so smooth and gentle that even the most hidebound purist must begin to question the value of listening to the run-out groove.

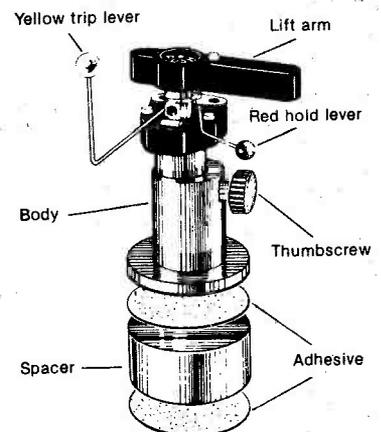
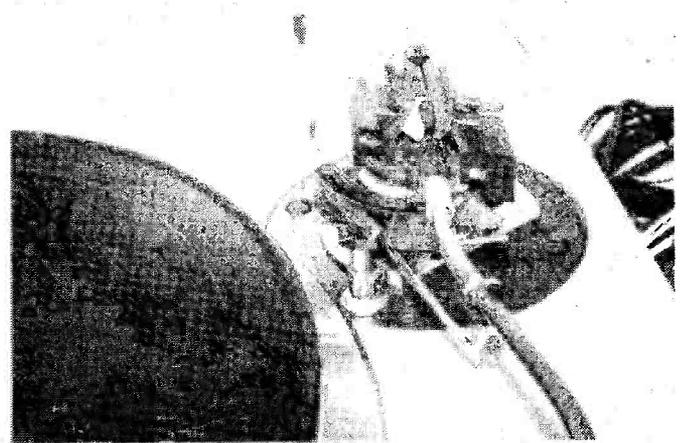
Lift-off

The trip lever is positioned so that it lies in the path of the pickup arm as it swings across at the end of the side. Once touched it leaps back out of the way, magnetically releasing the damped action platform to rise up and take the stylus away from all this, so to speak.

The required force on the trip lever to achieve this is so minute that it could not possibly be said to interfere with the arm anymore than would a passing butterfly breathing on it. Before fitting it I spent a good half-hour with the thing in the middle of my desk trying to touch the trip lever, without triggering the arm lift.

One thing's for sure — I ain't no butterfly, passing or otherwise. A big kid maybe, but butterfly no. Ah well, mine is not to do and fly . . .

In use the Raiser is a delight, although positioning it could prove a problem in some cases. I had a devil of a time persuading it to sit under an SME III such that it avoided the edge of the turntable, but reached the arm when it went for it.

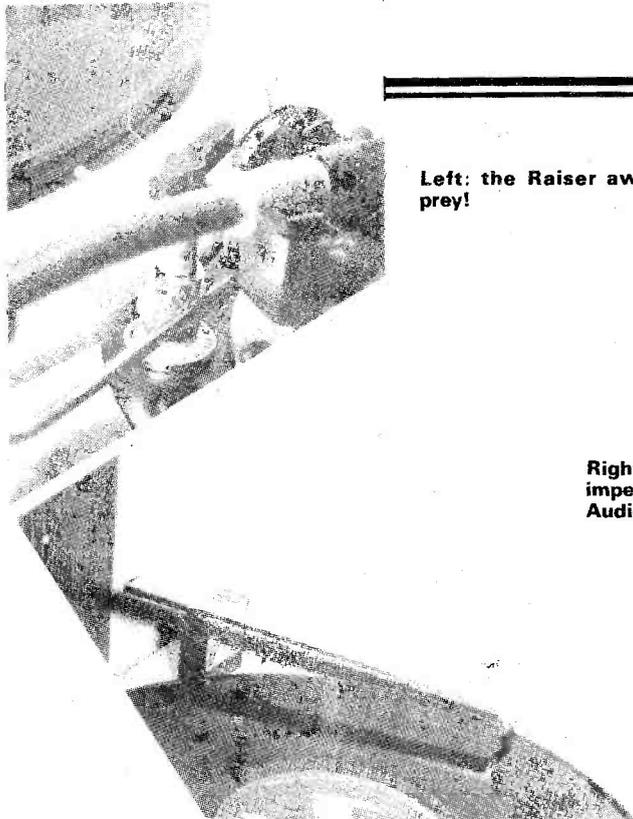


The little safety raiser in situ, i.e. stuck under the SME III, and what all the bits are for! The yellow lever is the one which the arm contacts on its way across the LP, thus triggering the action.

The height adjustment must be tightened up solidly, since you have to push the platform down after every operation and if you haven't tightened the screw enough . . .

Anyway, it's not often you can spend as little (circa £11) on the hi-fi and get such a welcome return. After all — admit it, oh ye followers of the holy musicality, there are times when you simply *cannot* get to the deck at once — aren't there?

No? Hmm . . . you're more dedicated to this hobby than I thought. Didn't Daddy ever take you aside for a little talk . . . ? ▶



Left: the Raiser awaiting its prey!

Right: circuit diagram of the low impedance driver circuit for the Audiophile Amp.

Above: the Decca record brush in action. Note the earthing wire snaking away in the background.

Brush Up On Carbon

While I was meandering around the local audio emporium in search of the Raiser, I promised myself I'd finally replace my ageing Dust Bug — which is now so old it has a good claim to have kept the Magna Carta records clean.

After a deal of bewilderment in the face of the veritable horde of appliances vended to trail a brush across an LP, I settled on the Decca version as potentially the most useful.

Despite the varying claims for all these contraptions, their aim is usually identical. The purpose *should* be to sweep the grooves just ahead of the stylus, picking out any debris lurking therein to prevent it gathering around the diamond and suffocating its tracking ability.

Decca claim a static removal ability too, as do droves of the others. The bristles of the brush are conductive carbon fibre and an earth return lead is provided to attach to the deck earth. The scheme is that any local static charge will be grounded by the passage of the brush before the pickup reaches it.

Besides all this I simply thought the Decca was a nice looking little device and a bit more individual than most.

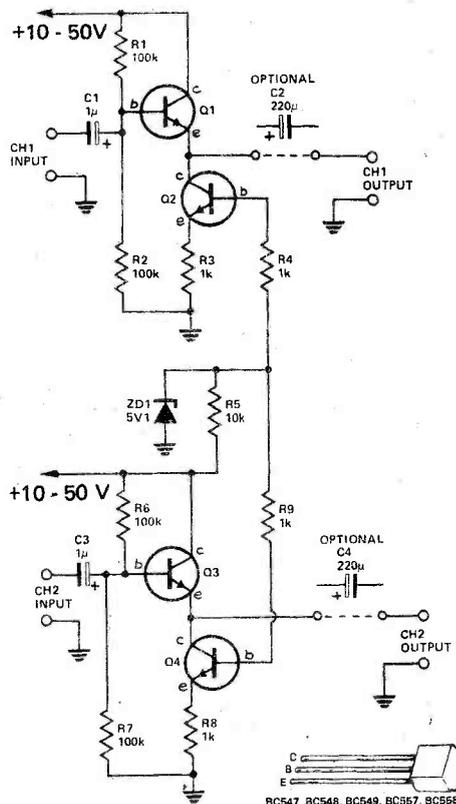
Since I've been using it I can report a definite drop in perceived surface noise, quite dramatic at times in fact. It seems that earth path *does* lead somewhere after all.

The device has been around a while I know, but has probably been buried under a mound of similar offerings from beyond the edge of the Empire in a lot of shops.

It deserves better! It works very well indeed — at least give it a look over next time you're browsing around, the brush-off would be un-just!

Audiophile Amp

Amongst the many bits of paper with stamps on that that funny little man with the flat cap (and head?) keeps dropping all over our floor every morning has been some correspondence on the Audiophile amp.



PARTS LIST

Resistors — All ½W, 5%

R1,2,6,7 100k
R3,4,8,9 1k0
R5 10k

Capacitors

C1,3 1u0 35V tantalum
C2,4 200u 35V electrolytic

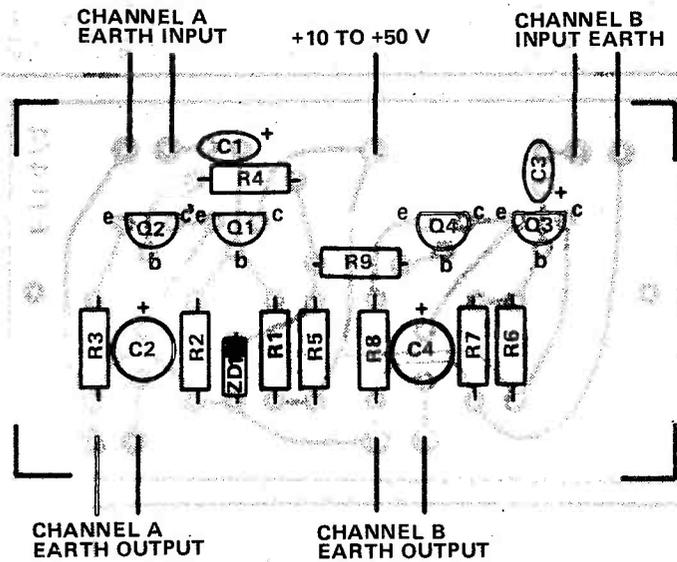
Semiconductors

ZD1 5V1 400mW zener
Q1-Q4 BC547, BC107 etc.

It seems that some fickle fiddlers out there are using the power amps of this superb design, but not the pre-amp. Tsk, Tsk terrible people. Anyhow this may just cause problems. Our pre-amp was designed as a low impedance driving source for the power amps, the input impedance of which varies with frequency from a few kilo-ohms at extreme LF to hundreds of ohms at the top end.

If you go driving this with a high impedance output, the amplifier will load down the driving current at HF, causing distortion. With a low output impedance pre-amp (50R) no symptoms need be expected. However it is for the rest I speak these words of doom.

As there is no chance of anyone out there abandoning the idea of separating the Audiophile system, it falls to us to do the decent thing and provide a low impedance driver which will allow greater compatibility with the universe in general. The circuit given here will do just that.



Above: component overlay for the low impedance driver circuit. The PCB is to be found hiding with the rest of its kind.

It consists of two emitter followers, Q1 and Q3 with constant current generators in their emitters. Both the latter share a common reference, ZD1, which feeds the bases of Q2 and Q4, setting their emitter voltages at 4V4.

These transistors will always pass the exact amount of current required to maintain that emitter voltage, regardless of supply voltage. The constant current generators are to limit supply current and dissipation of the emitter followers when used with a high supply rail. It also lowers output resistance.

Output is derived via the optional blocking capacitors C2 and C4, which can be omitted if our modules are ALL you're driving with this buffer, but as we don't trust you Fit them if any other equipment at all is to be linked to the circuit. Replace the C1 capacitor in the power amp with a 220u (35V), with positive lead towards the input, if you leave out the blockers.

We've provided a PCB layout which we would advise using, and be careful with earthing arrangements — use the signal earths wherever possible.

Trailing Trailers

Next month I'm taking a look at some of the best of budget hi-fi. A heated conversation arose here some little while ago about just what level of fidelity could be obtained for £300 or less.

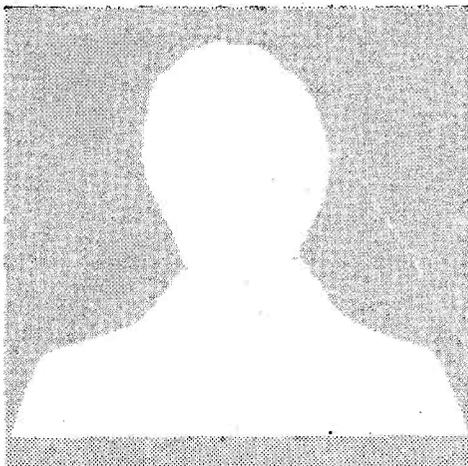
Everyone had their own ideas and tastes. Trouble is some of the combatants showed a deplorable *lack* of taste — would you believe not all of them had the sense to see that Felicity Kendal is the most beautiful woman in creation. Given that obvious blind spot in their make-up how can one possibly listen further?

I went ahead and assembled *my* £300 system despite the heathen howling hereabouts, and am presenting the results next issue.

I must confess there is one component I am not entirely happy about, but the amp and cartridge are real gems and together barely cost £100.

ETI

ETI NEEDS YOU!



ETI is seeking to expand its staff once more and we are looking for a Project Engineer to join our ranks. In order to complement existing staff skills within our organisation we expect that the successful candidate will have had some experience with MPU based designs. He need not have been a specialist.

Our Engineer will be designing and testing projects for the magazine — and writing them up! This is the easiest part of the job and has caused no-one any problems yet, even though none of our existing staff were journalists prior to joining us.

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ETI Magazine,
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Please mark your envelop "Project Engineer"

Metac

ELECTRONICS & TIME CENTRES

QUARTZ LCD 11 Function

Slim chronograph

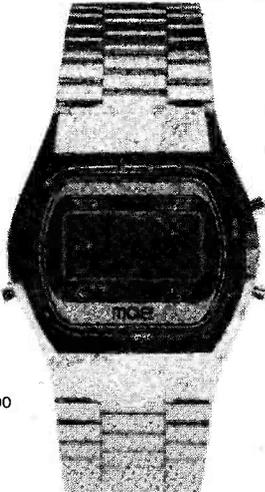
12:30^{pm}
Hours mins secs

8 14TH
Month date day

0:00⁰⁰
Min secs 1/10 1/100

6 digit, 11 functions.
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8 14
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7:30^A
Alarm

6 Functions plus Alarm:
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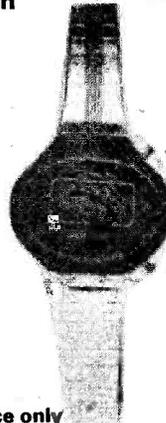
:45
Secs

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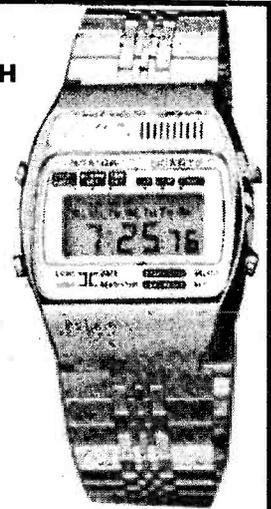
8 14TH
Month date day

0:00⁰
Min sec 1/10th

Alarm
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 1/10th secs.

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8 14
Month date

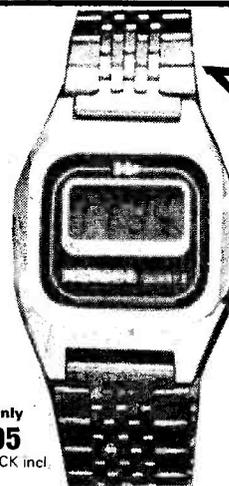
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Secs

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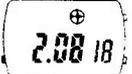
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Alarm



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Attractive Man's watch in black resin with mineral glass. Hours, mins, secs, am/pm. Month, date, alpha-numeric day. Auto-calendar set 28th Feb. Stopwatch working range 1 hour, units 1/100 sec. Mode. Net Time/lap/time/1st-2nd place times. Accuracy approx 15 secs per month. Battery 12 months.



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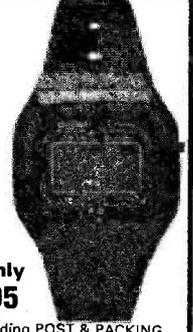
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M24

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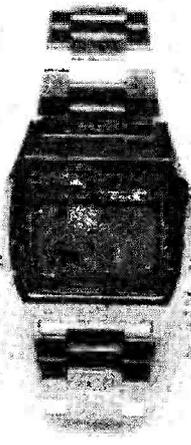
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M36

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CHRONOGRAPH
NEW STYLE**

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ELECTROMYOGRAM

ETI's latest biofeedback box converts the electrical impulses associated with moving a muscle - any muscle - into observable outputs. Either audio output or a meter reading can be obtained and if you can't relax with this, try reading ETI again!

The design and construction of an electromyogram presents some unique problems. The object is to detect the minute electrical signals produced by the 'firing' of muscle fibres in a particular muscle. For our purpose metal electrodes of some sort are attached to the skin over the muscle(s) of interest. For a relaxed muscle, these signals are fractions of a microvolt in amplitude. That's a small enough signal to detect on its own without having to find it amongst *volts* of 50 Hz hum that will be present in the body - induced from power and light wiring.

When the body is grounded, this hum will drop to typically one volt peak-to-peak, but trying to see one microvolt in one volt of unwanted noise (50 Hz hum here) isn't easy.

The overall block diagram of the unit is shown in the drawing.

Battery operation is essential as, with any device connected directly to the body, the possibility of accidental contact with mains potential from a mains-operated unit is very real - with lethal results.

The instrument is called upon to detect quite small signals in the presence of large amounts of noise. It should have variable gain control - adjustable by the user, a threshold control so that small variations of a large signal may be readily detected, a visual indication (a meter) and an audible output that follows the convention of rising pitch or pulse rate for increasing muscle activity, and vice versa. Also some form of band-pass filtering to sort out the predominant muscle signal which is in the 100 Hz to 500 Hz range, and selectable integration of the feedback response was considered desirable.

Biasing the differential input stage is important and this is discussed in the "How it Works" section. One trimpot is used to set up the input stage for correct operation. Once set up, any of the component values may be varied by +/- 10% without affecting the CMRR.

The choice of this type of first stage has resulted in a very low noise figure. The prototypes (we built two) had measured noise figures close to 150 nV at the input. This equals the performance of the best commercial units we have seen.

To provide some integration of the muscle activity level, so that the meter and audible responses are not too rapid (as researchers have found undesirable in some instances), switched capacitors are provided to provide integration times of about 0.5 second and 4 seconds - selected by a front panel switch. ▶



PARTS LIST

Resistors All 1/4W, 5%

R1,2,18,	220k
31	
R3,7,9	4k7
R4,25,26	100R
R5,6	2M2
R8,10,11,	1M0
22,23,40,41	
R12,45	1k0
R13	8k2
R14-17,	47k
27-30	
R19,32	270k
R20,24,33,	10k
38,39,42,47	
R34	330k
R35	560k
R36	5M6
R37	3M3
R43	390k
R44	470k
R46	680R
R48	2k7
R49	18k
R50	27R

Potentiometers

RV1	1M0 linear
RV2	5k0 linear
RV3	1k0 linear
RV4	1k0 trimmer

Capacitors

C1-C6	1u0 polyester
C7,8,29,30	1n0 polyester
C9,10,12,	33u 16V tantalum
19,20,23,35,	
41	
C13,31,34,	100n polyester
21	
C14-17,	68n polyester
24-17	
C11,36	100n 25V
C18	22n polyester
C22,39,40	1000u 25V
C28	47n polyester
C32	220n polyester
C33	150n polyester
C37	470u 25V
C38	47u 25V

Semiconductors

D1,2	1N914
D3,4	1N4004
Q1,2	BC559
Q3,4	BD140
Q5-7	BC549
IC1	LM3900
IC2,3	741
IC4	555

Switches

SW1,2	SPST
SW3,4	DPDT

H - TO MONITOR OUTPUT
RCA SOCKET ON BACK PANEL

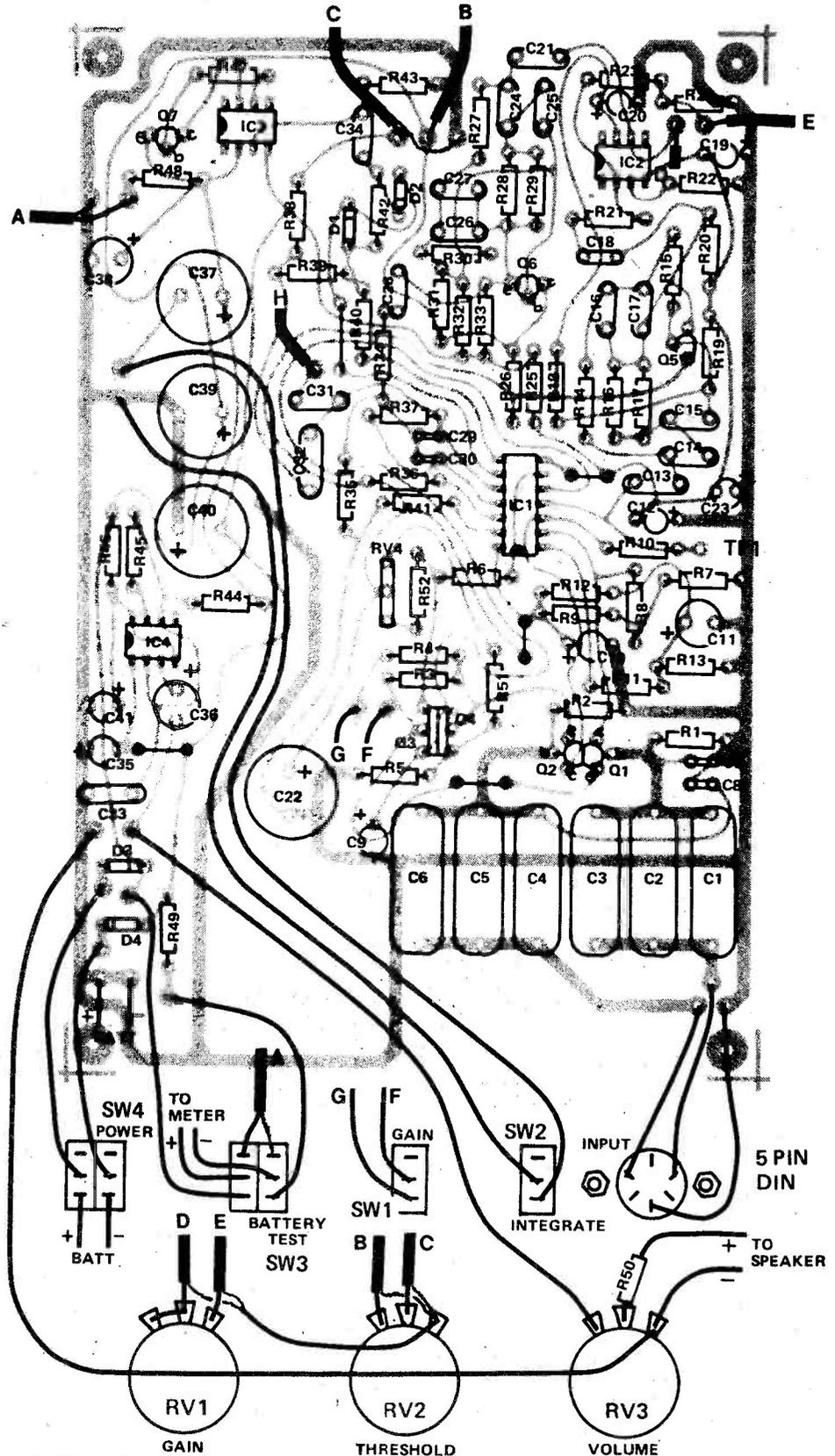


Fig.1. (Above) Component overlay for the electromyogram board.

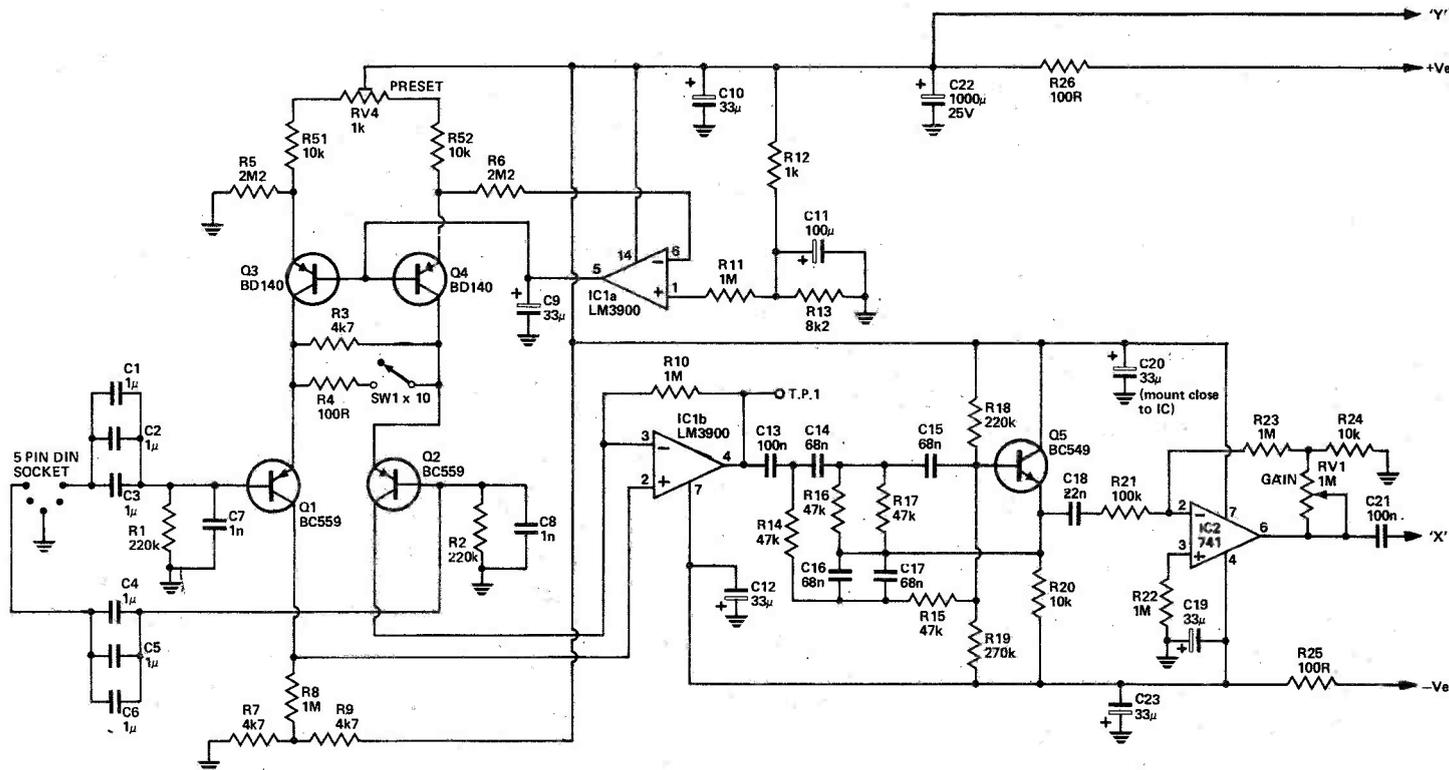


Fig.2. (Above) Circuit diagram of the unit. Note the battery connections carefully.

Since the circuit is fairly complex, a detailed analysis of its operation is best tackled by looking at the individual stages in turn, from input to output.

Input signals from sensors on the body drive Q2 and Q1 which are arranged as a differential pair. Emitter current, and thus collector current, for Q1 and Q2 is derived from a precision constant current source comprised of Q3, Q4 and IC1a. Transistors Q1 and Q2 share the current supplied by the constant current source. If Q1 (for example) is driven harder, by an input signal, than Q2 then, while the collector current of Q1 increases, there will be a corresponding decrease in the collector current of Q2.

Now, the collectors of Q1 and Q2 are each connected to the input of IC1b, one amplifier in an LM3900's quad op-amp package. The amplifiers in the LM3900 package have the special feature that they amplify current differences applied to the inputs.

To ensure a high common-mode rejection ratio, the quiescent (no signal) collector currents of Q1 and Q2 must be held very close to a fixed amount. Hence, the precision constant-current source.

To derive this constant current source for Q1 and Q2 the two bases of Q3 and Q4 are driven by the output of IC1a. The non-inverting input (marked +) of IC1a is driven by a fixed voltage derived from a voltage divider (R12, R13) from the positive supply rail. C11 is a bypass capacitor to prevent supply rail variations modulating this reference voltage.

The inverting input (-) of IC1a is coupled to the emitter of Q4 placing this transistor in the feedback loop of IC1. The

op-amp (IC1a) will attempt to maintain the current flowing through its inputs at a constant level, thus maintaining the base-emitter current through Q4, and therefore the collector current, constant at nominally, 100 mA. Assuming Q3 has similar gain to Q4, its collector current will be the same. The 1k preset, RV4, allows adjustment of the two collector currents to offset any slight differences in gain.

The input stage gain is determined by the value of the resistance between the emitters of Q1 and Q2. The lower this resistance, the higher the gain. The 'x10' switch simply connects a 100 ohm resistor in parallel with R3, increasing the gain.

Capacitors C7 and C8 ensure high frequency stability through bypassing the bases of Q1 and Q2 at frequencies above the range of interest.

To ensure good common-mode rejection ratio, it is essential that the bases of Q1 and Q2 each receive the same level of input signal. As the input is AC-coupled the characteristics of the input coupling capacitors must closely match each other. If stranded 10% capacitors are used the slightly different impedances of each will limit the common mode rejection. The solution we adopted was to use several capacitors in parallel so that the slight capacitance variations, and corresponding impedance variations, average out. It is important therefore that these six capacitors, C1-C6, are all the same type.

Supply rail decoupling for the input stages is provided by R25, R26 and C22, C23.

Two 50 Hz hum filters are employed, as can be seen in the block diagram, one

immediately following the differential input stage, the other between the variable gain stage and the band-pass filter.

Both 50 Hz filters employ a 'twin-T' circuit - as used in our Hum Filter project, ETI-451.

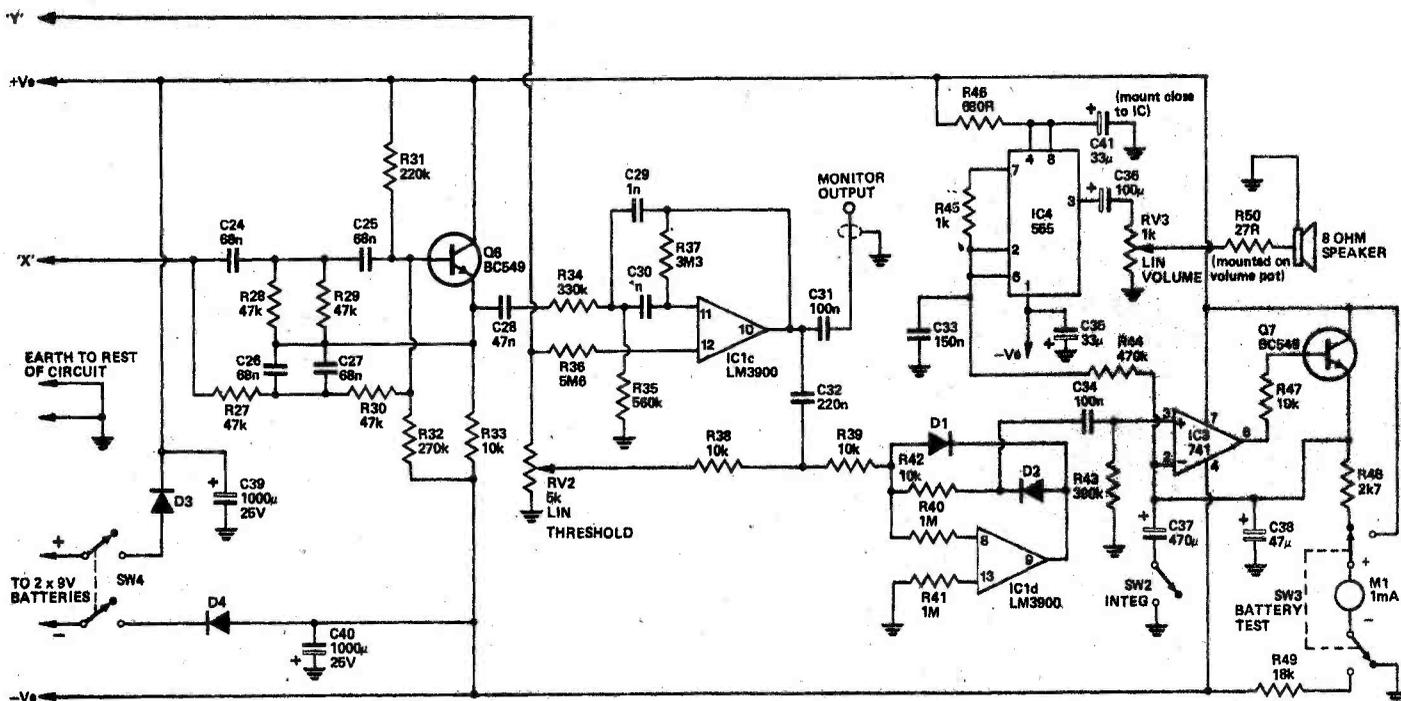
In the first hum filter, Q5 is connected as an emitter follower, the twin-T components connected to provide feedback at 50 Hz. In order to obtain a high circuit Q and thus good rejection at 50 Hz, the value of the resistance formed by R16 and R17 (paralleled) must be as close as possible to half the value of R14 and R15. As the latter are 47k resistors, the best way to obtain a value of half that is to connect two 47k resistors in parallel.

Similarly, for the second hum filter, Q6 is the active component and the filter consists of C24, 25, 26, 27 and R27, 28, 29 and 30. Resistors R28 and 29 form a resistance half that of R27 and 30 to provide good rejection at the notch frequency.

These stages provide a total of 20 dB rejection at 50 Hz.

Following the first hum filter is a variable gain stage employing a 741 op-amp. This is quite a conventional amplifier, gain variation being provided by RV1, a 1M potentiometer connected in the feedback path of the 741. RV1 is a front panel control. Gain is variable between 10 and 1000.

To avoid problems arising from large output offset voltages and unstable gain settings, the feedback for the 741 has been arranged via a voltage divider consisting of R23 and R24, the gain potentiometer being connected between the op-amp output and the junction of these two resistors.



HOW IT WORKS

The gain of the circuits is given by the equation:

$$\text{GAIN} = R_{23} + \frac{R_{23} RV1}{R_{24}} + RV1$$

Signal levels at the output of the variable gain stage are around 1V. Any hum exceeding this level could easily cause clipping in succeeding stages and the purpose of the second hum filter is to prevent this.

The bandpass filter employs one op-amp from the LM3900 package, IC1c. A filter network, consisting of R34, R35 and R37 and C29 and C30, is connected around a feedback path between the op-amp output and its inverting input. This provides a bandpass extending from 100 Hz to 500 Hz which encompasses the range of interest for the muscle fibre signals. At midband (250 Hz), the gain of this stage is roughly four.

A monitor output is taken from the output of IC1c so that the muscle activity waveforms (filtered) may be viewed on an oscilloscope if desired.

This consists of a precision rectifier that passes only the positive peaks of the signal that are greater than a preset DC voltage — determined by potentiometer, the threshold control on the front panel.

The output of the bandpass filter is mixed with a DC voltage derived via the positive supply rail by the potentiometer RV2. The resultant signal — the AC muscle activity signal superimposed on a DC voltage

— is then applied to the input of the precision rectifier. This involves IC1d, D1 and D2 and resistors R39, 40, 41 and R42. The latter two resistors convert the current-differencing input of the LM3900 into a conventional voltage-input op-amp.

Positive-going signals of less than 0.5 V, above the voltage present on the junction of R39 and R40 will be amplified by the full open-loop gain of IC1d. The output of this stage increases rapidly until D2 conducts, the stage then has only unity gain (x 1), determined by the ratio of R42 and R39.

Output from the precision rectifier is taken from the cathode of D2 and will consist of the amplified, positive-going part of the muscle fibre signals that are above the positive voltage set by the threshold potentiometer, RV2.

Diode D1 ensures that the gain of the stage remains at unity gain for the negative-going portions of the muscle fibre signals from the output of IC1c.

This consists of an op-amp (IC3) with an emitter-follower stage (Q7) connected in the negative feedback path. The emitter of Q7 drives the meter.

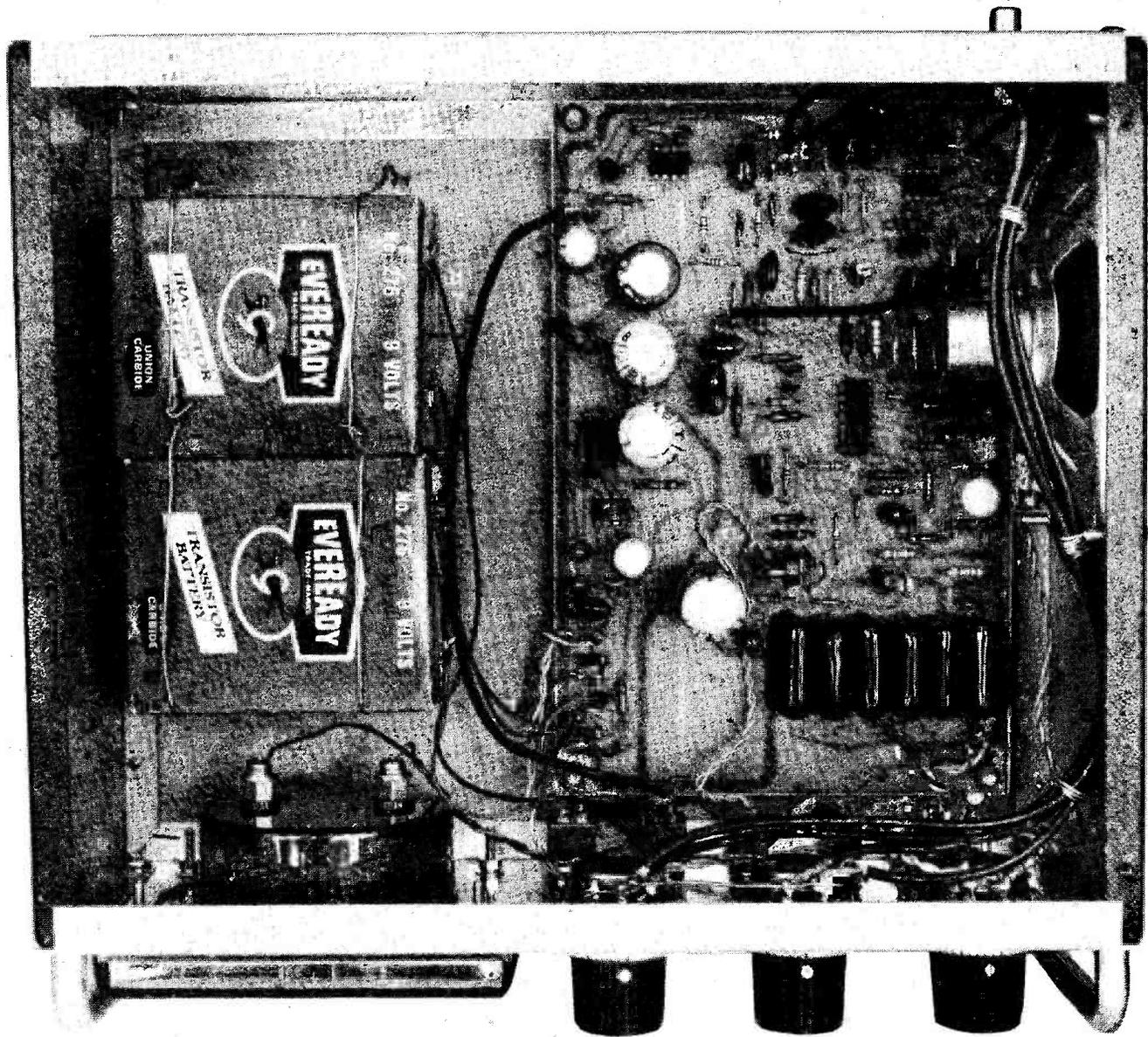
The threshold stage output is coupled to the input of IC3, a 741, via a 100nF capacitor, C34. Resistor R47 limits the base current of Q7 to a safe value as the 741 will provide much more current than the transistor will stand! A signal from the output of the threshold circuit will be amplified by IC3, causing Q7 to turn on, charging C38.

The meter is connected to read the charge on C38, via M1. The more signal that appears above the threshold, the longer Q7 will be turned on increasing the charge in C38, thus increasing the meter reading. The circuit will respond quickly to increasing input signal, showing a corresponding increase in the meter reading. As the signal decreases, the meter reading slowly returns to zero, the meter reading being a function of the capacitance between the emitter of Q7 and ground. This provides for some integration of the signal level variations.

The integrate switch, SW2, connects a 470 µF capacitor (C37) in parallel with C38 (47 µF). With this in circuit (integrate switch 'on'), the meter takes some four seconds to drop from full scale to zero.

This provides an audio output, consisting of a series of pulses, the repetition rate being an indication of muscle activity.

The emitter of Q7 is coupled to IC4, a 555 timer, via R44. Current through this resistor charges C33 until the voltage on pin 6 of IC4 reaches 2/3 of the voltage on pins 4 and 5. At this point, pin 7 of the 555, previously appearing as an open circuit, will conduct discharging C33 via R45. Once the voltage on pin 2 drops below 1/3 of that on pins 4 and 5, pin 7 returns to an open circuit condition, allowing C33 to charge again. In this manner, the 555 oscillates providing pulses on pin 3 to the speaker, via RV1, which serve as a volume control. As the voltage at the emitter of Q7 varies according to the variation in muscle activity signals, the rate at which C33 charges will vary. This varies the pulse repetition rate of the 555 oscillator in sympathy with the variations in muscle activity.



The case will hold the PCB, batteries and the loudspeaker. Note the positions of the front panel controls.

The audible output is derived from the meter drive so that it corresponds with the visual feedback response provided by the meter. This consists of a voltage-controlled oscillator (VCO) that provides a series of pulses to drive a speaker. The VCO employs a 555 timer IC.

Originally, it was intended to use a tone for the audio output. However, battery consumption on the prototype was almost 150 mA — at best! Battery life would be very limited at this consumption. A class A audio output stage is necessary to provide a tone output, and these are quite inefficient. Using a pulse output enables us to reduce the total current consumption to 20 mA.

Muscle Building

Construction is best commenced with the board. This method of construction is recommended as layout of the various stages is critical to avoid feedback or interaction between stages as one LM3900 package does sterling service in several parts of the circuit!

Assembly of the board should start with the resistors and capacitors. We found it easier to leave the six 1 μ input capacitors until the input transistors (Q1-Q4) were mounted. Be sure to check the polarity of the electrolytic and tantalum capacitors.

Finish loading the board by inserting the diodes, transistors and ICs. The input transistor pair, Q1 and Q2, must be mounted so that their flat faces are touching to provide thermal coupling. The best way to do this, to avoid straining anything, is to solder only the collectors and emitters of Q1 and Q2 at first. Smear some thermal paste on the two flats and then tie the two transistors together using a link of enamelled (coil) wire — this prevents the possibility of shorts to the transistor leads should the loop slip off at some time. Tighten the loop by taking the ends in a pair of pliers and twisting until the transistors are held tightly together. Once this is done, solder the base leads.

The two BD140s, Q3 and Q4, also need to be mounted together. As they are in TO-126 packages they may be bolted together. It is necessary to use an insulating washer between them to prevent the collector contacts touching. Use thermal paste to improve the thermal coupling.

Once these devices are mounted, six 1u input capacitors may be soldered into place.

If you use board pins, the external connections to the board may be made after it is mounted in the case, otherwise, now is the time to attach all the leads going to the externally-mounted components.

Pinned Down

As high gain stages are used in several places, the circuit is sensitive to noise or signals radiated from other parts of the board. The 555 VCO output can be especially troublesome, so use shielded cable to connect the output of the 555 to the volume control. The only resistor not mounted on the board (R50) is mounted between the wiper terminal of the volume control and one of the loudspeaker terminals.

There are a number of other connections that should be made with shielded cable and these are shown in the wiring diagram.

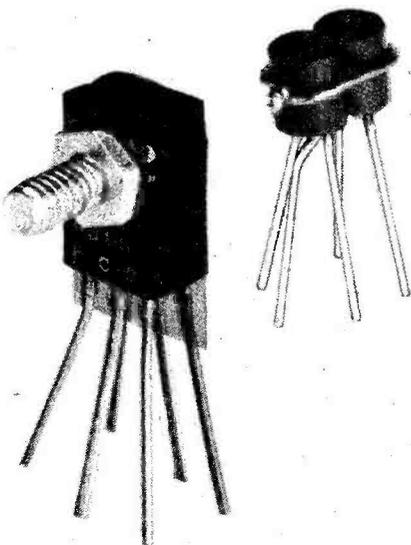
There is sufficient room inside the cabinet to accommodate a variety of 9 V batteries. The type of connection to the battery will depend on the particular style of battery used.

The speaker is mounted on one side of the cabinet and the monitor output (and RCA coax socket) is mounted on the back.

On the front panel, the switches should be mounted first, followed by the pots and the meter.

Although the common mode rejection of the input is better than 100 dB this will be degraded drastically if the contact to the skin is not good enough. To enable the input stage CMRR to effectively reduce 50 Hz hum it is necessary to ensure that the hum is exactly the same level on both inputs. For this reason the construction of the electrodes is very important.

The two input leads are made by soldering the centre conductor of the shielded cable to small metal discs about the size of 5p pieces. Cut the earth braid back enough so that it cannot touch the electrode. The braids of the two input cables are connected to pin 2 of the five-pin DIN plug (the grounded pin). This pin is also connected to the shield



Thermal stabilisation is achieved by mounting the input transistors together as shown and described in the text. Note the insulating piece between the BD140s.

BUYLINES

The design uses no unusual components, despite its complexity. The electrodes can be made at home easily enough, although commercial units, we believe, are available. Any of the bio-feedback firms, Aleph One etc will be able to supply.

of the third cable which becomes the ground electrode. The centre conductor of this cable is not used and the other end of the braid is soldered to another metal disc. Use a slightly larger disc (about the size of a 10p piece) as this helps to ensure a good ground connection to the body.

Before powering up, check the board. Check the orientation of all the polarised components — electrolytic and tantalum capacitors, transistors, ICs and diodes. If everything is all right, switch the unit on with the battery switch in the test position. With 9 V batteries the meter should read about 9. If the battery switch is now switched off the meter should immediately fall to zero provided the gain control is turned fully down. If the volume control is turned to full on a slow clicking should be heard.

Now, measure the voltage (with respect to earth) at the test point (TP1) at the output IC1a (pin 4). With the x10 switch in the x1 position adjust the preset pot to obtain zero volts.

If the gain control is now increased, the meter reading will move along with the frequency of the clicks.

Threshold Advances

Now, advance the threshold control and the meter reading and click frequency should decrease. This threshold control works by varying the minimum signal required to cause a meter response. The higher the threshold control is set, the higher the input signal must be to cause a meter response. The threshold can be set just above the noise level so that even a very small input signal can be detected.

The electrodes can now be connected to the body and plugged in. The ideal way to secure the electrodes to your skin is to use a band of Velco tape, although we found Band-aids okay. If all three electrodes are placed reasonably close to each other along the inside of the arm (earth between the others) they can be secured in place all at once with a single wide band of Velco wrapped right around the arm. Some electrode paste may be used between the electrodes and the skin to improve the contact. This is available from some distributing chemists and medical suppliers, although it is relatively expensive. We found moistening the electrode to be a good alternative.

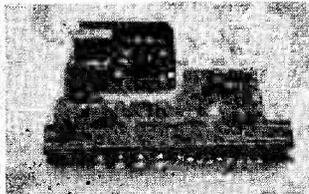
Once the electrodes are attached to the arm and plugged into the EMG monitor a reading should be easily obtained. Start with the gain and threshold controls set fully anti-clockwise, the gain switch in the X1 position and the integrate switch off.

If the arm is tensed the meter should indicate muscle activity readily. With these settings the EMG is really acting as a strength meter. Relaxing the arm, the gain switch can be switched to the x10 position and the gain control slowly increased. With each gain increase, the threshold can be increased slightly to cancel any increase in noise that may have occurred, although don't overdo the use of the threshold control until you are familiar with the unit as it is easy to cover up muscle activity as well as noise.

Eventually you should reach a stage such that the gain control can be set at maximum but with muscle activity held so low that the meter reads about 2 to 3. This isn't easy!

Some experimentation with electrode placement will indicate how to get good results on particular muscles.

B.K. ELECTRONICS



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Tape Sensitivity: Output — typically 150 mv. Input — 300 mv for rated output.
Disc Sensitivity: 100 mv (ceramic cartridge)
Radio: FM (VHF) 87.5MHz-108MHz. Stereo beacon lamp.
Long Wave: 145KHz-265KHz.
Medium Wave: 520KHz-1620KHz.
Short Wave: 5.8MHz-16MHz.
Size: Tuner — 2 3/4in. x 1 1/2in. x 7 1/2in. Approx. Power Amp — 2in. x 7 1/2in. x 4 1/2in. Approx.
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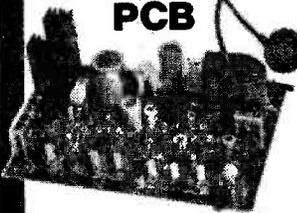
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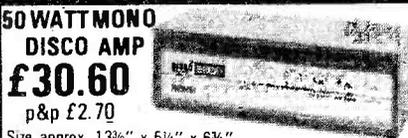
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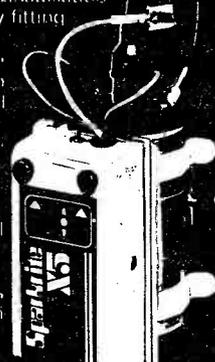
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ELECTRONIC TRANSLATOR

Ian Graham reports on his adventures with the Brainbank electronic information centre.

Whilst phrase books are valuable little tomes for those of us with the 'why can't foreigners speak English?' syndrome, it can be infuriating to have to thumb through the food, health and shopping sections to find out how to ask an impatient Parisian police person where their copy of Blackpool Tower is.

As I see it you have two alternatives. You could follow Jonathan Miller's observation of the British abroad. If you speak to a foreigner loud enough and sufficiently slowly, clearly enunciating every word, he's bound to understand you . . . eventually. The assumption is that all foreigners can speak English perfectly well, but are too bloody-minded to use it.

However, if you don't suffer from galloping xenophobia, you will accept that some of the onus of being understood abroad lies with you. Wouldn't it be simpler if you could select the word you want from hundreds of others without going through the others first? The Ami Memory System allows you to do that *and* a lot more.

Multi-Access

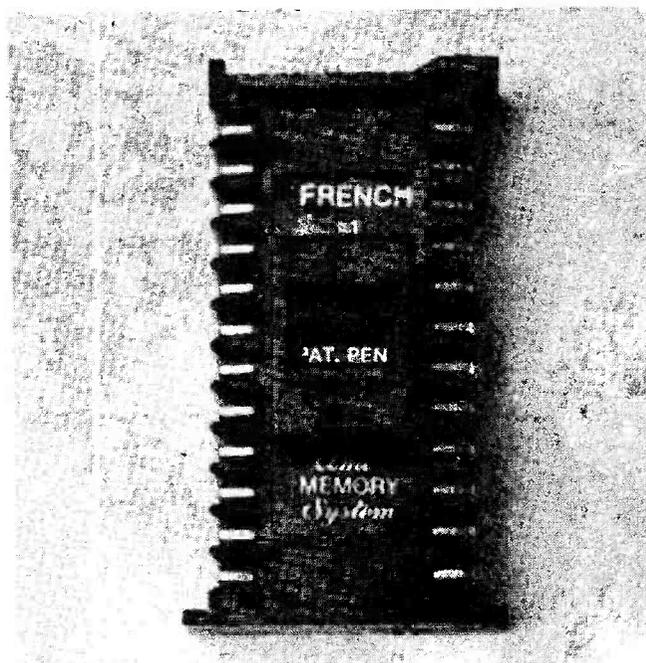
Although it can be used as a calculator and a desk diary, its chief use (and the reason why it's likely to be bought) is as an electronic translator. It can cope with single words and short phrases. You can also get at the words in a number of ways.

Four stores are accessible through the keyboard. Buttons L1, L2 and L3 permit access to plug-in memory cells. L4 is a general-purpose on-board memory. It contains common imperial/metric conversions, gallons to litres, etc and over twenty common words and phrases, available in French, Spanish and German.

Button-Pushing

On receiving the 'Brainbank', the first thing you must do is turn it upside down. Some of its capabilities are inscribed on its bobby.

If you know the word you want to translate, you can punch in the English word. On the model I had, L1 was in English, L2 French and L3 German. So, to translate your word into French, just press L2, the screen blanks for a moment, then up comes your translation. It couldn't be simpler.

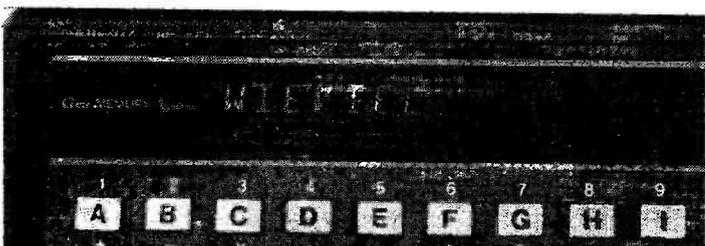


Schooldays might be a bit more fun, if you could plug in one of these to learn French. It's one of Brainbank's memory cells.

Re-Search

But what happens if the Box of tricks doesn't know your word? Let's take an example. Translate ABILITY into German. When you punch in ABILITY and press L3 for German, each letter is miraculously transformed into a dotless question mark. The Brainbank doesn't understand you. You can now press the SCH (search) key. The machine will then start taking letters off the end of your word until it recognises what is left and can compare it with words it knows. ABILITY is cut down to AB. Brainbank (or BB to its friends) will then go through its store of English words beginning AB. The first one is ABLE. So, you can now have a bash at forming your sentence a slightly different way.

If you're not a superb speller of the Queen's lingo, the search facility eliminates any difficulties arising from your own bad spelling. You can see the memory cycling through all the possible words on the display.



At the touch of a button you can translate straight from English to French or German and vice versa.

Although L1 is programmed in English, you don't have to swap the chips round in order to translate, say, from French into English. As you're strolling down the rue and you see an arrow directing you to the gare, switch BB on, press L2 (for French), punch in GARE and press L1 (for English) — Up flashes TRAIN STATION.

Phrases

If you want a well known phrase, the chances are that you won't have to enter the whole thing, letter by letter. Have a look at BB's botty again. You can press PHR (phrase) plus any one of 26 letters, each of which represents a word or a complete phrase. For instance, pressing PHR plus V will enter 'Do you change traveller's cheques?' Pressing PHR twice plus a letter will enter partial phrases eg PHR PHR D

will flash 'I am looking for . . .' on the display.

You can also access words by category eg pressing HOTEL plus LRN will make BB cycle through words relating to hotels. Pressing LRN again stops the cycling process and you can translate the word you want.

Summing Up

BB can also be used as a calculator, albeit a rather slow one. The calculation of two times four takes around three seconds, so BB is unlikely to be bought as a pocket calculator alone. However, it is convenient to have the simple four function calculation facility built in. It saves carrying an extra box around.

Extras

BB has one or two luxury extras. If you would prefer to see the words moving from right to left across the display instead of flashing up at the same end everytime, you can do just that with the ROT (rotate) key.

If you can soak up the words faster than BB's standard rate you can speed things up with the F/S key.

Hardware

Six plug-in language cells were available when we first heard about BB (English, French, German, Spanish, Italian and Portuguese) with Japanese and Arabic due in the following weeks. Each cell holds 1200 of the most common words, together with 25 complete and 25 partial phrases. Up-rated cells containing 9,600 words should soon be available. That's good news, as even 1200 words is rather restricted.

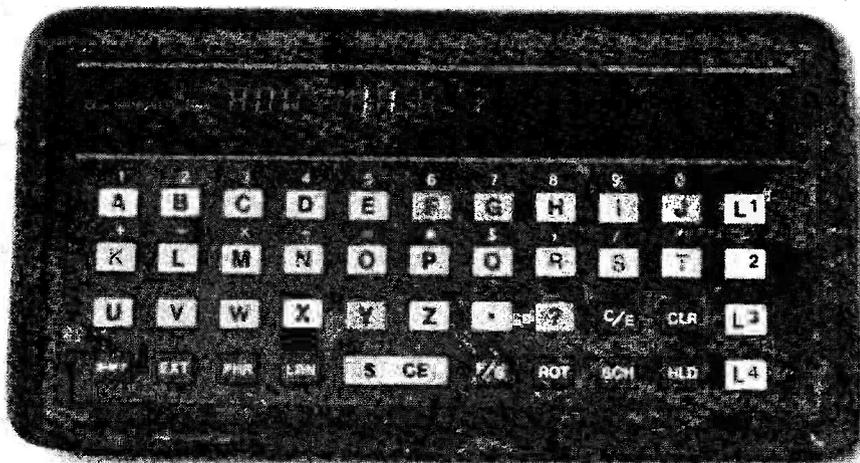
Cells covering pronunciation, diet and nutrition, first aid, taxation and a thesaurus are already complete. A cocktail mixer guide, a spelling guide and word games and puzzles are on the way. Blank cells which the user can program through the keyboard are also imminent.

The Brainbank is powered by four HP7-size cells (giving ten hours of continuous operation) or by rechargeable nickel cadmium batteries.

Your cheque for £150 or thereabouts will buy you one Brainbank, complete with mains adaptor, battery charger and one free cell. Extra cells will cost less than £20. Brainbank is marketed in the UK by Ring Electric.

If you want to see Brainbank 'in the flesh', it is on display at the 'Challenge of the Chip' exhibition at the Science Museum in London until June.

ETI



One criticism of Brainbank is the keyboard layout. A QWERTY board would be much quicker to operate. You can use the superior symbols and numerals by using the shift button just as on a normal typewriter OR by pressing the EXT button, you can use Brainbank as a calculator until the next time you press the CLR button.

HEATER CONTROL

A hyper-efficient circuit that can be used to give automatic precision control of any electric heater unit with a power rating not exceeding 3 kW. The unit can maintain room temperatures to within 0.5 C of a pre-set value

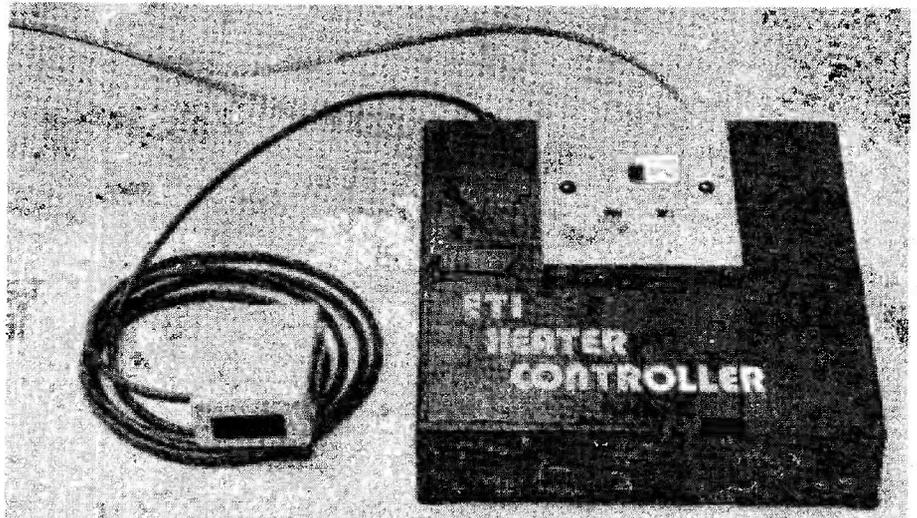
This unusual project is designed to impart automatic precision electronic control or regulation to virtually any electric convector or radiant bar heater with a power rating not exceeding 3kW. The heater is simply plugged into the electronic controller, which uses a remotely-mounted sensor/control unit to sense room temperature. The circuit can maintain the room temperature within 0.5° C of a pre-set value. Desired temperatures can be pre-set via the sensor/control unit.

The action of the ETI controller is such that, when first activated, it turns the heater on at full power until the room temperature rises to within a degree or two of the desired temperature and then progressively reduces the heater power output until the precise desired temperature is attained. From that point on, the controller maintains the room temperature within 0.5°C or so of the desired value and automatically adjusts the heater power output so that it exactly balances the thermal losses of the room: if an additional person enters the room, the controller reduces the heater output by an amount equal to that person's radiant body heat, thereby maintaining a thermal balance.

Zero RFI

Conventional thermostat-controlled electric heaters suffer from two major defects. First, their crude on/off electro-mechanical switching action gives poor thermal regulation and causes room temperatures to vary in a repeating series of thermal overshoots and under-shoots. Secondly, because the thermostat switching action is not synchronised to the mains frequency, the thermostat causes high switch-surge currents to be generated and generates a high level of RFI (radio-frequency interference).

The ETI controller, by contrast, uses a solid-state mains-synchronised triac to switch up to 2kW of mains



power to the heater. The switching action is synchronised to the 'zero crossover' points of the mains cycles and consequently causes virtually zero RFI generation. The triac is controlled via a thermistor proportional or 'burst fire' control circuit which enables the mean power output of the heater to be infinitely varied between zero and maximum and thereby enables the temperature to be regulated with negligible over-shoot or under-shoot.

The complete control unit uses only a handful of components, including two ICs and the triac. It can be built in an evening, at a total cost of about £15, including the case and 13A output socket.

Construction

Construction should present few problems. The unit uses two PCBs. The small board holds the remotely-located RV1-TH1 sensor/control components. All remaining components are mounted on the larger board, which is housed in the main units case. The 2N5574 triac is fixed to a large (64mm x 100mm) heat sink which is bolted directly to the PCB. The two ICs are mounted in suitable holders. The completed PCB is bolted

to the case base-plate via stand-off insulators.

The remotely-located sensor/control board is mounted in a small (25mm x 50mm x 72mm) plastic Vero 'potting' box, which can be fixed in a suitable location via sticky-pads. The lower end of the box must be cut away to allow air to reach the temperature-sensing thermistor. A small hole should be drilled in the front of the case to allow screwdriver access to the RV1 'set temperature' pot.

On our prototype, we used a 3-pin DIN socket to connect the sensor unit to the main unit. You can use direct wiring if you prefer. When you complete the interwiring of the unit, remember to use adequately rated cables and plugs and sockets: the unit is intended to carry up to 13 amps of mains current!

Note that there is no need to fit the unit with fuses or on/off switches, as these should already be provided via your mains plug and socket. If the triac does short-circuit, the heater will simply lock on and no significant damage will be done.

Using the Unit

When construction is complete, plug ▶

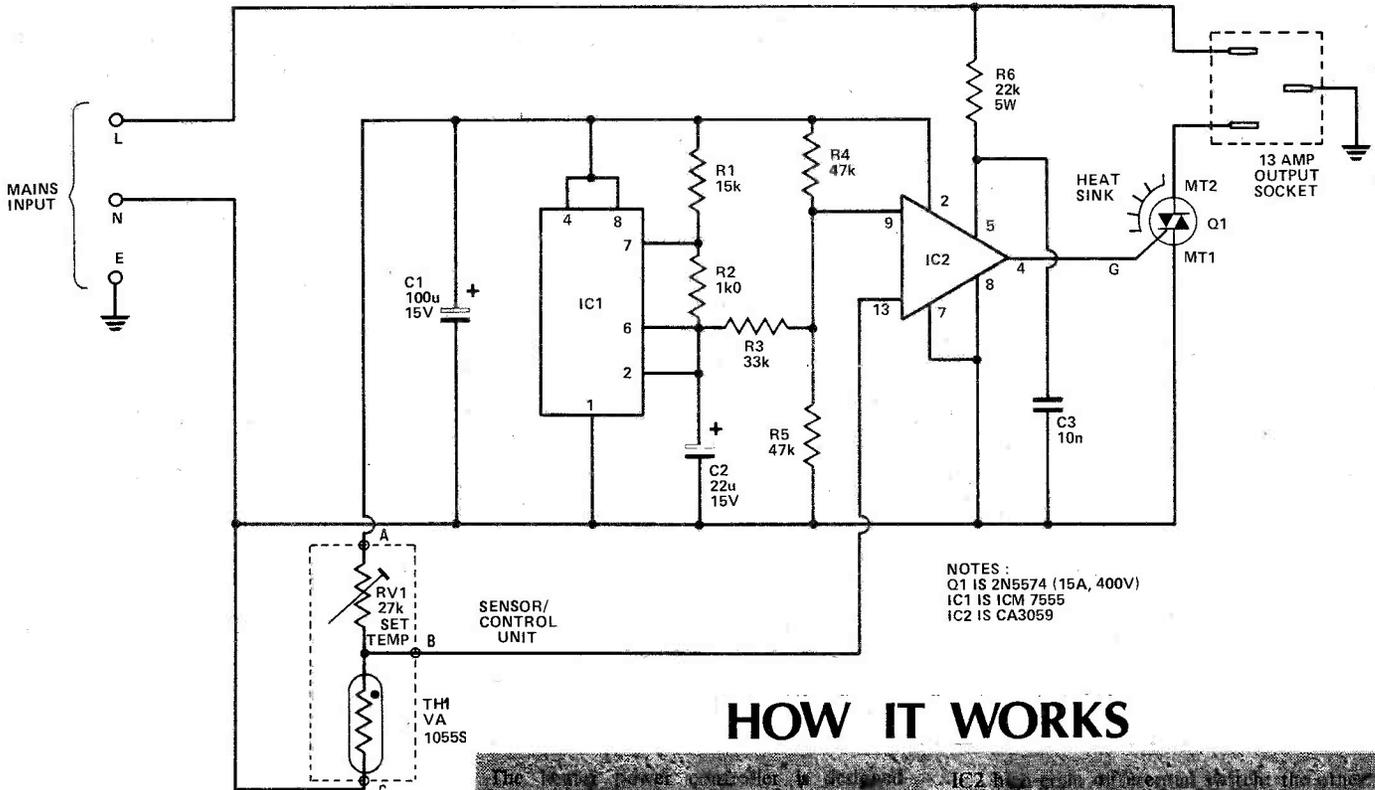


Fig. 1. Circuit diagram of the heater controller and remote sensor unit.

a heater into the unit, plug the unit into the mains and give the unit a functional check: if possible, temporarily wire a lamp in parallel with the heater, as this will give you a visual indication of the functional operation. Adjust RV1 and check that the heater/lamp load can be turned on and off via the preset pot. When RV1 is set to a value corresponding with the prevailing ambient temperature, power should pulse to the load at the timebase rate and the heater output should set to some value below maximum. If this action is obtained, the circuit is functioning correctly and you can complete the installation of the system.

When you install the system, be sure to fit the sensor/control unit in a position away from draughts and local sources of heat. Set RV1 by trial and error so that the heater produces a reduced output at the desired room temperature. If your heater is provided with its own thermostat, set the thermostat to maximum.

If your heater is fitted with a built-in lamp, you'll find that an annoying 'pulsing' action occurs as the heater power is regulated. You can overcome this problem by either disconnecting

The heater controller unit is designed around a 555 timer, plus a second purpose of an on-off controller which has a 1000V version of the well known 555 timer.

The sensor unit is made up of a 555 timer, which acts as a pulse generator, and a 1000V power MOSFET, which is used as a switch. The sensor unit is powered via a 15V supply, which is fed from the mains via a transformer. The pulse rate and amplitude of the output are set by the values of the resistors and capacitors in the circuit. The output of the sensor unit is connected to the heater unit, which is a 1000V power MOSFET. The heater unit is powered via a 1000V supply, which is fed from the mains via a transformer. The heater unit is controlled by the sensor unit, which provides a pulse to the gate of the MOSFET, which in turn switches the heater on and off.

The sensor unit section is detailed in Fig. 1, which shows a mains transformer, a 1000V power MOSFET, and a 1000V power MOSFET. The sensor unit is powered via a 15V supply, which is fed from the mains via a transformer. The pulse rate and amplitude of the output are set by the values of the resistors and capacitors in the circuit. The output of the sensor unit is connected to the heater unit, which is a 1000V power MOSFET. The heater unit is powered via a 1000V supply, which is fed from the mains via a transformer. The heater unit is controlled by the sensor unit, which provides a pulse to the gate of the MOSFET, which in turn switches the heater on and off.

the lamp or providing it with an independent connection to the mains input terminal of the controller unit. ETI

HOW IT WORKS

IC2 has a gain of 10,000, which is the other side of the output, it is fed from the top of the output of RV1. The output of IC2 is connected to the heater unit, which is a 1000V power MOSFET. The heater unit is powered via a 1000V supply, which is fed from the mains via a transformer. The heater unit is controlled by the sensor unit, which provides a pulse to the gate of the MOSFET, which in turn switches the heater on and off.

When the room temperature is higher than a preset level, the sensor unit sends a pulse to the heater unit, which in turn switches the heater on. The heater unit is powered via a 1000V supply, which is fed from the mains via a transformer. The heater unit is controlled by the sensor unit, which provides a pulse to the gate of the MOSFET, which in turn switches the heater on and off.

As the room temperature falls below the preset level, the sensor unit sends a pulse to the heater unit, which in turn switches the heater off. The heater unit is powered via a 1000V supply, which is fed from the mains via a transformer. The heater unit is controlled by the sensor unit, which provides a pulse to the gate of the MOSFET, which in turn switches the heater on and off.

If the room temperature drops below the preset level, the sensor unit sends a pulse to the heater unit, which in turn switches the heater off. The heater unit is powered via a 1000V supply, which is fed from the mains via a transformer. The heater unit is controlled by the sensor unit, which provides a pulse to the gate of the MOSFET, which in turn switches the heater on and off.

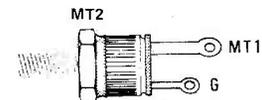


Fig. 2. Q1 outline

PARTS LIST

Resistors

R1	15k
R2	1k0
R3	33k
R4,5	47k
R6	22k 5W

Potentiometers

RV1	22k 0.25W horizontal preset
TH1	VA1055s

Capacitors

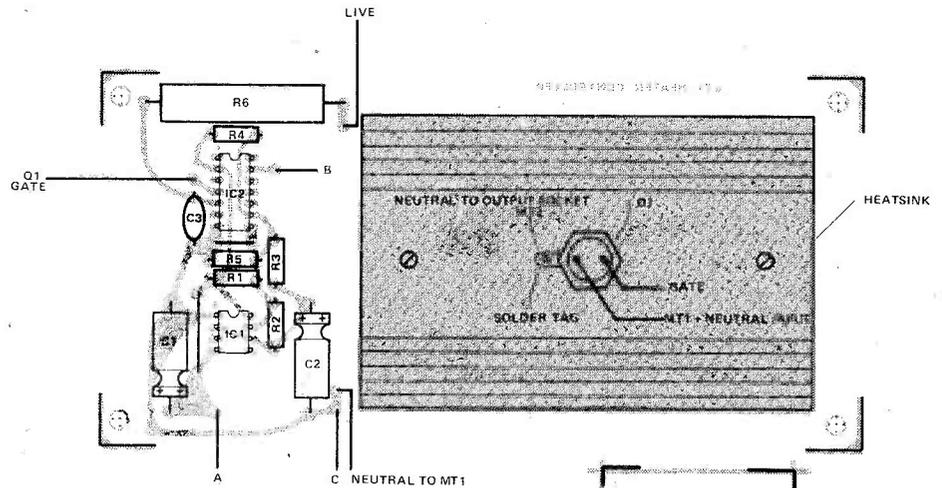
C1	100u 25V electrolytic
C2	22u 25V electrolytic
C3	10n polyester C280

Semiconductors

IC1	ICM7555
IC2	CA3059
Q1	2N5574 (15A 400V)

Miscellaneous

13A MK socket; 3pin plug + socket;
 1/2" grommet; 1/4" grommet; Vejo
 potting box order code 202-21025K
 heatsink 100mm x 65mm.



BUYLINES

The case chosen for the Heater Power Controller was obtained from CSC Ltd (see below for address), order as DMC-1.

The CA3059 IC can be purchased from Marshall's, all other components used are readily available from major stockists that advertise in this issue.
CSC (UK) Limited,
 Shire Hill Industrial Estate,
 Saffron Walden, Essex CB11 3AQ
 Phone: (0799) 21682.

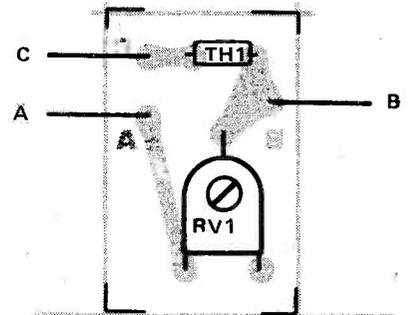


Fig. 3a (top) Component overlay of main control unit.
 Fig. 3b (above) Component overlay of remote sensor.

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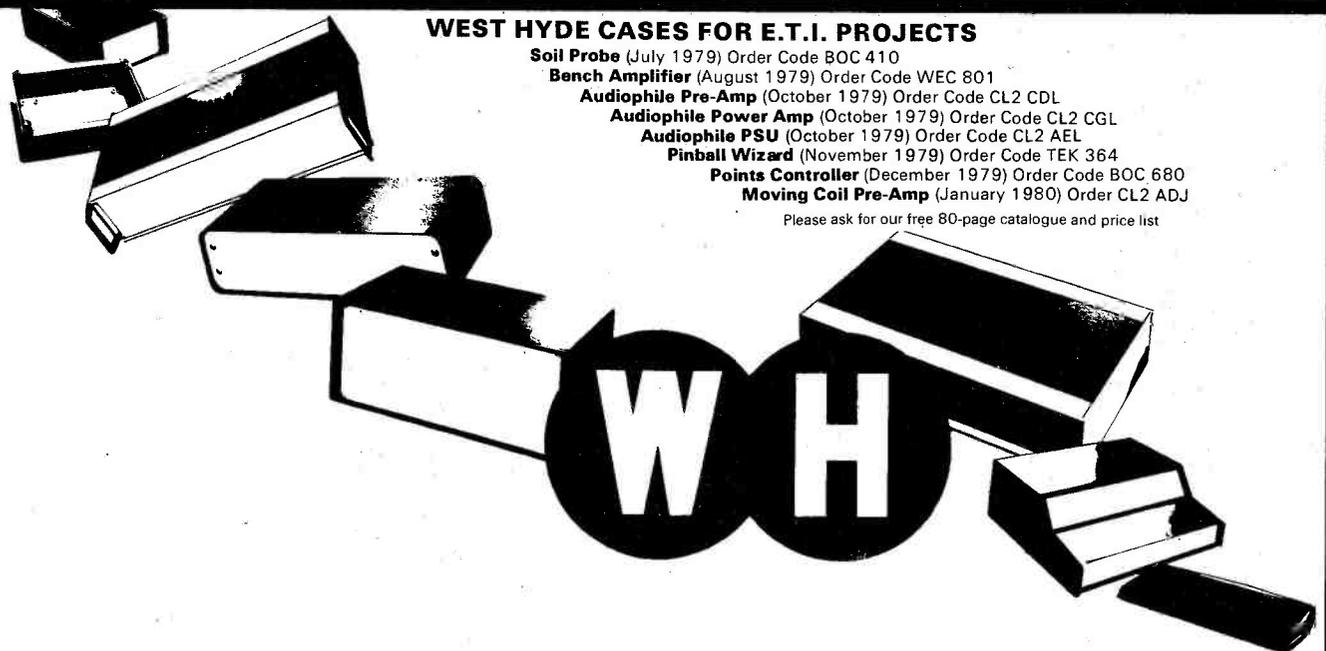
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10 Game COLOUR SPORTSWORLD £22.50 + VAT.

CHESS COMPUTERS

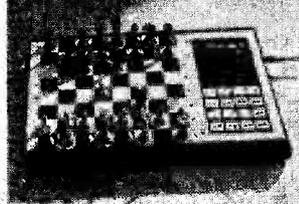
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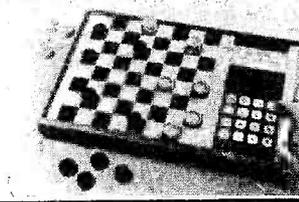
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TELEVISION SOUND

Rick Maybury takes the back off his telly (and his life in his hands) for ETI to give a few hints on improving TV sound

There was a rumour some years ago that one of America's top Hi-Fi manufacturers was using old television loudspeakers instead of fancy new ones in their systems. That actually makes some sense when you consider the amount of use the average telly speaker gets. The cone tends to lose its stiffness and enables it to cover a greater range of frequencies. Whether you believe this or not, one fact is beyond dispute. The TV speaker is probably the most 'used' speaker in any piece of household audio.

It is, therefore, surprising to consider that the circuitry devoted to handling audio frequencies within a TV set and the speaker that produces the sound was up to only a few years ago (and still is with some manufacturers) actually considered a nuisance. In the ideal world of the TV set designer there would be no sound. This is perhaps best illustrated by the speakers used. They are deliberately shaped to take up the minimum space. Elliptical speakers on their own may not seem too bad but just consider where they are sited. One manufacturer (who shall remain nameless) actually put it at the back, unable to find anywhere it could be usefully placed. Side facing speakers are not uncommon (even one on the bottom of the cabinet). Within the last five years something of a revolution has been taking place. Tone controls have been spotted on some sets. The growing awareness of the set-maker to the interest in audio have stirred the advertising men, looking for new features to sell their boxes. This has led to some rather dubious claims for quality, so it is perhaps a good time to look at the transmitted signal which, unless someone has managed to do without it, remains the be-all and end-all of the sound that emanates from your telly.

The quality of the transmitted sound is relatively high. The main factor from the broadcaster's point of view is source. The video tape recorder is probably the worst in that respect. The tape used for VTRs is designed for just that. The oxide particles that make up the catering are aligned to optimise the helical scanning of the VTRs recording/playback head. The audio track is usually arranged on the bottom edge of the tape and nearly always recorded in a linear fashion. Because of this the best bandwidth that can be expected will be around 10 kHz.

Live broadcasts and telecine material will do a little better, provided that the audio material is carefully handled something like 12 kHz can be expected.

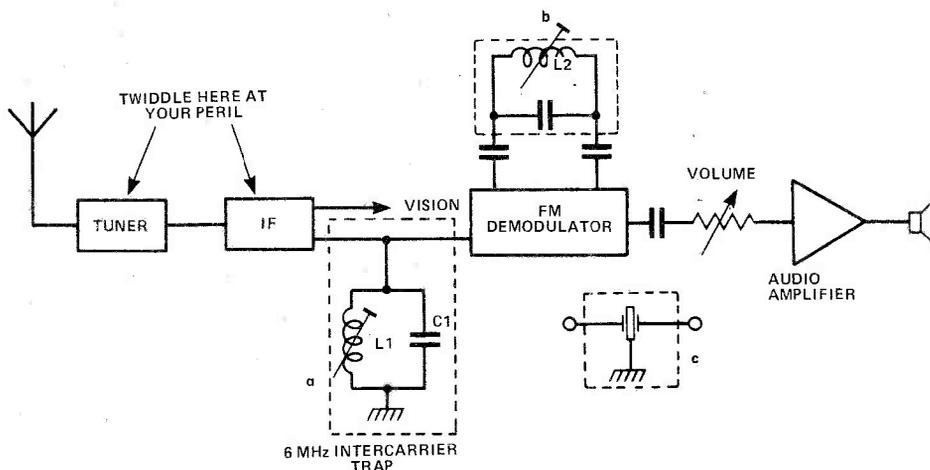
The best quality undoubtedly comes from the 'simulcast' and separate synchronised audio recording. The audio material is recorded quite apart from the video on high quality studio tape recorders. At no time is this material ever allowed to come in contact with lesser machines and in theory at least, will have a bandwidth of something like 18 kHz. What it will be like by the time it comes out of your loudspeaker is another story.

At present there are two methods of transmitting a composite sound and vision signal used in the UK TV system.

The first and most obvious is to send the audio on a slightly different frequency or carrier to that of the video signal. This is the method used for domestic TV broadcasting at the moment. It has the rather glamorous sounding title of Intercarrier Sound. It involves transmitting the FM encoded audio on a carrier 6 MHz above the vision carrier. For instance, channel 21 on band IV — the video is

used in place of circuitry around trap L1, C1 — no twiddling possible! Please DO NOT attempt to twiddle anything before the intercarrier trap you will only regret it and that's a promise.

Fig. 1. Twiddling points within the sound signal path. (a) 6 MHz intercarrier sound trap coil, L1. (b) Balance circuitry for setting up coincidence detector demodulator now widely found on sets using TBA120 sound and IF detector ICs. (c) Ceramic filter sometimes



transmitted on a frequency of 471.25 MHz whilst the accompanying audio is to be found on 477.25 MHz. We will deal with Intercarrier Sound demodulation in more detail later on.

The second, less obvious method rejoices under the name of Sound in Sync or SIS. This is not used for normal broadcast transmissions but for transmission of audio between studio and transmitter or relay stations. This is a rather cunning technique utilising the space 'inside' the line synchronisation pulse that occurs at the beginning of every TV line. This pulse is sited at a point on the TV waveform 'below black level'. This means it occurs below a pre-determined voltage at which the TV receiver will recognise it as picture information. The sync pulse lasts for approximately 4.7 microseconds and occurs at a repetition rate of 15.625 kHz (line timebase frequency).

Because SIS occurs in a synchronisation pulse it has to be removed if the signal is to be displayed. Within the studio environment a filter is used to remove SIS for insertion in studio monitors. It is removed at the transmitter prior to encoding into intercarrier sound for normal broadcast.

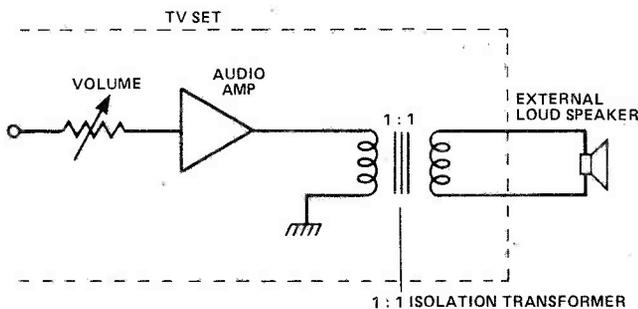


Fig. 2. Connecting an external speaker to a set with a live chassis (see fig. 4). Of course, if the set has an isolated chassis, the transformer is unnecessary and a direct connection may be made. Ensure the replacement speaker matches the impedance and power handling of the original.

Inter Sound

The broadcast sound is FM modulated onto a carrier with an impressive 8 MHz bandwidth. The peak FM deviation, ie the amount by which the signal deviates around the centre frequencies, is 50 kHz. This compares with a 75 kHz deviation on FM sound radio. The sound and vision signals make uneasy bedfellows, even being 6 MHz apart. A variety of problems can arise with these two signals, sharing as they do a great deal of common circuitry within the TV receiver — not the least being intermodulation resulting in a loud irritating buzz, aptly called Intercarrier Buzz.

Those are the bare bones of TV sound. From a critical standpoint the signal that leaves the TV transmitter is rarely the same one as the one coming from the set's loud-speaker.

If it is your wish to improve upon what greets your ears every night you have a problem. Basically you are limited by the original design. You have two courses of action open to you. Firstly you can take it upon yourself to build a

complete tuner/IF/demodulator. This is not recommended for the faint of heart. To get round this a couple of enterprising manufacturers have got TV sound tuners on the market. You would be hard pressed to improve upon them, let alone do it as cheaply.

The second, more practical route is to make the best of a bad job and improve upon what you already have.

The first and most obvious problem is perhaps the hardest to cure. That is the initial design. Modern receivers of the last few years have at least made some attempt to demodulate the sound responsibly. If your set is more than five years old — forget it. Proceed to step 2.

Step one. The aerial, the first link between the speaker and the incoming signal must be OK. As a general rule of thumb if the picture looks OK the sound will be. The colour TV is a very good indicator of signal quality being far less forgiving than a monochrome set. Look for noise or snow on the picture. If there is any, get a better aerial/move to an area with better reception/give up and proceed to step two.

The second principle of step one (confusing isn't it?) comes under the heading of alignment. Two symptoms to look for. Number one is intercarrier buzz. No big prizes for guessing how to recognise it. The second symptom of the second principle of step one (Prize for understanding that bit now available from the ETI offices) is called sound on vision. This is not necessarily detrimental to the sound quality but you might as well sort it out whilst you're at it.

Both these maladies point to one thing; poor alignment. The obvious remedy consists of whipping the back off your telly and twiddling the appropriate components. But hold on, which one. Most tellies have forty or fifty presets, coils, trimmers, etc just waiting for the eager, would-be twiddler. The answer here is arm yourself with a manufacturers' service sheet. You will be able to locate the audio section on the diagram quite easily. Just look for the loud speaker, amplifier section and decoder. On a modern colour TV just before the demodulator there will be a trap circuit. This usually consists of an LC network or a ceramic filter. For the sake of sanity DO NOT twiddle anything before this section. You will be entering the realms of IF alignment where only bold men tread, especially if you haven't got a wobulator. If you have, then you have our deepest sympathy (and why are you reading this anyway because your set should be perfectly aligned?)

Now having located the demodulator/audio section take a deep breath. **First thing to do is check up on your life insurance. Many thousands of volts run around the innards of tellies. Let them run up an errant finger and down your other arm, (the one clutching the gas pipe) and it won't really matter how bad your sound is on your TV set. The only noises you'll be hearing will be the strumming of heavenly harps (If you're lucky).**

Start again, are you sound of wind, limb and brain. Yes? Then look for the vision signal trap. Does it consist of a LC network. If it does, mark the position of the slug relative to the coil, with one eye on a reflected image of the screen (use a mirror in front of the set) and the other on your shaking hand. Twiddle, no more than half a turn either way. Look for any striation on the screen (that's wavy lines). If they disappear back off and try the other way. If on the other hand the picture contorts with the sound coming from the set then go back to the starting point.

To make matters clear, if there is sound on vision this may cure it, it may also cure intercarrier buzz. If nothing changes or gets worse then return the slug to its original position.

Our next twiddle, or first, if you didn't have the first, ▶

should be found around the demodulator circuit. As the sound is FM modulated you may be lucky and have a ratio-detector type decoder. If you have, chances are that there is another twiddle in store.

This time we will be setting up the decoder by ear. There is no practical way round it. Just twiddle and listen, keep looking at the screen, though nothing really terrible should happen. As always, make sure you know the starting point and NEVER twiddle more than half a turn either way. That way at least you should be able to get back to where you started without too much bother.

If neither of these exercises did anything for you, now is the chance for you to proceed to step two. It must be said however that if the sound is still really dreadful your IF stage is probably in need of attention. The only really capable people are the manufacturers themselves. Have a word with your local (friendly) TV serviceman about doing a swap. Most sets in the last few years use modular construction so the IF strip and/or tuner might just unplug and easily substitute for another.

tions I am about to make blow my set/house/self/cat up. If you can hold your hand on your heart and still pick up that soldering iron with an easy conscience, then proceed.

As we said earlier, the loudspeakers used in TVs can be particularly nasty items. Why not replace your one with a nice big 12in woofer? It won't fit in the case. Solution, disconnect the existing speaker making notes of impedance, power rating, etc and replace. Problem number one is likely to be the high voltages running around the speaker. Most modern colour sets have a metal chassis at around half mains potential. This is because of the types of power supply used do not employ mains transformers, or, if they do, they are of the auto type with no separate primary and secondary. You have been warned. Let not your fingers touch these wires or you will know all about it. Problem number two with this procedure is called visual/audio image separation. Be sure not to site the speaker too far away from the screen. You will have the disturbing effect of seeing the picture in front of you and the sound coming from one side or another. This is especially irritating when watching Crossroads, as it can appear that Meg Richardson is at the same time on telly and somewhere in your living room. To be avoided at all costs.

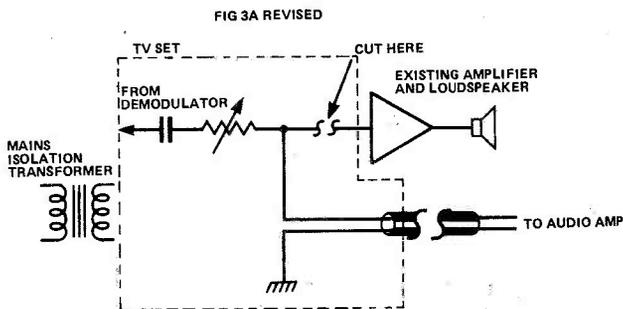


Fig. 3a. By isolating the set with a 1:1 mains isolation transformer, connections to the outside world should be safe. If your set has an isolated chassis, you should be OK.

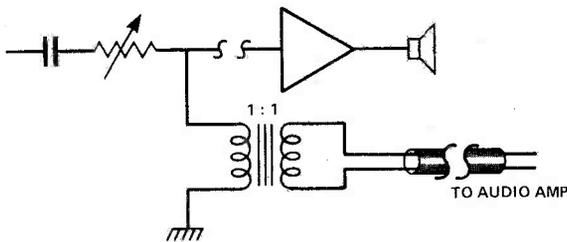


Fig. 3b. Using a 1:1 isolation transformer to prevent nasty shocks. The isolation transformer shown in fig. 4 is, however, the best solution for safe connection.

The Famous Step Two

Step two exists for those of you who are either scared of rooting about in the back of 'live' TV sets or have tried step one without success.

This involves modifications to your set. Two things must be ascertained before you pick up that soldering iron. Firstly, the set must be your own. It's no good trying to tell the man from Radio Rentals that you were trying to improve his set. Be assured something nasty will happen if you do. The second thing to consider is, will I mind if the modifica-

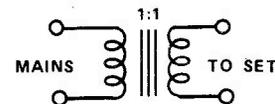


Fig. 4. Recommended method of isolating a TV set with a live chassis. Please note that the transformer should be rated at a minimum of 500 watts for a colour set.

The Step Three Bit

Step three is for the intrepid only. Going back to your trusty manufacturers' diagram, try to locate the point of entry of the audio signal into the audio output stage. Most manufacturers do this around the volume control area. The trick we are about to play here is to take this point, sever the connection between the volume control and the audio stage and introduce it to your expensive hi-fi equipment. The proviso in step two still holds good, but this time add expensive Hi-Fi to the list of things that could be blown up.

Because we still have the live chassis situation, you must first rid the wires coming from your set of any high voltages. A 1:1 mains isolation transformer is the only practical answer. Now you have to determine the impedance and level of the signal coming out of the demodulator. There is only one reliable way to do this. Measure the level on a 'scope. Use your judgement for the impedance. Safest bet (though don't blame us if it's not) is to assume it will be a fairly hefty signal and treat accordingly. All being well and nothing nasty happening, place your speakers either side of the telly and switch to Mono. You may be rewarded with a really rich sound, complete with a full set of tone controls. On the other hand you may be left with a smouldering mass of high technology that was the telly and the Hi-Fi. Seriously though, any of these methods outlined here should only be attempted if you have a very good grounding in electronics. **Do not on any account muck around with your set unless you know what you are doing.** If you don't then save up and buy yourself a TV sound tuner and you'll live to read all the complaints about this article next month from irate TV manufacturers.

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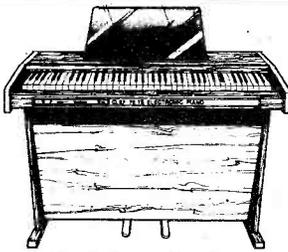
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It uses a ready made search head, as a home-made one would have no hope of giving the results needed for a design of this nature (would you use a home-made speaker with your hi-fi?). The search head from Altek enables depths of over 12" for a single coin to be achieved.

Construction

The use of sockets for IC1 and IC5 is not recommended due to the increased risk of leakage currents in the push button circuitry. C12 is a very critical component. Its value is not too important but it must be of the highest quality, have low dielectric absorption and high resistance. Polycarbonate types were used, but polystyrene would be equally suitable.

To keep the design as tidy as possible 20 way ribbon cable is used to connect the board to the controls. As each colour appears twice they are differentiated by indicating from which side of the ribbon they come — either white or black (the colour of the wire at the edge of the ribbon). Circuit pins are used at all other connection points so that wires can be attached after the board is installed in the case.

Setting Up

When construction is complete and the detector appears to function it is necessary to make sure that the Rx



coil has been properly connected. Due to the way the head is aligned it is not possible to check it until this stage.

Hold the head away from all metal and set the controls as follows: MODE and GROUND fully anticlockwise. ALL OTHERS at mid-rotation. Depress the tuning button and hold it in, rotate the TUNE control until the meter needle is approx mid scale. Release the button and bring the head close to a metal object — the meter should be deflected to the right. If it goes left, reverse the wires from the Rx coil (see diagram).

Use

Using the detector and interpreting the results is very much a matter of experience but the following notes will help.

Tuning

To adjust, the push button must be depressed. When tuned to your satisfaction release the button. If the tuning point drifts then it can be brought back simply by pushing the button for a second or two. When first switched on the memory retune button will be needed every few seconds but as thermal equilibrium is established it will be needed less often.

Sensitivity

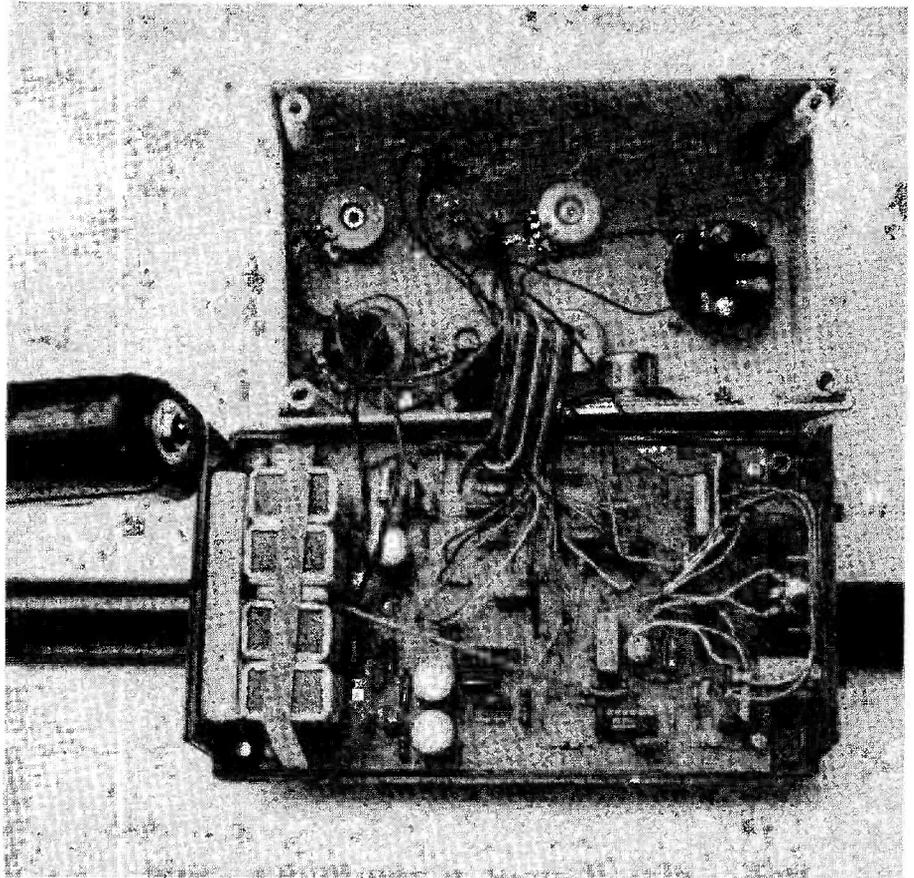
It is not necessary to set the sensitivity to maximum to achieve the greatest depth. Amplification is so great that a maximum setting may bring on instability. Experiment intelligently with it — mid-rotation is about right.

Ground

This only works in the VLF mode. Its setting is quite critical. First set the tuning with the head away from the ground. Move the head down to the ground and observe the meter. If it swings left — rotate GROUND clockwise, if it swings right — turn anticlockwise. Hold the head away from the ground and depress the button to reset the tuning. Repeat this procedure until the meter does not deviate when the head is lowered. A slight misadjustment is tolerable but if it is turned too far clockwise the detector will work in "reverse". When VLF is selected the detector is in its most sensitive mode.

Discrimination

It only functions when a TR mode is selected. The degree of discrimination

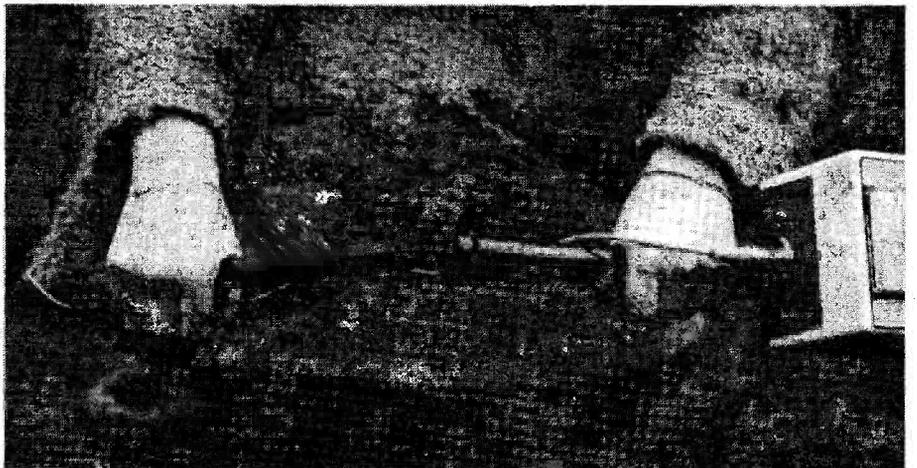


Connections from the PCB are taken to the top panel controls by 20 way ribbon cable.

is controlled jointly by the MODE (coarse setting) and the DISCRIMINATION (fine setting) controls. Together they set the point at which the resistance of the target causes a left or right deflection on the meter. The circuit in this design is very good indeed. It is possible to differentiate between a can ring pull and a gold ring, for example. However, the discrimination control reduces sensitivity slightly. It is best to use a detector of

this type in VLF mode until a target has been found and then use discrimination to determine its likely value!

Finally we ought to point out that in the UK it is necessary to obtain a licence before using a metal detector. This is not necessary elsewhere. Application forms can be obtained from: Home Office, Radio Regulatory Dept., Waterloo Bridge House, London S.E.1.



No, we haven't broken it. The two-piece shaft is telescopic, accommodating varying altitudes of treasure hunter.

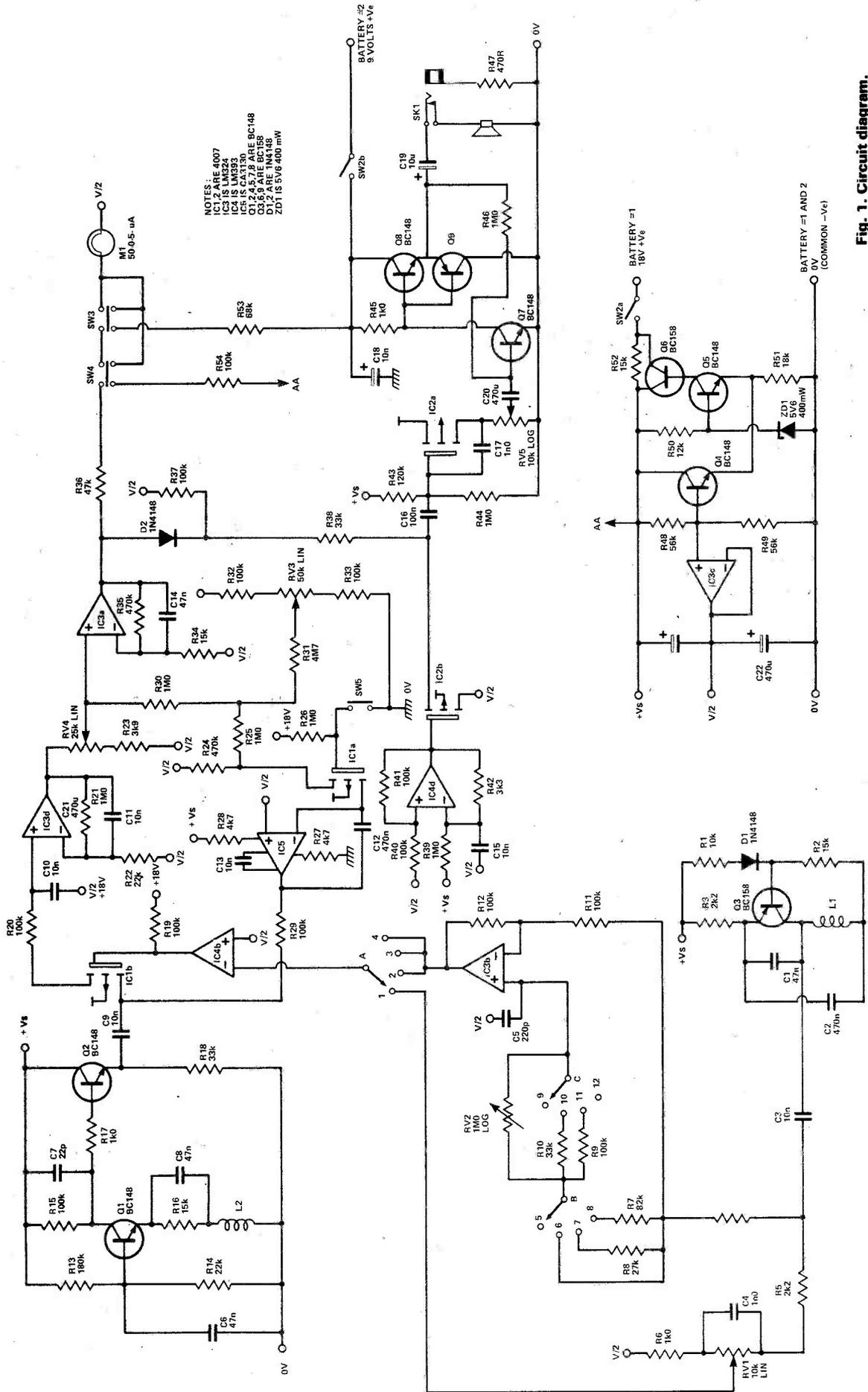


Fig. 1. Circuit diagram.

HOW IT WORKS

L1 and L2 are the TX and its coils in the search head. The signal is drive L1 is produced by Q1 and associated components which generate a sine wave of approx 16 kHz. Part of this signal passes via C3 to the phase shift section which produces a reference signal for the "phase comparator". When the VLF mode is selected, RV1 (ground control) and C4 provide a variable phase advance of 0 - 180°. The suitably modified signal is squared up by the precision voltage comparator IC1 and applied to the gate of the phase comparator IC1b. Meanwhile the signal picked up by L2 passes through Q1 and Q2 which amplify but do not distort or shift the phase, and meet the reference signal at IC1b.

The signal emerging from IC1b is a DC signal upon which superimposed are AC components corresponding to the phase coincidence of the reference and received signals. This is integrated by IC3d and a portion of the resulting signal is tapped off by the sensitivity control RV4. This is further amplified by IC3e and applied to the meter and via D7 to the audio gate IC2b.

Audio is generated by an auzible formed from the remaining half of the voltage comparator IC3a and after being gated by IC2b is amplified by IC2a, Q7, Q8 and Q9. RV5 is the volume control push button, IC1a form the heart of the voltage tuning system. Part of the voltage from RV4 is added to a voltage

determined by the position of the slider search head. The signal is applied to the base of IC1a when the tuning button is depressed. The normally high source to drive the instance falls and allows current to flow through the FET and build up as a voltage across C12. IC3 inverts and buffers the voltage to provide a DC bias for the phase comparator. The change of bias at L1b in turn affects the DC conditions at L1a (via Q3 and RV4). In other words a negative feedback loop is established which near the tuning button is present. Within a second or two the new DC level settles down and the button is released. The system is then maintained by the charge held on C12.

The power supply to the audio section is supplied, but due to the precision nature of the DC levels in the control section, stabilization is required. A Zener diode is voltage reference for the differential amplifier formed by Q4 and Q5, which carries the audio pair elements Q6, R32 about a small current to Q4 and Q5 at switch on to ensure that Q4 starts conducting. The base of Q4 must always be at 50% of the unregulated supply (R44 -R49). This point is buffered by IC3c as a V2 supply. C11, C13 and C20 are decoupling components. Special attention has been given to cutting down the current consumption. The control section only takes 1.5 mA and the audio section less than 2 mA when absent of other loading headphones.

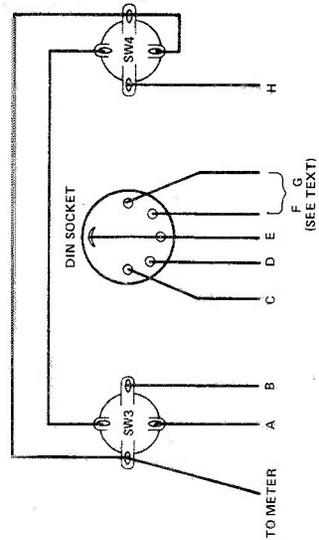
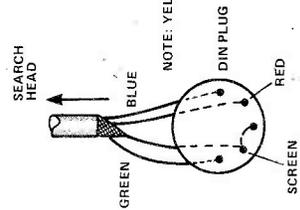
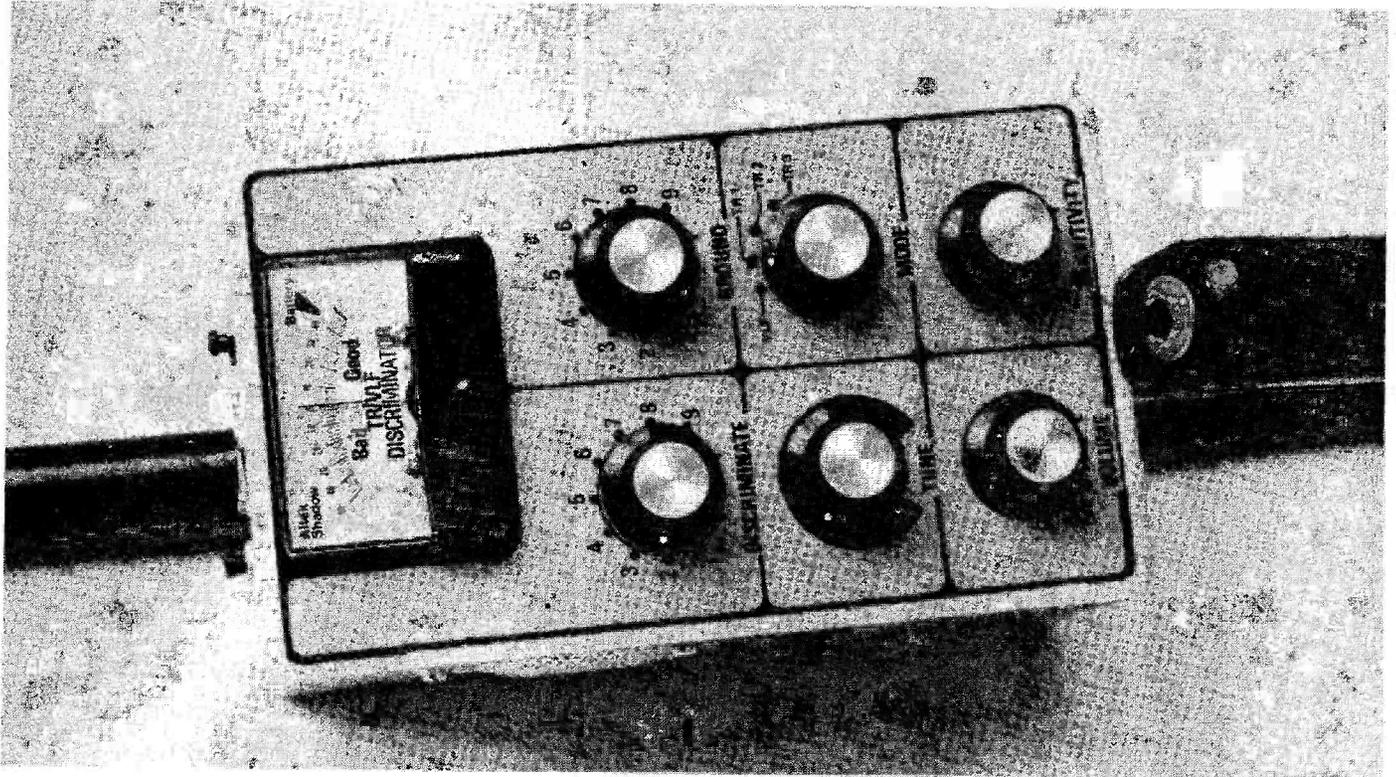


Fig. 2. Connection details for DIN plug and socket and SW3, 4. Note the tag lengths on SW3, 4.



You'll need a driving lesson before you commence twiddling with this control panel.



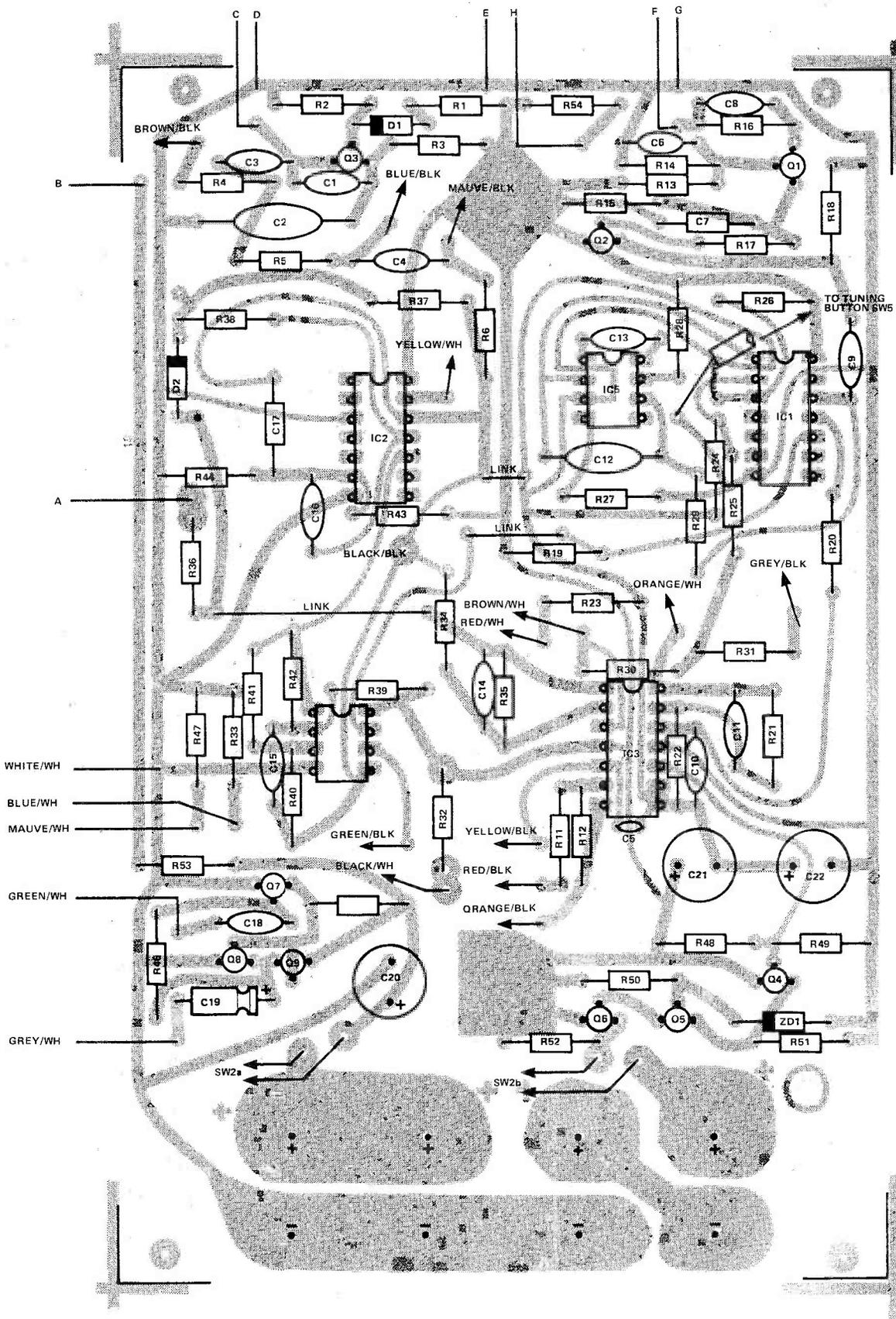
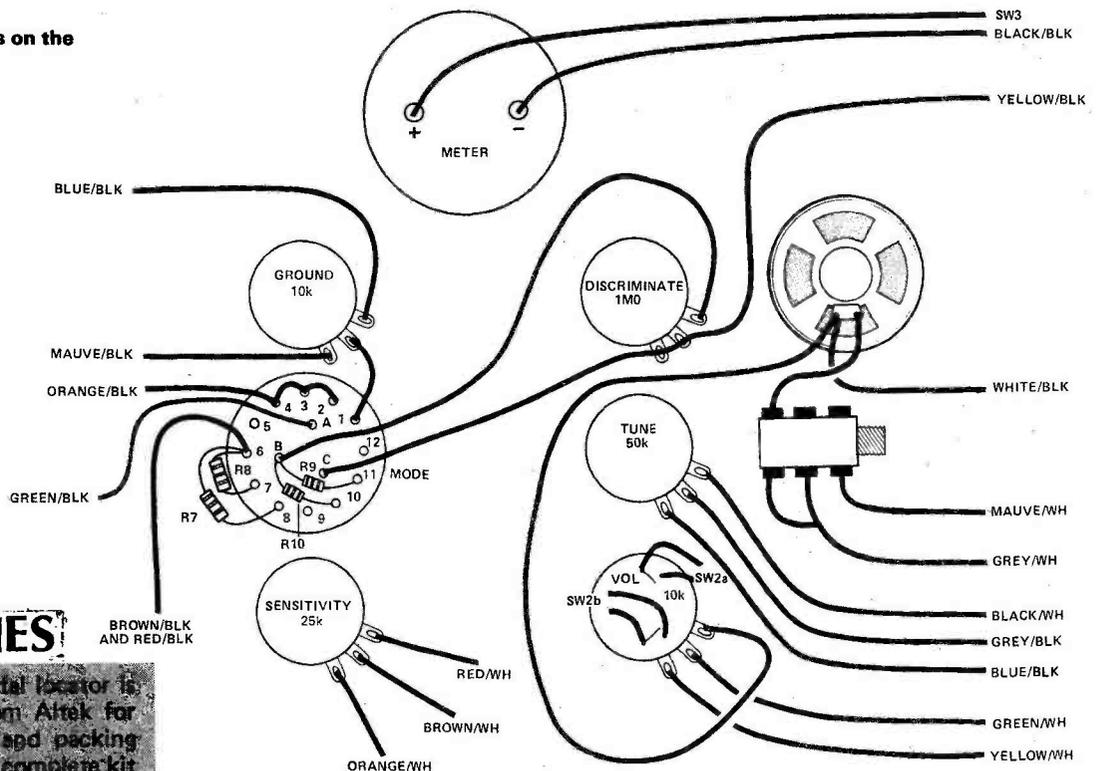


Fig. 3. Component overlay.

Fig. 4. Connections to controls on the front panel.



CONNECTION DETAILS FOR CONTROLS, METER, SPEAKER AND JACK SOCKET

BUYLINES

The Radsw VLF/TR metal locator is available in kit form from Aitek for £65 plus VAT (Postage and packing £1.50). Purchasers of the complete kit will also receive free parts and details of an extra switched function to sound a tone for 'good' and 'bad' or just 'good' finds when in discriminate mode.

A hardware kit is also available. It includes shell, search head, PCB and case and costs £47 plus VAT (P and P £1.70) from Aitek.

Aitek (ETI)
Green Lane
Wotton-on-Thames,
Surrey

PARTS LIST

RESISTORS All ¼W, 5%

R1	10k
R2,16,34	15k
S2	
R3,5	2k2
R4,51	18k
R6,17,45	1k0
R7	82k
R8	27k
R9,11,12	100k
15,19,20,29	
72,33,37,40	
41,54	
R10,18,38	33k
R13	180k
R14,22	22k
R21,2,26	1M0
10,19,44,46	
R23	3k9
R24,35	470k
R27,28	4k7
R31	4M7
R36	47k
R42	3k3

R43	120k
R47	470R
R48,49	56k
R50	12k
R51	18k
R53	68k

POTENTIOMETERS

RV1	10k lin
RV2	1M0 log
RV3	50k lin
RV4	25k lin
RV5	10k log

CAPACITORS

C1,6,8,14	47n polyester
C2	470n polyester
C3,9,10,11	10n polyester
13,15,18	
C4,17	1n0 polystyrene
C5	220p ceramic
C7	22p polystyrene
C12	470n polycarbonate
C16	100n polyester

C19	10u 25V electrolytic
C20,21,22	470u 16V electrolytic

SEMICONDUCTORS

IC1,2	4007
IC3	LM324
IC4	LM393
IC5	CA3130
Q1,2,4,5	BC148
7,8	
Q3,6,9	BC158
DI,2	1N4148
ZD1	5V6 400mW

MISCELLANEOUS

50.0 50 nA meter, 8R 2½" speaker, ¼" stereo jack socket, 6 knobs, 2 double pole c/o push buttons, single pole make push button, 3p 4W rotary switch, 5 way 180° latching DIN plug and socket, PCB, search head, shaft and handle, case to suit, 4 pairs PP3 battery connecting studs, 20 way ribbon cable.

24 HOUR CLOCK/ APPLIANCE TIMER KIT

Switches any appliance up to 1KW on and off at preset times once per day. Kit contains AY-5 1230 IC, 0.5" LED display.

Mains supply, display drivers, switches, LEDs, triac, PCBs and full instructions.
CT1000K Basic Kit £14.90
CT1000KB with white box (56x131x71mm) £17.40 Ready-built £22.50

DVM/THERMOMETER KIT

Based on the ICL 7106. This kit contains a PCB resistors, presets, capacitors, diodes, IC and 0.5" liquid crystal display.

Components are also included to enable the basic DV kit to be modified to a Digital Thermometer using a single diode as the sensor. Requires a 3mA 9V supply (PP3 battery).

£20.75

LEDS

0.1" Red 8p
0.1" Green 12p
0.1" Yellow 12p
0.2" Red 8p
0.2" Green 12p
0.2" Yellow 12p
0.2" LED Clips 3p
Rectangular Red LED 10p
Rectangular Green LED 20p
Rectangular Yellow LED 21p

DISPLAYS

DL32 Red 0.3" cc (pin compatible with EL704) 70p
DL307 Red 0.3" cc (pin compatible with DL707) 70p
DL847 Red 0.8" cc (pin compatible with DL747) £1.80
DL350 Red 0.8" cc (pin compatible with DL750) £1.80
DL727 dual 0.5" cc Red £1.50

IC SOCKETS

8 pin 8p
14 pin 12p
18 pin 17p
24 pin 24p

RESISTORS

1/4 W 22 ohm, 10M E12 Series Pack of 10 (one value) 10p
10 Packs (10 values) 80p

TRIACS

400V Plastic Case (Texas) 80p
3A 49p 16A 180p
8A 55p 20A 185p
12A 70p 25A 190p
6A with trigger 80p
8A isolated tab 65p
Disc 18p

INTEGRATED CIRCUITS

555 Timer 21p
741 Op Amp 19p
AY-5-1230/2 Clock/Timer £2.60
AY-5-1224 Clock £4.20
AY-3-1270 Thermometer £8.20
ICL7106 DVM (LCD drive) £7.00
LM377 Dual 2W Amp £1.45
LM379S Dual 6W Amp £3.50
LM380 2W Audio Amp 80p
LM382 Dual low noise preamp £1.00
LM386 250mW low voltage amp 75p
LM1830 Fluid Level Detector £1.50
LM2807 1-v Converter £1.40
LM3909 LED Flasher/Oscillator 55p
LM3911 Thermometer £1.20
LM3914 Dot/Bar Driver £2.10
MM57160 (stag) Timer £5.90
MM74C911 4-digit display controller £6.50
MM74C915 7-segment-BCD converter 96p
MM74C926 4-digit counter with 7-seg outputs £4.50
S566B Touchdimmer £2.50
S9263 Touchswitch 16-way £4.85
T8A800 5W Audio Amp 58p
T8A810AS 7W Audio Amp 85p
TDA1024 Zero Voltage Switch £1.00
TDA2020 20W Audio Amp £2.85
ZM1034E Timer £1.80
All ICs supplied with data and circuits. Data sheets only 5p

MINI KITS

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

TEMPERATURE CONTROLLER/THERMOSTAT

Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater. PCB (4cm sq.) potentiometer, plus all other components included, with instructions. 500W £3.20 1KW £3.50

SOLID STATE RELAY

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

BAR/DOT DISPLAY

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

BURST FIRE/PROPORTIONAL TEMPERATURE CONTROLLER

Based on the TDA1024 Zero Voltage Switch this kit contains all the components required to make a "burst fire" power controller or a "proportional temperature" controller enabling the temperature of an enclosure to be maintained to within 0.5°C. 1.5kW £5.25 3kW £5.55

ALL COMPONENTS ARE BRAND NEW AND TO SPECIFICATION. ADD VAT AT CURRENT RATE TO ABOVE PRICES PLUS 30p P&P. MAIL ORDER — CALLERS WELCOME BY APPOINTMENT.

TK Electronics

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16 pin	12p
18 pin	15.5p
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24 pin	24p
28 pin	27p
40 pin	32p
4013 CMOS	24p
7401 TTL	7.5p
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BRIDGE RECTIFIER BY MOTOROLA 1.5a, 50v 28p.
20k LIN-POT BY AB (+1) 20p, (+10) 19p.
100k LIN MOULDED TRACK (+1) 55p, (+10) 50p.
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PDM 35 SINCLAIR MULTIMETER £34.99.
TFM 200 SINCLAIR FREQUENCY METER £53.
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CPR 1 — THE ADVANCED PRE-AMPLIFIER. The best pre-amplifier in the U.K. The superiority of the CPR 1 is probably the disc stage. The overload margin is a superb 40dB, this together with the high slewing rate ensures clean top, even with high output cartridges tracking heavily modulated records. Common-mode distortion is eliminated by an unusual design. R.I.A.A. is accurate to 1dB; signal to noise ratio is 70dB relative to 3.5mV, distortion < .005% at 30dB overload 20kHz.

Following this stage is the flat gain/balance stage to bring tape, tuner, etc. up to power amp signal levels. Signal to noise ratio 86dB, slew-rate 3V/uS. T.H.D. 20Hz—20kHz < .008% at any level.

F.E.T. muting. No controls are fitted. There is no provision for tone controls. CPR 1 size is 138x80x20mm. Supply to be ± 15 volts.

MC 1 — PRE-PRE-AMPLIFIER. Suitable for nearly all moving-coil cartridges. Sensitivity 70/170uV switchable on the p.c.b. This module brings signals from the now popular low output moving-coil cartridges up to 3.5mV (typical signal required by most pre-amp disc inputs). Can be powered from a 9V battery or from our REG 1 regulator board.

XO2:XO3 — ACTIVE CROSSOVERS. XO2 — two way, XO3 — three way. Slope 24dB/octave. Crossover points set to order within 10%.

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

POWER AMPLIFIERS. It would be pointless to list in so small a space the number of recording studios, educational and government establishments, etc., who have been using CRIMSON amps satisfactorily for quite some time. We have a reputation for the highest quality at the lowest prices. The power amp is available in five types, they all have the same specification. T.H.D. typically .01% any power 1kHz 8 ohms. T.J.D. insignificant, slew rate limit 25V/uS, signal to noise ratio 110dB, frequency response 10Hz-35kHz — 3dB stability unconditional, protection drives any load safely; sensitivity 775mV (250mV or 100mV on request), size 120x80x25mm.

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

POWER SUPPLIES

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

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

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THIS INCLUDES ALL METALWORK, POTS, KNOBS, ETC — TO MAKE A COMPLETE PRE-AMP WITH CPR 1(S) MODULE AND THE MC1(2) IF REQUIRED.

POWER AMPLIFIER MODULES	
CE 608 60W/8 ohms 35-0-35v	£19.52
CE 1004 100W/4 ohms 35-0-35v	£25.96
CE 1008 100W/8 ohms 45-0-45v	£31.90
CE 1704 170W/4 ohms 45-0-45v	£33.97
CE 1708 170W/8 ohms 60-0-60v	£33.97

TOROIDAL POWER SUPPLIES	
CPS1 for 2xCE 608 or 1xCE 1004	£18.56
CPS2 for 2xCE 1004 or 2/4xCE 608	£19.75
CPS3 for 2xCE 1008 or 1xCE 1704	£17.12
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HEATSINKS	
Light duty, 50mm, 2 C/W	£1.44
Medium power, 100mm, 1-4 C/W	£2.35
Disco/group, 150mm, 1-1 C/W	£3.04
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POWER AMP KIT	£35.03
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PRE-AMPS	
These are available in two versions — one uses standard components, and the other (the SL) uses MO resistors where necessary and tantalum capacitors.	
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CPRIS	£40.87
MC1	£21.28
MC1S	£33.17
Pre-amp Kit	£38.07

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XO2	£15.16
XO3	£23.58

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REG1	£6.90 TR6	£1.91

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10MV/DIV £159.85



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BURROUGHS 8 DIGIT Panaplex calculator display 7 segment 0.25" digits. Neon type with red bevel socket and date. £1.95 ea. 10 for £17.100 for £140.

HONEYWELL PROXIMITY DETECTOR integral amplifier 8V DC £3.50 ea. 10 for £30.

MULLARD TBAB00. IC audio amplifier 95p ea. 10 for £8. 100 for £70. 500 for £300.

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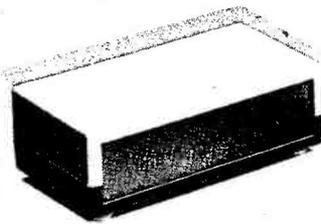
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BD246	£25	1k	£46
BD525	£25	1N4148	£2.30
BD526	£25	1k	£17
BD173	£13		
BF181	£17	ICs	
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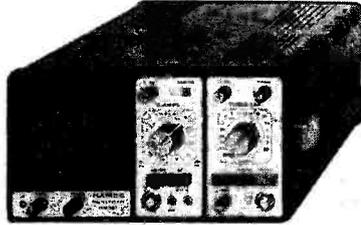
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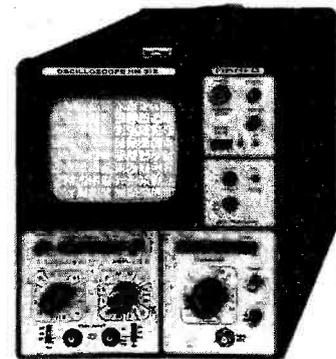
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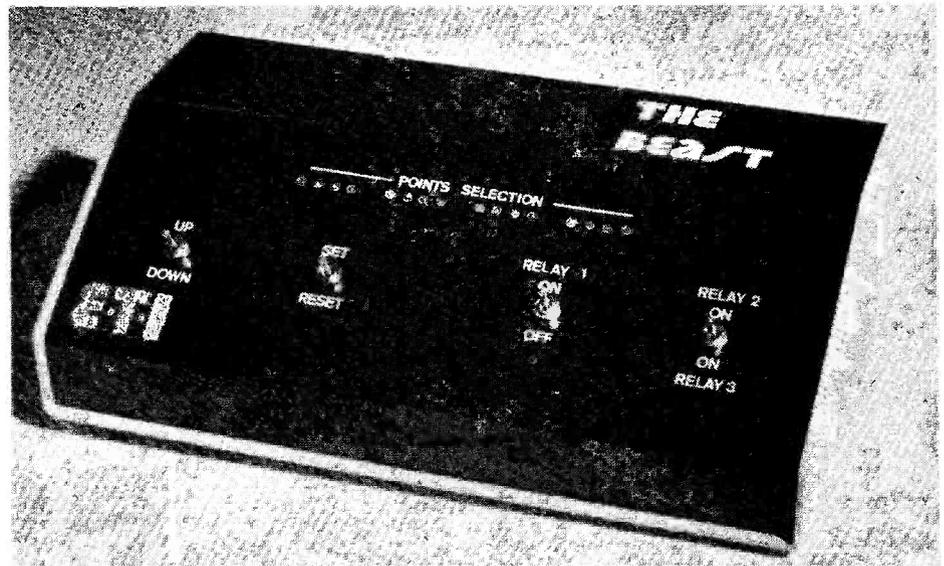
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0.6, 0.6	1A 1A	212	2.85	.70	1.0	103	4.45	1.00	
9-0-9	100	13	2.15	.65	2.0	104	7.15	1.15	
0.9, 0.9	330 330	235	2.00	.65	3.0	105	8.45	1.15	
0-8-9, 0-8-9	500 500	207	2.60	.70	4.0	106	10.70	1.25	
0-8-9, 0-8-9	1A 1A	208	3.70	.70	6.0	107	14.95	1.45	
0-15, 0-15	200 200	236	2.00	.65	8.0	118	20.05	1.65	
0-20, 0-20	300 300	214	2.60	.85	10.0	119	23.95	2.15	
20-12-0-12-20	700(DC)	221	3.35	.85	60 VOLT (Pri: 220-240V) Sec: 0-24-30-40-48-60				
0-15-20, 0-15-20	1A 1A	206	4.45	1.00	Amps	Ref. No.	Price £	P&P	
0-15-27, 0-15-27	500 500	203	3.90	.85	0.5	124	3.70	.85	
0-15-27, 0-15-27	1A 1A	204	5.95	1.00	1.0	126	5.45	1.00	
12 AND/OR 24 VOLT Pri: 220-240 Volts					2.0	127	7.40	1.15	
	Amps	Ref. No.	Price £	P&P	3.0	125	10.95	1.25	
12v	24V				4.0	123	12.20	1.45	
0.5	0.25	111	2.15	.70	5.0	40	14.00	1.55	
1.0	0.5	213	2.60	.85	6.0	120	17.45	1.55	
2	1	71	3.10	.85	AUTO TRANSFORMERS				
4	2	18	3.90	.85	Input / Output Tapped 0-115-210-240V				
6	3	70	5.45	.90	VA	Ref. No.	Price £	P&P	
8	4	108	7.30	1.15	(Watts)				
10	5	72	8.10	1.15	20	113	2.50	.85	
12	6	116	8.70	1.15	75	64	3.95	.85	
16	8	17	10.70	1.25	150	4	5.45	1.00	
20	10	115	13.70	1.45	Input / Output Tapped 0-115-210-220-240V				
30	15	187	16.70	1.45	300	53	9.05	1.15	
60	30	226	33.20	1.75	500	67	10.70	1.45	
30 VOLT (Pri: 220-240V) Sec: 0-12-15-20-24-30V					1000	84	18.45	1.55	
	Amps	Ref. No.	Price £	P&P	Also 1500/2000/3000VA				
0.5	112		2.70	.85	MAINS ISOLATING (Centre Tapped & Screened)				
1.0	79		3.45	.85	Pri: 120/240V Sec: 120 240V				
2.0	3		5.45	1.00	VA	Ref. No.	Price £	P&P	
3.0	20		6.15	1.15	(Watts)				
4.0	21		6.45	1.15	60	149	6.45	1.00	
5.0	51		9.45	1.15	100	150	7.45	1.25	
8.0	117		10.95	1.15	200	151	10.95	1.25	
8.0	88		14.20	1.45	250	152	13.15	1.45	
10.0	89		16.45	1.45	350	153	16.15	1.55	
					1000	156	36.95	3.15	

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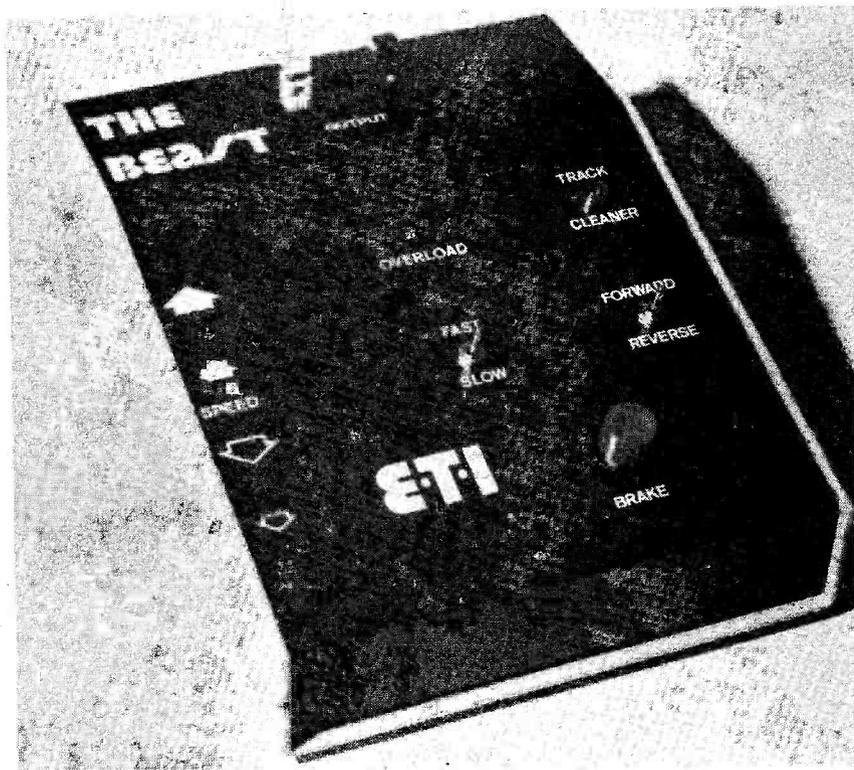
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The points controller (above) can control up to sixteen sets of points or relays. It can activate several times per second. The set of points chosen is shown on the row of LEDs on the front panel. Think about your own particular points control needs before you start to build this unit. The data distribution unit is shown on page 91.

epoxied to the front panel. Our controller unit connects to the decoder/data-distributor unit via approximately 3.5 metres of 3-core coiled cable and a 3-pin DIN plug and socket.

The main power supply unit (below) has electronic overload on its output and can power up to four sets of track systems simultaneously.



The train controller (above) gives exceptionally fine speed control, from crawl to supersonic (well nearly). There's also a built-in track cleaner to keep things running smoothly.



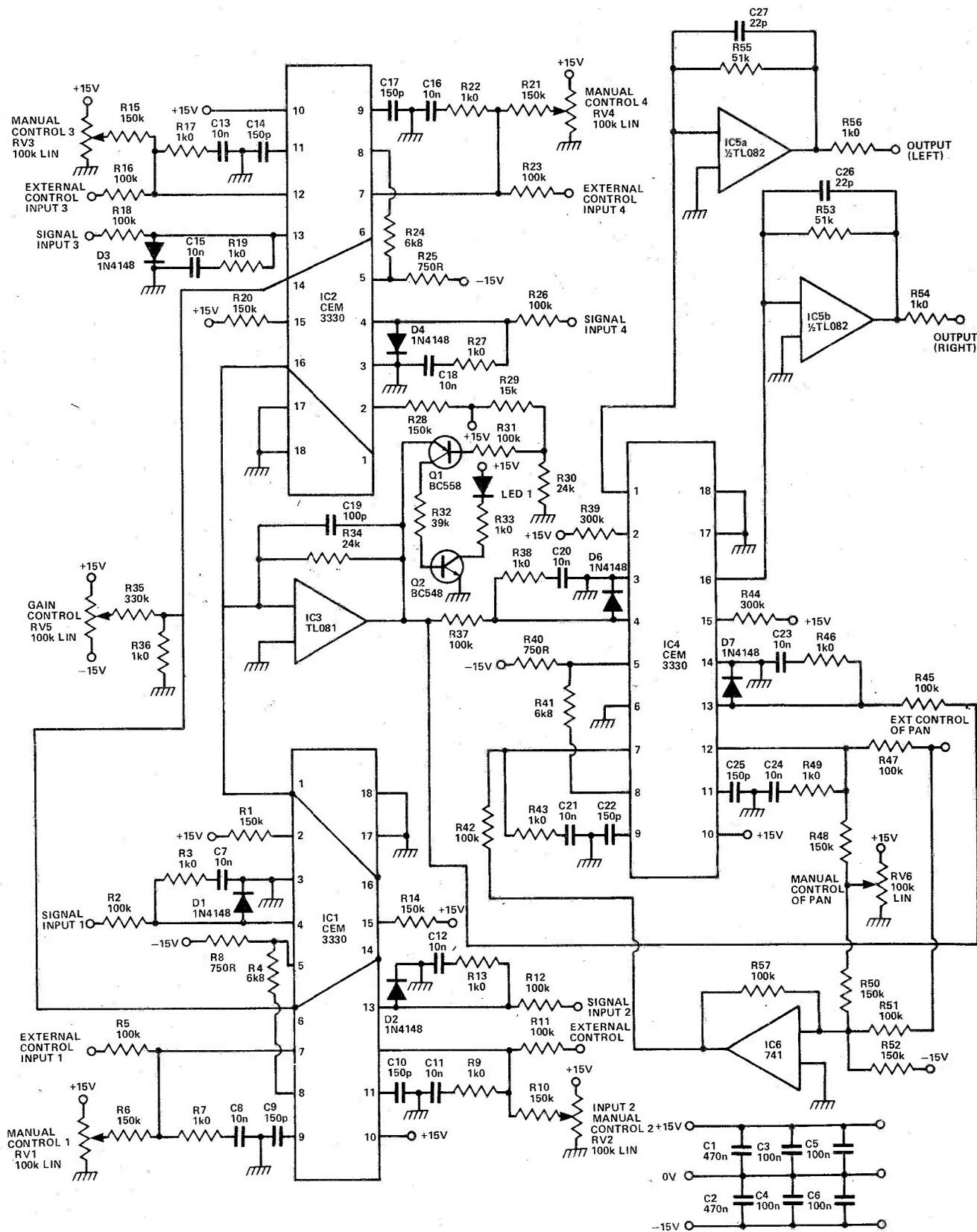


Fig.1. Circuit diagram of the voltage controlled mixer.

HOW IT WORKS

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

Reference to the circuit diagram and Pin 1 to 9 of IC1 illustrate the basic principle of the design and some of the features of the CEM 3330. The signal input (Pin 4) is a summing node and can, therefore, accept multiple inputs. In this application where we require independent control over each input only one input has been provided and with R2 = 100k the signal level should be kept to $\pm 10V$. R3 and C7 are compensation components and the diode, D1, is to prevent latch-up problems. R1 connected to +15V provides a reference current to the gain cell and this current should be limited to 100 μA for best linearity. The design is based on proportional mixing of up to four signals and thus the linear control input is used to independently control the gain of each signal input. Again, this is a summing node input at Pin 7 which allows manual control of gain via RV1 and R6 or external control via R5 without additional op amps. By using a 150k resistor for R6 the control pot can make use of the standard +15V supply and provide the same gain as a 10V external control signal applied to the 100k resistor. R5, R7 and C8 compensation network stabilise the log converter. C9 is for compensation of the gain cell. A master gain control is obtained by injecting a small voltage into the exponential control input (Pin 6). This voltage is derived from RV5, R13 and R34 and is common to the four input stages.

The overall gain of the VCA is given by:

$$A_v = \frac{R_2}{R_1} \times \frac{I_{CE}}{I_{REF}} \times \frac{V_{CE}}{V_T}$$

where R_2 is the value of the output resistor (R14), R_1 the signal input resistor (R2), I_{CE} the linear control current developed across R5 (or R6), I_{REF} the current input to Pin 3 via R1, and V_{CE} the exponential control voltage. This equation indicates how the mixer may be altered to suit other signal and control levels.

One of the unique features of the CEM 3330 is that the operating point of the amplifiers may be set anywhere from Class B to Class A according to which parameters are most important in a particular application. The quiescent standby current of the signal-carrying transistors is varied by placing a resistor between the IEX pin (Pin 5) and the idle current adjust pin (Pin 8). In this application the amplifiers are run Class AB with the 6k Ω resistor (R4) providing a standby current of about 7 μA .

The four signal input and control stages are identical and their output currents are summed at IC3 and converted to a voltage across R34. This voltage is applied to Q1 which is turned on when the peak output voltage is about 0V (normal signal level for the synthesiser), which is set by the voltage divider R29, R30. Q2 is also turned on when this peak voltage is reached and the LED (D5) will then light up. At constant amplitude high frequency the LED will tend to glow dimly but intermittent peak voltages are clearly indicated.

The output voltage from IC3 also goes to both VCAs in IC4 which is configured in a similar manner to ICs 1 and 2 except that the exponential output is provided. The amplifiers and associated op amps (IC5a) and (IC5b) are set to unity gain when a 10V control voltage is applied to R42 or R47. The panning effect is obtained through IC6 and associated components which provides a 10V output with zero volts at R47 or RV6, and 0V when there is 10V at R47 or when RV6 is fully clockwise. The left and right outputs are obtained by converting the current to a voltage across resistors R55 and R53 respectively. The use of op amp, IC5, provides low impedance outputs.

The CEM 3330 may be trimmed for precision control of gain and for use in high quality audio applications. The arrangement used in this design is entirely satisfactory for its intended use with high signal levels.

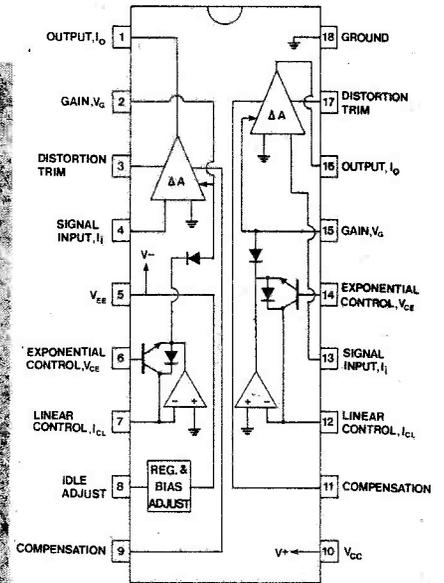
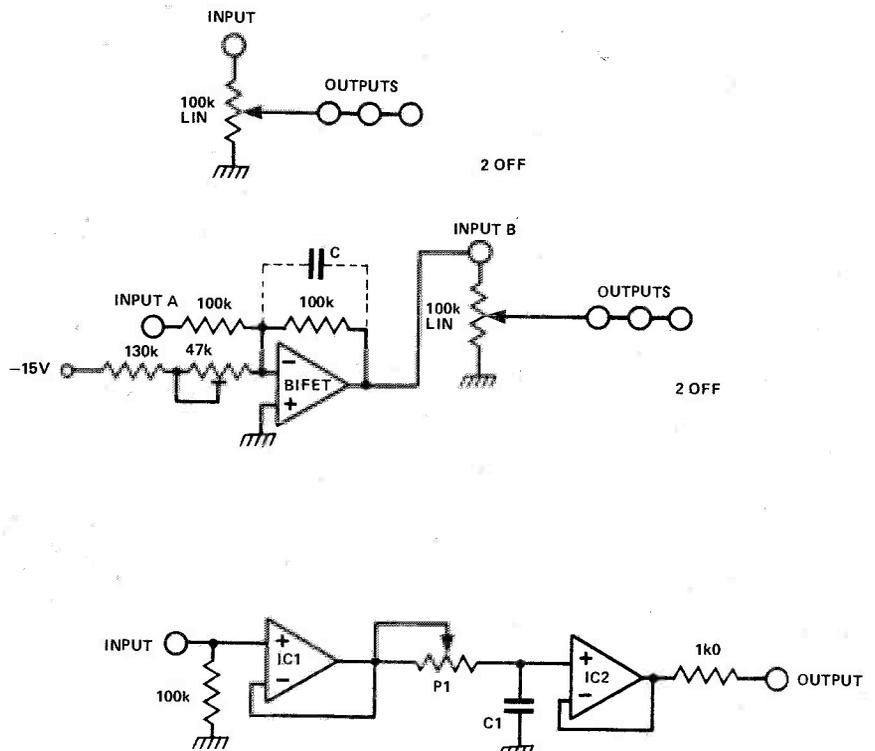


Fig. 2. The internal structure of the CEM 3330 dual VCA.



○ = JACK SOCKET

Fig. 3. Circuit diagram of the simple processor.

PARTS LIST

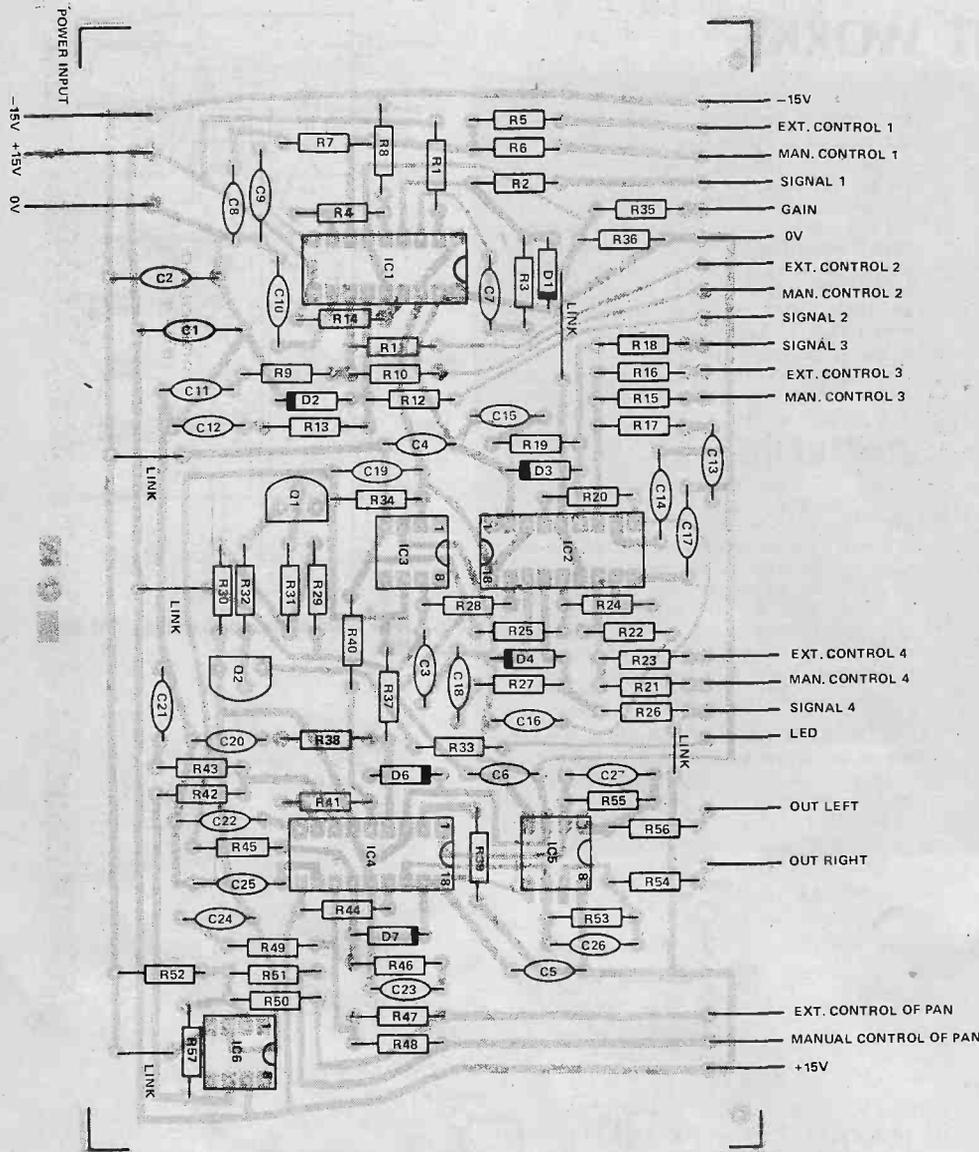


Fig.4. Component overlay of the VCM.

RESISTORS

R1,14,20,	150k 1% metal film
28,50,52	
R2,5,11,	100k
12,16,18,23,	
26,31,37,42,	
45,47	
R3,7,9,13,	1k0
17,19,22,27,	
33,36,38,43,	
46,49,54,56	
R4,24,41	6k8
R6,10,15,	150k
21,48	
R8,25,40	750R
R29	15k
R30,34	24k
R32	39k
R35	330k
R39,44	300k 1% metal film
R51,57	100k 1% metal film
R53,55	51k

POTENTIOMETERS

RV1-6	100k lin
-------	----------

CAPACITORS

C1,2	470n polyester
C3,4,5,6	100n polyester
C7,8,11,12,	10n polyester
13,15,16,18,	
20,21,23,24	
C9,10,14,	150p polystyrene
17,22,25	
C19	100p polystyrene
C26,27	22p polystyrene

SEMICONDUCTORS

IC1,2,4	CEM3330
IC3	TL081CP or equivalent
IC5	TL082CP or equivalent
Q1	BC558
Q2	BC548
D1,2,3,4,6,	1N4148 (1N914)
7	
D5	Red LED

Using The Mixer

A few guidelines on use are given to demonstrate the versatility achieved by incorporating voltage control.

1. A simplistic view would be to consider the mixer as four voltage controlled amplifiers with a common output. One technique often applied to a VCA is amplitude modulation (tremolo). Usually, however, the VCA is one of the last stages and, if a number of signals have been combined in a conventional mixer prior to the VCA, then the total signal has to be amplitude modulated. Using the voltage controlled mixer only parts of the signal need be modulated and the resultant effect can be more pleasing.

2. One of the early works with a synthesiser was Morton Subotnick's "The Wild Bull," recorded in 1968. In this work extensive use is made of a sawtooth waveform (high harmonic content) which is separated into four octave bands to provide the signals for a four-channel voltage controlled mixer. Each channel was controlled by an ASDR envelope shaper gated from a sequencer. This arrangement allows the separate timbral characteristics of any sound to

be independently treated. Furthermore, by varying the speed of the sequencer the characteristics of the sound can be made to vary widely, for example, as the rate is increased the four bands begin to sound simultaneously. Only a simple digital sequencer is required for the above and the voltage controlled mixer becomes the heart of a useful music making instrument within the body of the synthesiser. This type of approach is particularly useful for those without access to multi-track recording equipment.

3. Adding and subtracting waveforms from two or more oscillators set to different pitches has not been widely used with synthesisers due to the tendency for the voltage controlled oscillators to track at different rates. The latter makes it impossible to maintain the same tone quality over several octaves. With the incorporation of synchronising facilities in modern VCOs this problem is overcome and additive and subtractive synthesis is a worthwhile field of exploration. Of course, subtractive synthesis is already widely employed by filtering techniques but more subtle tones can be obtained by mixing techniques.

BUYLINES

The voltage controlled mixer PCB and all the components shown on the circuit diagram are available for £24.62 including postage and VAT from Digi-sound Limited, 13 The Brooklands, Wrea Green, Preston, Lancashire PR4 2NQ.

4. A major application of the voltage controlled mixer is the ability to alter loudness and harmonic content with pitch. One of the criticisms of 'live' electronic music is the precise nature of its sounds and the initial excitement of a new sound turns to boredom as the brain adversely reacts to its repetitive nature. By applying the keyboard control voltage (or its inverse, or a proportion of either) to one or more of the mixer control inputs then the amplitude or harmonic content (often both) will vary with pitch and so provide a useful means of dynamically altering the timbral characteristics of the sound.

5. Applying a low frequency waveform to the pan control input can produce some interesting spatial and rotational effects, but for greatest impact this technique should be used sparingly.

6. Mention has been made of waveforms, envelope shapers and keyboard voltage for control of the mixer and in common with other voltage controlled modules any variable voltage source may be used. A foot pedal control adapted to provide a 10V output is particularly useful in conjunction with a mixer.

Processor Module

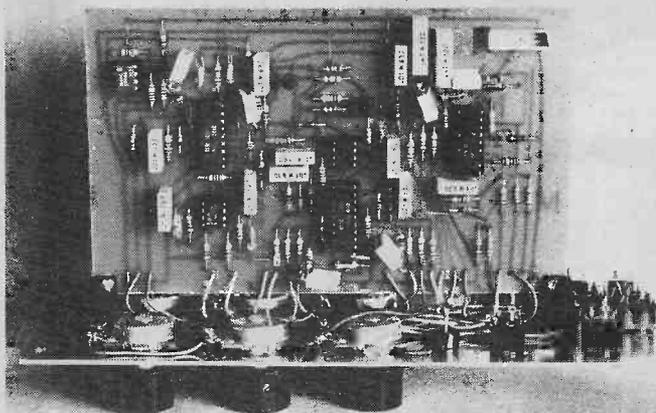
As discussed in Part 1, the low output impedance and high input impedance of the modules allows one output to drive several inputs without overloading or introducing appreciable errors. Thus attenuators should be on inputs rather than outputs so that their level can be independently adjusted. Likewise the modules should ideally have a number of commoned output sockets to facilitate distribution of the signal to other modules.

Additional attenuating potentiometers and jack sockets add to cost and also take up valuable panel space and so for situations where the controls are used infrequently a distribution panel was discussed last month.

A suggested configuration for the module (a 'processor') is two distribution blocks which allow one input to be distributed to three outputs with or without attenuation.

Secondly, there are a further two

The mixer PCB attached to its front panel.



blocks which may be used as above, or the signal may be inverted via an op amp. In this instance inverting means subtracting the input voltage from 10 volts and not turning a positive input voltage into a negative one. This is achieved by adding components R3 and TP1 to a conventional unity gain inverter.

Another addition is the so-called 'lag processor' which is simply a low pass filter and akin to the usual portamento circuit. This is useful for slowing down fast control signals and also for delaying control signals.

Construction

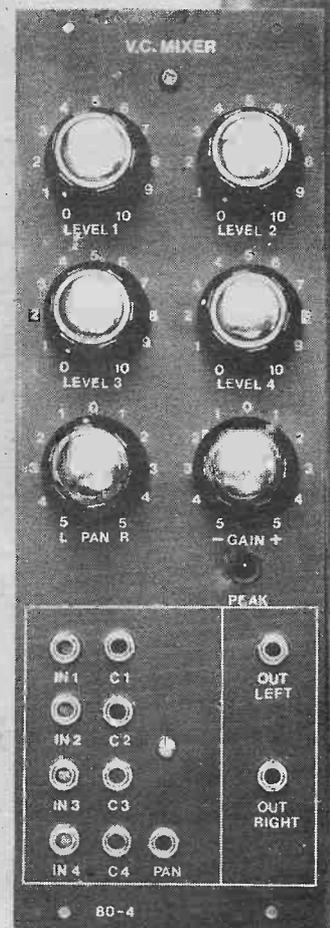
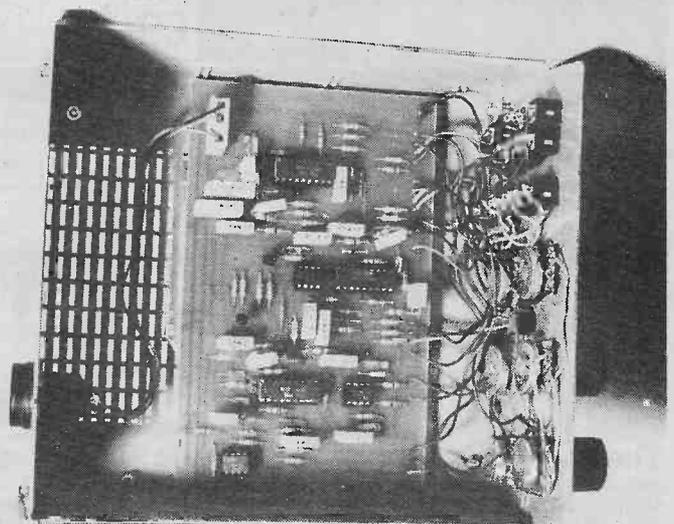
Because of the simple construction of the circuits no printed circuit board is shown but a few construction hints may be of value. For the inverter a BIFET type op amp (LF 351, TL 081, etc) should be used to prevent distortion of high frequency or fast signals. The main precaution is to keep the signal input resistor close to the inverting pin. A small capacitor (10 or 22p) across the op amp also reduces the likelihood of instability. Furthermore, if you decide to install more than two inverters on a board then 100nF decoupling capacitors mounted close to the power supply pins of the IC will prevent the tendency of these devices to talk to one another. The circuit should be wired up so that the inverter stage is disabled when input jack socket 'B' is in use.

A LM1458 type op amp should be adequate for most applications of the lag processor. $RV1 = 2M2$ and $C1 = 220nF$ will provide sufficient delay and since short delays are the most useful a polyester capacitor may be employed.

ETI

Panel layout of the mixer.

The mixer PCB installed in its case.

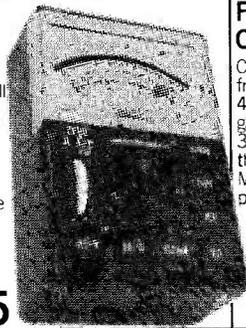


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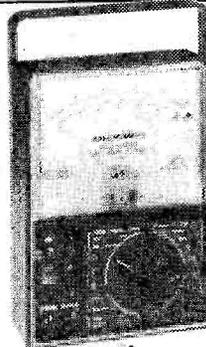


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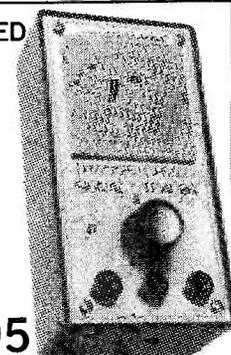
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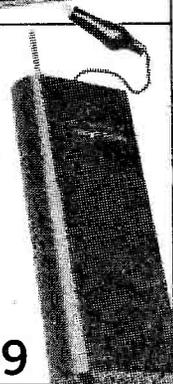
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REG. PRICE **£2.79**



AC/DC CIRCUIT TESTER

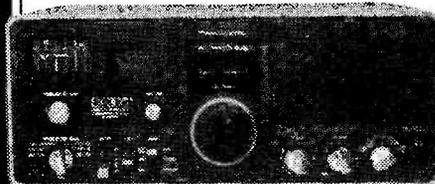
Accuracy in 1-300 volts ranges. Safe in live/dead circuits. Needs two "AA" batteries. 22-4034.

REG. PRICE **£1.99**

REALISTIC DX 300

General coverage receiver. Quartz-synthesised tuning, digital frequency readout. 3-step RF Attenuator. 6-range preselector with LED indicators. SSb and CW demodulation. Speaker. Code oscillator. Batteries (not included) or 12V DC. 20-204.

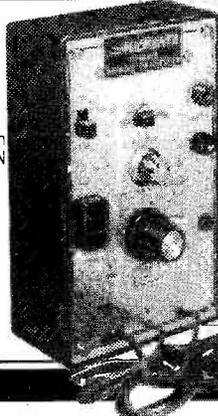
REG. PRICE **£229.95**



DYNAMIC TRANSISTOR CHECKER

Shows current gain and electrode open and short circuit. Tests low, medium or high power PNP or NPN types. Go/no-Go test from 5-50mA on power types. 22-024.

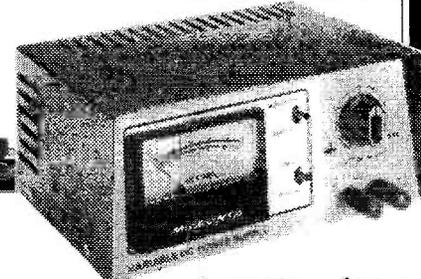
REG. PRICE **£9.95**



VARIABLE POWER SUPPLY

Power project boards. IC's, other low-voltage DC equipment. Load regulation: less than 450mV at 1 amp at 24V DC. Ripple: less than 25mV. Maximum output current: 1.25 amps. Switchable colour-coded meter reads 0-25V. DC and 0-1.25 amps. Three-way binding posts take wires, banana plugs or dual banana plugs with 0.75" centres. For 220/240V AC. 22-9123

REG. PRICE **£35.95**

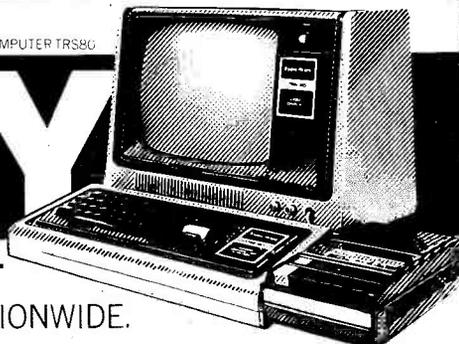


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TECH TIPS

Example game of "Grand-Prix".

Winner is the first player to travel 1000 km. Pre-load store 3 with 0.25.

Grand Prix

M. R. Harrison

Grand Prix can be played on the following calculators — Casio fx-201p and Casio Profx-1.

The game is played by the calculator explaining the conditions of the road by means of a skill factor. The conditions are as below:

- 1.5+ Excellent conditions and on a straight.
- 1.4+ Very good.
- 1.3+ Good.
- 1.2+ Reasonable road surface but bends in road. Take care.
- 1.1+ Greasy road surface due to water.
- 1.0+ Oil !!!! DANGER.

The player whose turn it is, decides how fast he dare travel without crashing. The faster the speed the further the distance the player's car will travel. The winner is the first person to travel a chosen distance.

The game is played as follows:

1. Press start.
2. Skill factor is shown for player 1.
3. Player 1 enters his required speed.
4. Total distance player 1 has travelled will only be displayed if player 1 did not crash.
5. Skill factor is shown for player 2.
6. Player 2 enters his required speed.
7. Total distance player 2 has travelled will only be displayed if player 2 did not crash.
8. Go to stage 2.

The first part of the program is to obtain a random number between 0 and 1. This is done by multiplying another number between 0 and 1 again by -3.94. To the result, 1 is continually added until the result becomes positive. This result is used in obtaining the next random number in the same way and also in the next stage of the program, which is to obtain a skill factor. The skill factor is found by dividing the random number previously calculated by 2 and then adding on 1.021.

Player 1			Player 2		
Skill Factor	Speed (kmph)	Dist Travelled (km)	Skill Factor	Speed (kmph)	Dist Travelled (km)
1.03	10.00	0.15	1.49	100.00	80.81
1.17	20.00	5.92	1.44	90.00	crash!!
1.35	30.00	24.46	1.21	20.00	88.14
1.28	23.00	35.91	1.49	110.00	177.44
1.15	20.00	41.21	1.49	120.00	274.60
1.16	20.00	46.78	1.46	120.00	crash!!
1.27	30.00	61.15	1.03	15.00	275.08
1.45	110.00	crash!!	1.30	35.00	293.68
1.41	100.00	crash!!	1.46	100.00	crash!!
1.30	35.00	crash!!	1.45	80.00	354.48
1.32	35.00	80.86	1.34	37.50	376.95
1.25	25.00	92.16	1.09	20.00	crash!!
1.22	23.00	101.14	1.23	25.00	387.13
1.14	20.00	107.94	1.34	44.00	crash!!
1.27	25.00	119.92	1.04	10.00	387.43
1.46	90.00	189.52	1.28	33.00	403.72
1.50	150.00	crash!!	1.12	15.00	406.67
1.13	17.50	193.55	1.08	20.00	crash!!
1.26	25.00	204.90	1.07	12.00	407.96
1.30	35.00	223.93	1.38	50.00	441.47
1.07	10.00	225.01	1.31	45.00	crash!!
1.38	52.00	259.54	1.09	15.00	443.53
1.25	30.00	crash!!	1.13	17.50	447.14
1.11	15.00	262.25	1.16	20.00	452.72
1.46	90.00	crash!!	1.27	30.00	

ETC

By keeping a record of one's attempts, the player can soon realise how fast he may go with certain skill factors.

For a new game, stores 7 & 8 have to be cleared.

GRAND-PRIX

Steps:—

ST*0: GOTO9: I=9: GOTO8:	13
GOTO9: I=K2: GOTO8: GOTO0:	27
SUB*9: 3=3x6:	36
ST*4: 3=3+9:	45
IF3=K0:4:5:5:	57
SUB*8: IM=3÷K2+0:	69
ANS IM:	72
2=9 10 ^x x IM TAN:	80
I=I3K3:	87
ENT IM:	90
1=IM: IF IM=2:1:1:3:	105
ST*1: I=I+K3:	115
IM=3SINx1+IM:	124
ANS IM:	127

Pre-load memory stores as below:—

Store 9	1
Store 6	-3.94
Store 0	1.021
Store 3	any number between 0 and 1.

Rad-Deg-Grad switch *must* be set on "Radians".
For a new game, stores 7 & 8 have to be cleared.

All these only from HENRY'S



IN STOCK
WITH FREE POWER SUPPLY.

NASCOM-2 + FREE 16K RAM

Here's an offer you can't refuse:

Because of the lack of availability of MK 4118 RAMs, Nascom Microcomputers is supplying its Nascom 2 without the 8 spare 4118s but with a FREE 16K dynamic RAM board.

When the 4118s become available, Nascom 2 purchasers can have them at the special price of £80 + VAT for the 8K. So, for £295 plus VAT this is what you get:

NASCOM-2 with 32K RAM
£345 VAT
P&P 1.50

Buy British It's Best!!

MEMORY

- 16K RAM board (expandable to 32K).
- 8K Microsoft BASIC.
- 2K NAS-SYS 1 monitor.
- 1K Video RAM.
- 1K Workspace/Scratchpad RAM.
- Main board sockets for the 8x4118s or 2708 EPROMS.

No more slaving over a hot soldering iron - the Nascom 1 is now supplied BUILT!
Britain's biggest small system is available fully constructed for you to slot into your own housing for the ridiculously low price of £175 plus VAT (kit price still only £165 plus VAT). **EX-STOCK**

nascom-1
12" x 8" PCB carrying 5LSI MOS MOS memory packages. There is on-board unmodulated operating user RAM. Board Z80 which executing 158 instructions including all 8080 code.

With NAS-SYS **SCOOP KIT NOW ONLY FULLY GUARANTEED** Less P10 **£125**

MEMORIES

- MK4116 16K **£7.00**
- DYNAMIC RAM**
- 8 for **£55.00**
- MK 4027 4K **£3.80**
- 8 for **£27**
- 2708 **£8.50**
- 2102 **£1.20**
- 2716 **£32.00**
- Full List P.O.R.

MICROPROCESSOR

- Z80A which will run at 4MHz but is selectable between 1/2/4 MHz.

HARDWARE

- Industrial standard 12" x 8" PCB, through hole plated, masked and screen printed. All bus lines are fully buffered on-board.

INTERFACES

- Licon 57 key solid state keyboard.
- Monitor/domestic TV interface.
- Kansas City cassette interface (300/1200 baud) or RS232/20mA teletype interface.

The Nascom 2 kit is supplied complete with construction article and extensive software manual for the monitor and BASIC.

EXPANSION NASCOM-1

- *Expansion buffer board **£32.50**
- MEMORY KITS (include all hardware)
- 8K **£85**
- 16K **£140**
- 32K **£200**
- *I/O board with decoders and all hardware except ICS will accept up to 3 PIOs, 1 CTV and 1 UART **£35**
- NEW T 4 operating system in (2) 2708 EPROMS UPWARDS **£25.00**
- COMPATIBLE FROM T2 and B-BUG **£25.00**
- NAS SYS 1. MONITOR **£25.00**

Programming Manual £4.50

- *Power supply for up to 32K expansion Mk II **£24.50**
- *8A power supply for larger than 32K expansion **£60.00**
- *Expansion card frame **£29.50**
- *EPROM programmer **£13.95**
- SMART-1 **£74.95**
- Tiny Basic **£25.00**
- Super Tiny Basic (with editor and machine utility routines) **£35.00**
- Zeap assembler editor **£32.00**
- 8K BASIC ROM **£40.00**
- Naspen Text Handler **£30.00**
- Disassembler **£9.95**

NASCOM IMP
£325 VAT P&P £2.50

NASCOM-1 BUILT
£140 VAT P&P 1.50

NEW

The Nascom IMP (Impact Matrix Printer) features are:

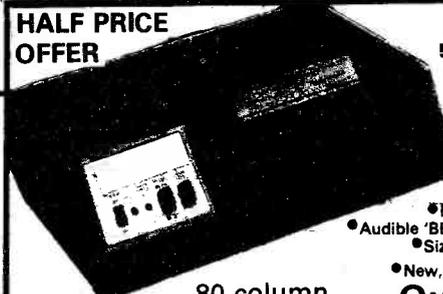
- 60 lines per minute.
- 80 characters per line.
- Bi-directional printing.
- 10 line print buffer.
- 96 character ASCII set (includes upper/lower case).
- Automatic CR/LF.
- Accepts 8 1/2" paper.

- Optional tractor feed.
- Baud rate from 110 to 9600
- External signal for optional synchronisation of baud

NASCOM IMP PLAIN PAPER PRINTER

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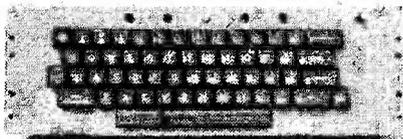
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- 150 lines per minute.
- Centronics parallel data interface for Nascom, Tandy, etc.
- 240volt mains input.
- ASCII character set
- Paper feed, and on/off select switches
- Audible 'BELL' signal. Weight 10lbs
- Size: 13" x 10 1/2" x 4 1/2" LIST PRICE £400

Our Price £195.00

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Spare paper £9 for 3 Rolls + VAT

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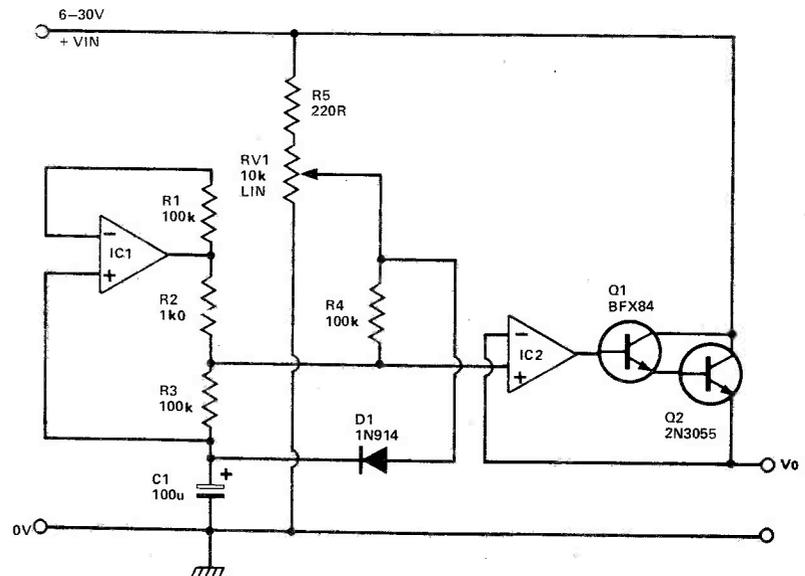


Gyrator Smoother

J. P. Macaulay

Although this circuit was developed to supply a well smoothed supply to a stereo class A amplifier it is well suited to many other applications. The circuit is based on the dual op amp LM358. A1 is used as an gyrator, C1 being amplified by the ratio of R3 to R4, ie 1000X. The simulated capacitor thus formed between the output of A1 and ground is 100n.

R5 and RV1 set the output voltage whilst R4 in series with the 'capacitor' forms a smoothing network with a time constant of 10,000 seconds! In order to avoid protracted turn on times the diode, D1, rapidly charges C1 to within 0V6 of the nominal output voltage within two seconds. Ripple is not measurable with the prototype when supplying 3A into a load. A2 and the Darlington



output pair Q1 and Q2 form a voltage follower with an output current

capacity in excess of 10A, if Q2 is mounted on a hefty heatsink.

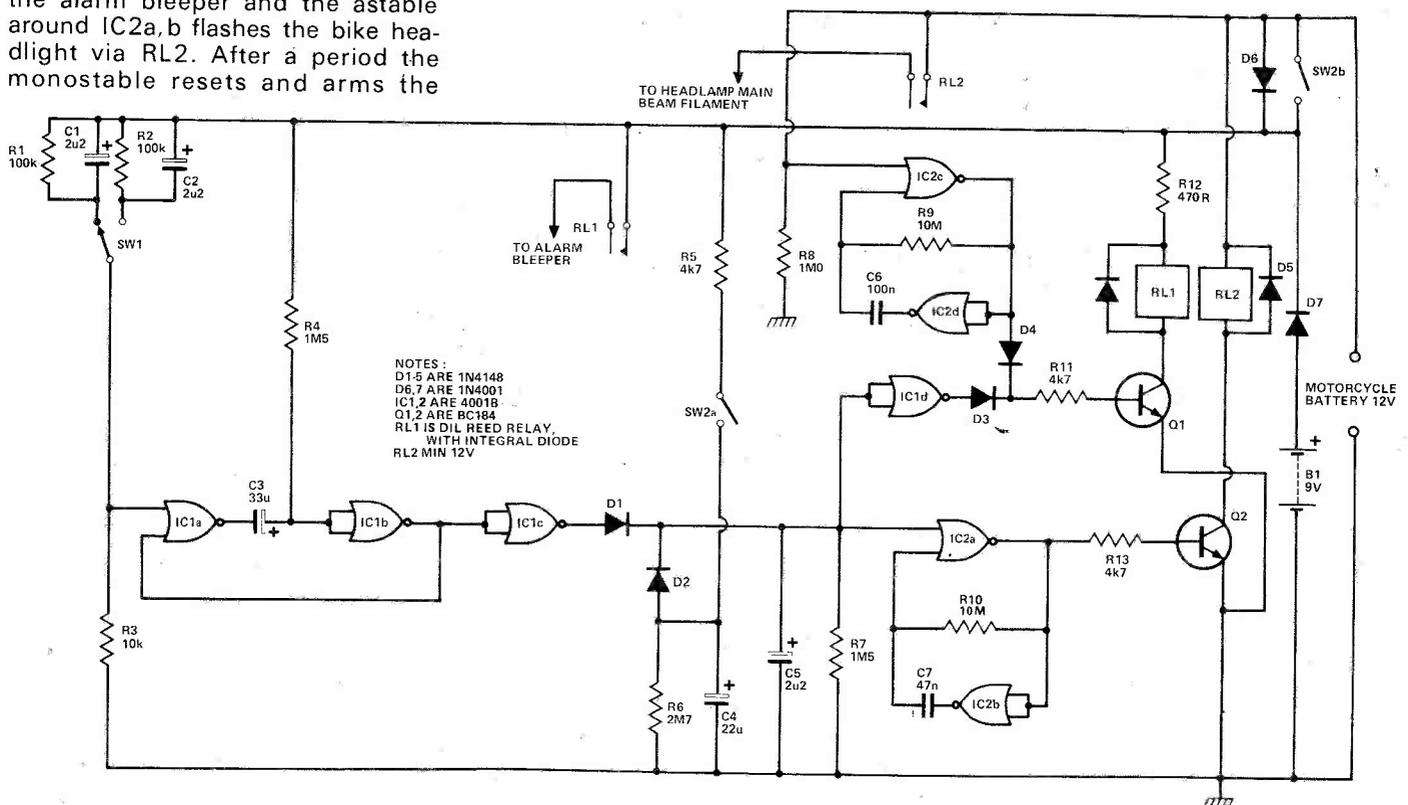
Motorcycle Anti-Theft Alarm

C. R. Goble

IC1a,b form a monostable triggered by mercury switch S1. IC1c then provides a low output, allowing the charge on C5 to decay over a couple of seconds through R7. After this short delay IC1d allows RL1 to sound the alarm bleeper and the astable around IC2a,b flashes the bike headlight via RL2. After a period the monostable resets and arms the

circuit once more. If the battery leads are cut then another astable around IC2c,d will switch the bleeper on and off continuously, via RL1, until disarmed by lockswitch S2. C4 discharging prevents the alarm from sounding for about 20 seconds after initial arming. RL2 contacts should be suitably rated and, ideally, RL1 should take only a low current to help con-

serve standby power. Current drain when untriggered amounts to that through S1.6V operation is possible with 6V relays although values may need altering to preserve timing. Mercury switch S1 can be formed either from one double switch or from two single switches, mounted across the 'bike and wired to give a changeover action.



8K ON BOARD MEMORY!

5K RAM, 3K ROM or 4K RAM, 4K ROM (link selectable). Kit supplied with 3K RAM, 3K ROM. System expandable for up to 32K memory.

2 KEYBOARDS!

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MEMORY MAPPED

high resolution VDU circuitry using discrete TTL for extra flexibility. Has its own 2K memory to give 32 lines for 64 characters.

KANSAS CITY

low error rate tape interface.

2 MICROPROCESSORS

Z80 the powerful CPU with 158 instruction, including all 78 of the 8080, controls the MM57109 number cruncher. Functions include +, -, *, /, squares, roots, logs, exponentials, trig functions, inverses etc. Range 10^{-99} to 9×19^{99} to 8 figures plus 2 exponent digits.

EFFICIENT OPERATION

Why waste valuable memory on sub routines for numeric processing? The number cruncher handles everything internally!

RESIDENT BASIC

with extended mathematical capability. Only 2K memory used but more powerful than most 8K Basics!

1K MONITOR

resident in EPROM.

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Even keyboards and power supply circuitry on the superb quality double sided plated through-hole PCB.

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Cabinet size 19.0" X 15.7" X 3.3". Television by courtesy of Rumblelows Ltd., price £5B 62

Kit also available as separate packs: e.g. PCB, Keyboards, Cabinet, etc.

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PRICE!**

POWERTRAN

PSI Comp 80. Z80 Based powerful scientific computer Design as published in Wireless World, April-September, 1979.

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

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

PSI COMP 80 Memory Expansion System

Expansion up to 32K all inside the computer's own cabinet!

By carefully thought out engineering a mother board with buffers and its own power supply (powered by the computer's transformer) enables up to 3 8K RAM or 8K ROM boards to be fitted neatly inside the computer cabinet. Connections to the mother board from the main board expansion plug socket is made via a ribbon cable.

Mother board:

Fibre glass double sided plated through hole P.C.B. 8.7" x 3.0" set of all components including all brackets, fixing parts and ribbon cable with socket to connect to expansion plug **£39.90**

8K Static RAM board

Fibre glass double sided plated through hole P.C.B. 5.6" x 4.8" **£12.50**
Set of components including IC sockets, plug and socket but excluding RAMs **£11.20**
2114L RAM (16 required) **£5.00**
Complete set of board, components, 16 RAMS **£89.50**

8K ROM board

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Set of components including IC sockets, plug and socket but excluding ROMs **£10.70**
2708 ROM (8 required) **£8.00**
Complete set of board, components, 8 ROMs **£78.50**

Floppy Disk, PROM programmer and printer interface coming shortly!

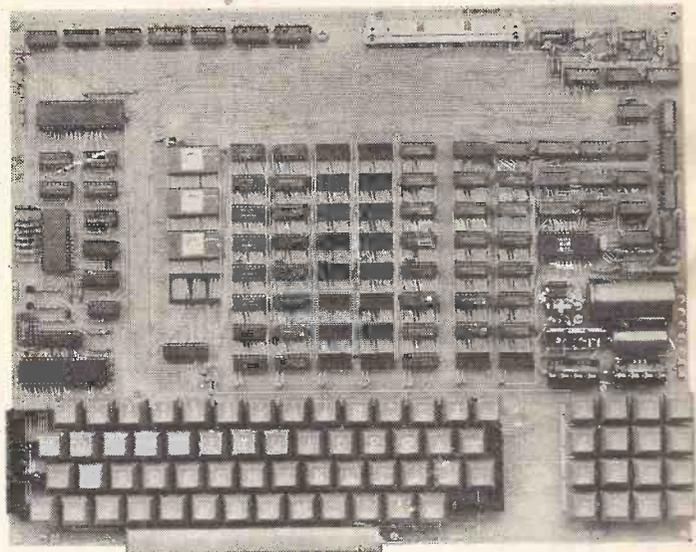
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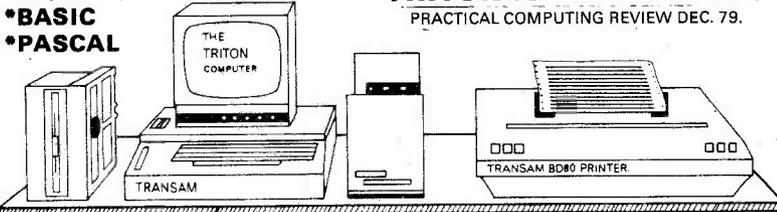
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- L8.1 4k ed/mon 20k res pascal £611
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28DIL 0.74	24DIL 0.30	24DIL 2.80	
40DIL 0.95	28DIL 0.36		
	48DIL 0.50		

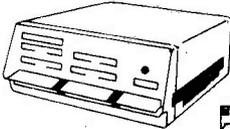
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SN74LS22N	26	SN74LS086N	1.75	SN74LS165N	1.70	SN74LS258N	95	SN74LS386N	57	8821P	4.50	2107	7.80
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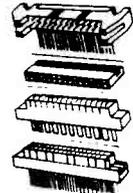
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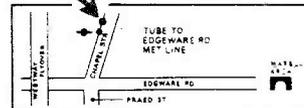
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