

electronics today

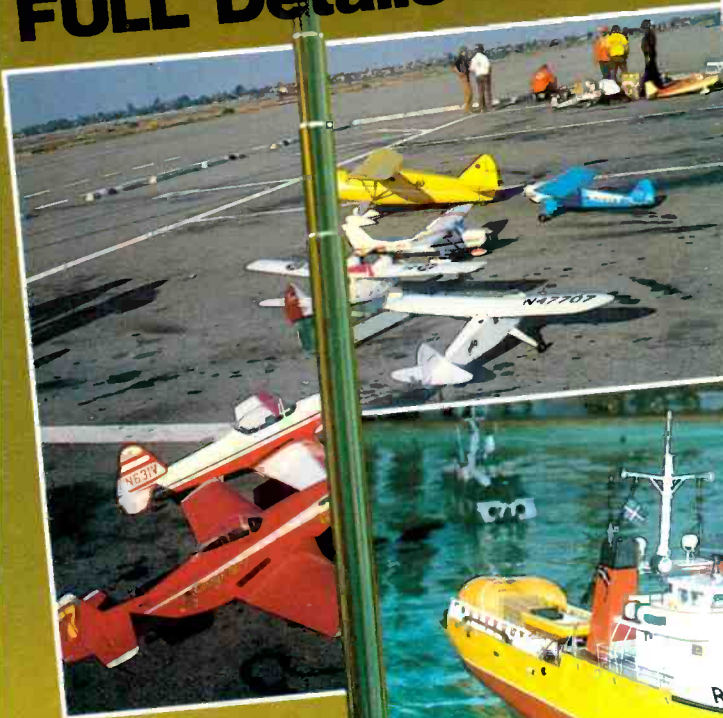
ISSN. 0142-7229

INTERNATIONAL

OCTOBER 1980 60p

FM RADIO CONTROL

FULL Details Inside



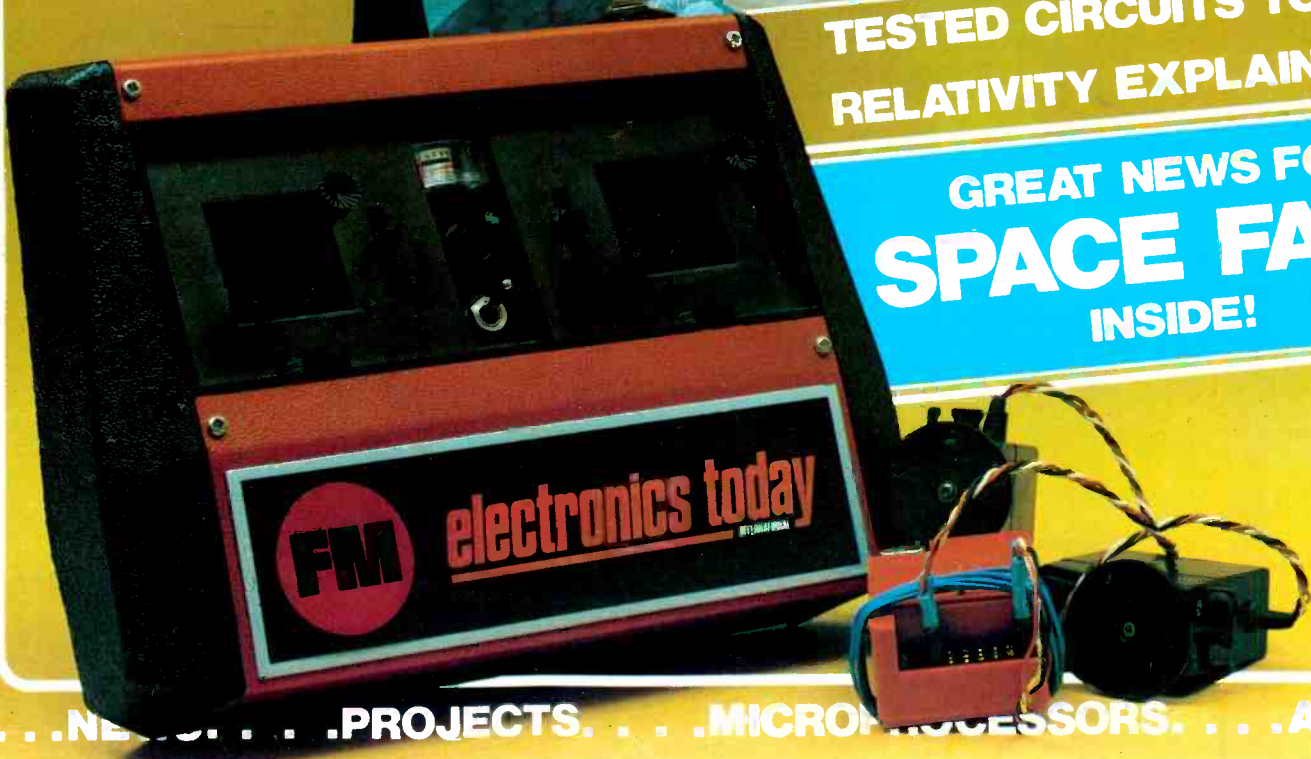
SPECIAL
COMPUTER
INTERFACE

FLASH TRIGGER
SUSTAIN PEDAL

SIX PAGES
OF TRIED AND

TESTED CIRCUITS TO BUILD
RELATIVITY EXPLAINED!

GREAT NEWS FOR
SPACE FANS
INSIDE!



...NEW... PROJECTS... MICROPROCESSORS... AUDIO...

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!

56 Key alphanumeric keyboard for entering high level language plus 16 key Hex pad for easy entry of machine code

GRAPHICS!

64 character graphics option — includes transistor symbols! Only £18.20 extra!

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 +, -, $\sqrt{\quad}$, 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

SINGLE BOARD DESIGN

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

PSI comp 80
Z80 Based powerful scientific computer design as published in **WIRELESS WORLD**

COMPLETE KIT
NOW ONLY
£225 + VAT

Cabinet size 19.0" x 15.7" x 3.3"

Television not included in price

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

KIT ALSO AVAILABLE AS SEPARATE PACKS

For those customers who wish to spread their purchase or build a personalised system the kit is available as separate packs eg. PCB (16" x 12.5") £43.20. Pair of keyboards £34.80. Firmware in EPROMs £30.00. Toroidal transformer and power supply components £17.60. Cabinet (very rugged, made from steel, really beautiful) (included) £26.50. P.S. Will greatly enhance any other single board computer including OHIO SUPERBOARD for which it can be readily modified. Other packs listed in our FREE CATALOGUE.

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 socket is made via a ribbon cable.

Mother board:

Fibre glass double sided plated through hole PCB 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 PCB 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

Fibre glass double sided plated through hole PCB 5.6" x 4.8" £12.40
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

BEING FEATURED
IN THIS ISSUE

★ ETI VOCODER ★



Panel size 19.0" x 5.25" Depth 12.2"

14 CHANNELS!
NOISE GENERATOR!
LED PPM METERS!
SLEW RATE CONTROL!

2 OSCILLATORS!
VOICED/UNVOICED
DETECTOR!

COMPLETE KIT ONLY £195 + VAT

Kit includes **FREE** foot control and test oscillator!

Like all our kits the ETI VOCODER really is complete — fully finished metal work, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc. — even a 13A plug!

POWERTRAN

OUR CATALOGUE IS FREE! WRITE OR PHONE NOW!
POWERTRAN ELECTRONICS

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ANDOVER
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PRICE STABILITY: Order with confidence. Irrespective of any price changes we will honour all prices in this advertisement until November 30, 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 £1 handling and documentation.

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

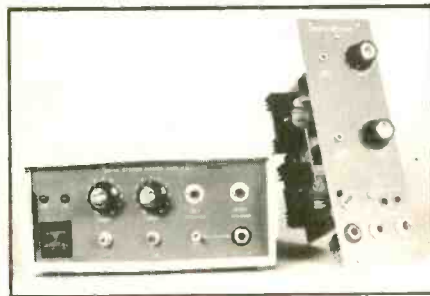
SECURICOR DELIVERY: For this optional service (U.K. mainland only) add £2.50 (VAT inclusive) per kit.

SALES COUNTER: If you prefer to collect kit from the factory, call at Sales Counter. Open 9 a.m. - 12 noon, 1-4.30 p.m. Monday-Thursday.

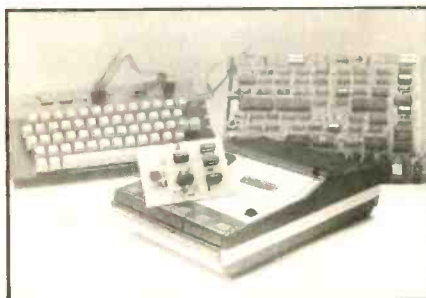
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Sounds for Project 80. p.79



From micro to tape in a flash. p.63



For photo special effects. p.30

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Britain's first com computer kit.

The Sinclair ZX80.

£79.95

Price breakdown
ZX80 and manual: £69.52
VAT: £10.43
Post and packing FREE

Please note: many kit makers quote VAT-exclusive prices.

You've seen the reviews... you've heard the excitement... now make the kit!

This is the ZX80. 'Personal Computer World' gave it 5 stars for 'excellent value.' Benchmark tests say it's faster than all previous personal computers. And the response from kit enthusiasts has been tremendous.

To help you appreciate its value, the price is shown above with and without VAT. This is so you can compare the ZX80 with competitive kits that don't appear with inclusive prices.

'Excellent value' indeed!

For just £79.95 (including VAT and p&p) 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 a cassette recorder and television (black and white or colour); *everything!*

Yet the ZX80 really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

The ZX80 is programmed in BASIC, the world's most popular computer language for beginners and experts alike.

The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done; connect it to your TV... 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.
- Complete components set, including all ICs—all manufactured by selected world-leading suppliers.
- New rugged Sinclair keyboard, touch-sensitive, wipe-clean.
- Ready-moulded case.
- Leads and plugs for connection to domestic TV and cassette recorder. (Programs can be SAVEd and LOAded on to a portable cassette recorder.)
- 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 boards allowing up to 16K bytes RAM. (Extra RAM chips also available—see coupon).

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

The 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:

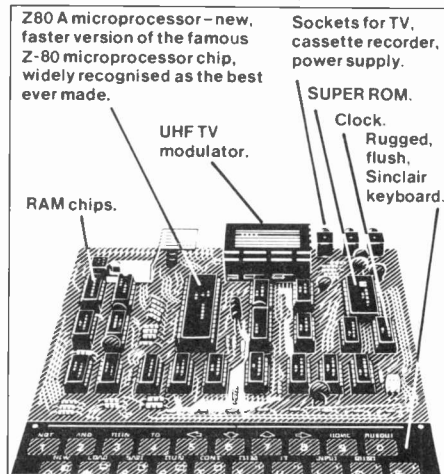
- Unique 'one-touch' key word entry: the ZX80 eliminates a great deal of tiresome typing. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry.
- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of 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

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

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

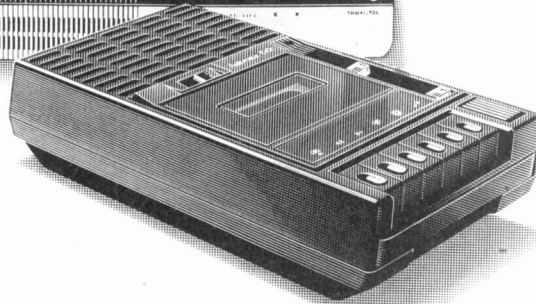
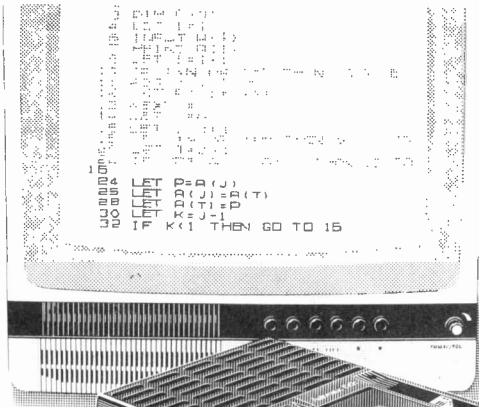
The display shows 32 characters by 24 lines. And Benchmark tests show that the ZX80 is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price



ETI OCTOBER 1980

plete



ZX80 software – now available!

See advertisements in Personal Computer World, Electronics Today International, and other journals.

New dedicated software – developed independently of Science of Cambridge – reflects the enormous interest in the ZX80. More software available soon – from leading consultancies and software houses.

The Sinclair teach-yourself BASIC manual.

If the specifications of the Sinclair ZX80 mean little to you – don't worry. They're all explained in the specially-written 128-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.) A hardware manual is also included with every kit.

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 and complete with mains adaptor, for only £99.95.

Demand for the ZX80 is very high – use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. We'll acknowledge each order by return, and tell you exactly when your ZX80 will be delivered. If you choose not to wait, you can cancel your order immediately, and your money will be refunded at once. Again, of course, you may return your ZX80 as received within 14 days for a full refund. We want you to be satisfied beyond all doubt – and we have no doubt that you will be.

sinclair

ZX80

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Tel: 0223 311488

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ORDER FORM

To: Science of Cambridge Ltd, 6 Kings Parade, Cambridge, Cambs., CB2 1SN.
Remember: all prices shown include VAT, postage and packing. No hidden extras.
Please send me:

| Quantity | Item | Item price £ | Total £ |
|----------|---|-----------------|------------|
| | Sinclair ZX80 Personal Computer kit(s) Price includes ZX80 BASIC manual, excludes mains adaptor | £79.95 | |
| | Ready-assembled Sinclair ZX80 Personal Computer(s) Price includes ZX80 BASIC manual and mains adaptor | £99.95 | |
| | Mains Adaptor(s) (600 mA at 9 VDC nominal unregulated) | 8.95 | |
| | Memory Expansion Board(s) (each one takes up to 3K bytes) | 12.00 | |
| | RAM Memory chips – standard 1K bytes capacity | 16.00 | |
| | Sinclair ZX80 Manual(s) (manual free with every ZX80 kit or ready-made computer) | 5.00 | |

NB Your Sinclair ZX80 may qualify as a business expense

TOTAL £

I enclose a cheque/postal order payable to Science of Cambridge Ltd for £ _____

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Name Mr/Mrs/Miss _____

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840p AV5-1224A 80p AV5-1315 240p AV5-1317A 450p AV5-4007D 525p CA3019 27p CA3046 70p CA3048 225p CA3080E 72p CA3086 48p CA3089E 225p CA3090AQ 375p CA3130E .90p CA3140E 50p CA3160E 100p CA3181E 140p CA3182E 450p CA3189E 300p CA3200 160p DAC1408-B 200p FX709 750p ICL7106 850p ICL8038 300p ICM7555 80p LF356P 95p LM10C 425p LM301A 30p LM311 70p LM318 200p LM319 225p LM324 45p LM339 75p LM348 95p LM377 175p LM380 180p LM3801 190p LM386 95p LM393 100p LM709 36p LM710 50p LM725 350p LM741 18p LM747 70p LM748 35p LM2917 250p LM3390 70p LM3909 70p LM3911 130p LM3914 225p LM3915 225p LM4136 120p LM13600 125p MC1310P 90p MC1458 45p MC1495L 38p MC1496 100p | | | | MC3340P 120p MK50398 750p ML920 775p MM571160 620p NE531 150p NE555 22p NE566 70p NE562B 425p NE564 420p NE565 130p NE566 155p NE567 142p NE567A 250p RC4154 400p S5668 270p SAB3209 POA SAD1024A 1250p SFF96364 1100p SN76003N 250p SN76013N 140p SN76013ND 120p SN76023N 140p SN76023ND 120p SN76477 175p SP8515 750p TAA621 225p TBA641B11 200p TBA651 200p TBA800 90p TBA810 100p TBA920 90p TBA950 300p TCA210 140p TCA220 350p TCA940 175p TD4004 300p TD41008 320p TD41010 225p TD41022 570p TD41024 120p TD41034B 250p TD41170 300p TD42020V 320p TD42020 320p TL071/81 45p TL072/82 75p TL074 130p TL084 110p TL170 60p UAA170 175p UDN1118 320p UDN6184 320p XR22003 100p XR22004 300p XR2207 400p ZN414 90p ZN419C 225p ZN424E 135p ZN425E 400p ZN427E 750p | | | | TRANSISTORS AC126 25p AC127/20 25p AC127 25p AC187/8 25p BF180 25p BF181 25p BFX29 40p BFX30 34p AD149 70p AD161/2 45p AU107 200p BC107/8 11p BC109 11p BC117 20p BC127/8 9p BC149 10p BC157/8 10p BC159 11p BC169C 12p BC172 12p BC173/8 17p BC179 18p BC182/3 10p BC184 11p BC187 30p BC1212/3 11p BC214 12p BC237 15p BC327 16p BC337 16p BC436 16p BC477/8 36p BCV127 270p BC547B 16p BC548C 9p BC549 18p BC557B 16p BC559C 18p BCV70 70p BCV72 22p BD139 56p BD140 60p BD189 60p BD232 75p BD235 85p BD241 70p BD242 70p BY56 200p BY57 200p BF258 32p BF259 36p BF39 25p | | | | BFR40 25p BFR41 25p BFR79 25p BFR80 25p BFR81 25p BFX29 40p BFX30 34p BFX84/5 40p BFX86/7 30p BFX88 30p BFX90 30p BFY50 30p BFY51/2 30p BFY56 33p BFY90 30p BRX39 20p BSX19/20 20p BU104 225p BU105 190p BU108 250p BU109 225p BU205 200p BU208 200p BU406 145p E300 50p E308 50p E310 50p MJ2501 225p MJ2955 90p MJ3001 225p MJE300 50p MJE3055 70p MPE102 45p MPE103/4 40p MPE105/6 40p MPS4534 50p MPSA06 30p MPSA12 50p MPSA13 50p MPSA20 50p MPSA21 50p MPSA43 50p MPSA56 32p MPSA70 50p MPSU07 63p MPSU10 63p MPSU11 90p MPSU65 78p OC28 130p OC35 130p TIP29A 40p TIP29C 50p TIP30A 48p TIP30C 40p | | | | TIP31A 58p TIP31B 62p TIP32A 62p TIP32C 82p TIP33A 90p TIP33C 114p TIP34A 115p TIP34C 180p TIP35A 225p TIP35C 290p TIP36A 270p TIP36C 340p TIP41A 65p TIP41C 78p TIP42A 70p TIP42C 82p TIP54 160p TIP120 120p TIP122 130p TIP142 130p TIP147 130p TIP2955 78p TIP4055 70p TIS43 34p TIS93 30p ZTX108 12p ZTX300 13p ZTX500 15p ZTX502 18p ZTX504 30p ZN457A 250p ZN696 35p ZN697 25p ZN698 45p ZN706A 25p ZN708 25p ZN718 40p ZN7930 18p ZN1131/2/3/6P 25p ZN11613 25p ZN1171 25p ZN1202 70p ZN1210 35p ZN2219A 30p ZN2222A 30p ZN2369A 25p ZN2484 30p ZN2646 45p ZN2904/5 30p ZN2906A 30p ZN1141 110p ZN2926 9p ZN3053 30p ZN3054 65p ZN3060 48p ZN3442 140p | | | | 2N3553 240p 2N3556 30p 2N3584 250p 2N3643/4 48p 2N3702/3 12p 2N3704/5 12p 2N3707/7F 14p 2N3709/9F 12p 2N3773 30p 2N3819 250p 2N3820 50p 2N3823 70p 2N3866 90p 2N3902 700p 2N3903/4 18p 2N3905/6 20p 2N3919/1 30p 2N4058/9 12p 2N4060 12p 2N4061/2 18p 2N4123/4 27p 2N4125/6 27p 2N4401/3 27p 2N4427 90p 2N4871 60p 2N5087 27p 2N5089 27p 2N5172 27p 2N5179 90p 2N5191 90p 2N5194 90p 2N5245 40p 2N5296 55p 2N5401 55p 2N5457/8 40p 2N5459 40p 2N5460 60p 2N5485 44p 2N5875 250p 2N6027 48p 2N6052 300p 2N6059 325p 2N6197 65p 2N6247 150p 2N6254 130p 2N6290 65p 2N6292 65p 2N6293 120p 2N6296 120p 2N6297 120p 2N6298 120p 2N6299 120p 2N6300 120p 2N6301 120p 2N6302 120p 2N6303 120p 2N6304 120p 2N6305 120p 2N6306 120p 2N6307 120p 2N6308 120p 2N6309 120p 2N6310 120p 2N6311 120p 2N6312 120p 2N6313 120p 2N6314 120p 2N6315 120p 2N6316 120p 2N6317 120p 2N6318 120p 2N6319 120p 2N6320 120p 2N6321 120p 2N6322 120p 2N6323 120p 2N6324 120p 2N6325 120p 2N6326 120p 2N6327 120p 2N6328 120p 2N6329 120p 2N6330 120p 2N6331 120p 2N6332 120p 2N6333 120p 2N6334 120p 2N6335 120p 2N6336 120p 2N6337 120p 2N6338 120p 2N6339 120p 2N6340 120p 2N6341 120p 2N6342 120p | | | | 40364 120p 40408 80p 40409 75p 40410 85p 40411 300p 40594 120p 40595 120p 40681 75p 40682 75p 40683 100p 40684 100p 40685 100p 40686 100p 40687 100p 40688 100p 40689 100p 40690 100p 40691 100p 40692 100p 40693 100p 40694 100p 40695 100p 40696 100p 40697 100p 40698 100p 40699 100p 40700 100p 40701 100p 40702 100p 40703 100p 40704 100p 40705 100p 40706 100p 40707 100p 40708 100p 40709 100p 40710 100p 40711 100p 40712 100p 40713 100p 40714 100p 40715 100p 40716 100p 40717 100p 40718 100p 40719 100p 40720 100p 40721 100p 40722 100p 40723 100p 40724 100p 40725 100p 40726 100p 40727 100p 40728 100p 40729 100p 40730 100p 40731 100p 40732 100p 40733 100p 40734 | | | |
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DIGEST

Watch Out

For under £44.95 you too can own a new Casio watch with continuous time readout, date display, full month, calendar information, professional grade stopwatch, plus alarm and time signal functions with a choice of tone pitch. What more can you ask for? And it's all in the 79CS51B Casio Stopwatch. A conventional LCD readout shows hour, minute, second, am/pm and date. Push a button to display year, month date and day. Press again for full calendar and cycle the display through earlier and later months if so desired. The automatic calendar is programmed from 1901 to 2099. As a stopwatch the 79CS51B has a running time of 12 hours and a measurement unit of one-tenth second. It handles normal start-stop timing, net timing, lap timing and first-second place timing. The watch will also sound an alarm at any preset time and/or signal every hour. One lithium battery will last about 15 months average use. For further information contact Casio Electronics Co Ltd, 28 Scrutton Street, London EC2A 4TY.



This Is A Recording

The Compu 385 is a new telephone answering machine from Agovox. It is a compact module which sits neatly under a conventional telephone. The facilities available include a remote control electronic decoder which enables the machine to be telephoned from anywhere in the world and instructed to play back over the telephone any messages received from previous callers. The machine is also capable of recording both sides of a conversation and can be linked

to a standard recorder for retaining permanent records of calls. It is also fully compatible with existing dictating machines which utilise mini-cassettes and has a foot switch and head set available. Message lengths can be limited and a call counter enables easy location and logging of messages. The 385 is available for rent at between £3.72 and £6.46 depending on the type of rental contract or £750 for outright purchase. For further information contact The Sales Office, Agovox Limited, 4 Sydenham Road, London SE26 5QY.

EMP — The Answer

All our inquiries addressed to the Prime Minister, the Home Secretary and the Secretary of State for Defence on the Government's plans to cope with the Electromagnetic Pulse effect (EMP) in wartime eventually found their way to the same office somewhere in the depths of the Home Office. This is what HM Government has to say: 'Her Majesty's Government is aware of the phenomenon of EMP and its possible effects on communications systems. We take it into account in the design of civil and defence systems but cannot, of course, comment on the details of all the forms of EMP protection used.'

The Home Office has given guidance to local authorities and other essential services concerned with the planning of communications systems for war, on the effects of EMP and about certain precautions that can be taken to reduce the risk of EMP damage to communications equipment.

The requirements for home defence communications are currently being reviewed and possible measures to protect them against the effects of EMP will be considered in the course of the review.'

So, it seems the Government and local authorities know all about EMP, but they aren't going to tell the likes of us.

In a statement to the Commons on August 7th, the Home Secretary (William Whitelaw) outlined

developments in Britain's civil defence programme. The UK warning and monitoring organisation is to improve its communications. Improvements are also to be made to the wartime broadcasting service to ensure the continuation of public broadcasting even after a large-scale attack (but no mention of EMP).

After a lengthy pronouncement on Central/Local Government co-operation in wartime, increased expenditure on equipment and services, greater involvement in civil defence by Central Government departments and finishing up with news of the refurbishment of our stocks of emergency fire appliances (Green Goddesses!), Mr. Eric Heffer's immediate reaction was, 'The right hon. Gentleman must be joking'.

We'll keep you posted on any further developments. Keep your letters coming. These given here are representative of those we have received so far. This article has stimulated a greater reader response than anything previously published in ETI. Most of our correspondents have understood the need for caution in our approach to publication.

The letter from Mr Keightley is particularly interesting and we are contacting Mr J. Pawsey MP to gather his views on the subject. In addition investigations are under way to find out exactly what that "guidance to local authorities" referred to in the Home Office reply consists of and of how much use it has

proved to be. We hope to be able to report back next issue on the results of that investigation.

In the meanwhile keep your letters coming to us and why not follow Mr Keightley's example and write to your local MP? Maybe together we can overcome the vast governmental inertia and raise the heads above the sand just a little.

Dear Sir,

I think you should visit the inside of a NATO USA or British Radar Command Station.

We have in the UK high gain very large units operating on all bands i.e. VLF to UHF by a switching unit thus making jamming very hard because the unit sends out piano type signal and only receives back the same. All are sent out through banks of pure mechanical harmonic filters, that also process the received signal. The front end is in liquid He and of the thermocouple type. Most of the units have a large valve content of the ECC82 size.

All cable passing through the 14g sheet steel building shield have 80 to 120 bd RFI filters even the power cable. The building is bonded every four feet against RFI.

You will find that you can get an electric shock from nylon rigging seven miles out from the radar station such is the power.

Thank you for bringing your statement to the public and that many items are covered up, it would seem that the designers took into account EMP in the design of the radar system and my part was commissioning the 3000 kW cooling system.

P.S. Do you think I have time to scrap my T151 III which is very limited and purchase and use a T159 before EMP!

M.G. Wadlow
Project Engineer

Dear Sir,

Congratulations on a most interesting article ('EMP'; ETI August 1980). The text was crisp and informative.

In view of the potential devastating effect of EMP, I feel that more people, both the public and industrialists should be made aware of this aspect of, perhaps, an inevitable nuclear war.

For my part, I have been largely unaware of EMP but feel that I may be able to at least inform engineers and managers in telecommunications.

Yours sincerely,
S.F. Gatley
Senior Electronics Engineer
Plessey Telecommunications

Dear Sir,

Thanks to ETI for an informative article on EMP.

I have drawn this article to the attention of Mr Jim Pawsey, the Member of Parliament for Rugby, who is also the secretary of the Civil Defence Committee in the House of Commons.

He informs me that he has tabled a question in the House on this matter after reading your feature.

As you may know, a major statement on Civil Defence by the Home Secretary has been promised before the House rises on August 8th.

Incidentally, a range of devices which offer protection from EMP are being marketed by Suhner. These incorporate a Cerberus gas discharge tube in a coaxial (50R) line.

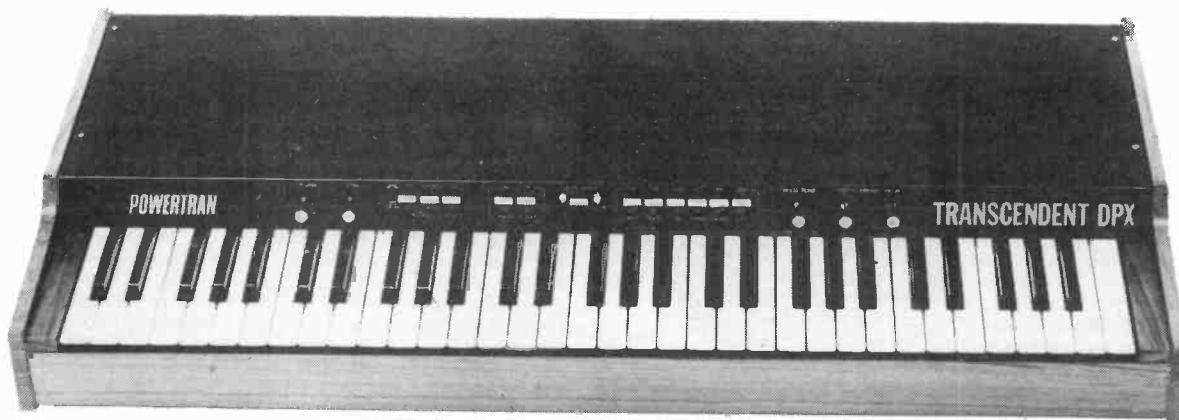
Yours faithfully,
M.R. Keightley, B.Sc., G8BLK
Bilton, Rugby,
Warwickshire

TRANSCENDENT DPX

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

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

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



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

COMPLETE KIT ONLY £299 +VAT

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

Although the DPX is an advanced design using a very large amount of circuitry, much of it very sophisticated, the kit is mechanically extremely simple with excellent access to all the circuit boards which interconnect with multiway connectors, just four of which are removed to separate the keyboard circuitry and the panel circuitry from the main circuitry in the cabinet. The kit includes fully finished metalwork, solid teak cabinet, professional quality components (all resistors 2% metal oxide), nuts, bolts, etc., even a 13A plug!

POWERTRAN

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

TRANSCENDENT 2000 SINGLE BOARD SYNTHESIZER

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

The TRANSCENDENT 2000 is a 3 octave instrument transposable 2 octaves up or down giving an effective 7 octave range. There is portamento, pitch bending, a VCO with shape and pitch modulation, a VCF with both low and high pass outputs and a separate dynamic sweep control, a noise generator and an ADSR envelope shaper. There is also a slow oscillator, a new pitch detector, ADSR repeat, sample and hold, and special circuitry with precision components to ensure tuning stability amongst its many features. The kit includes fully finished metalwork, fully assembled solid teak cabinet, filter sweep pedal, professional quality components (all resistors either 2% metal oxide or 1/2% metal film) and it really is complete — right down to the last nut and bolt and last piece of wire! There is even a 13A plug in the kit — you need buy absolutely no more parts before plugging in and making great music! Virtually all the components are on the one professional quality fibreglass PCB printed with component locations. All the controls mount directly on the main board, all connections to the board are made with connector plugs and construction is so simple it can be built easily in a few evenings by almost anyone capable of neat soldering! When finished you will possess a synthesizer comparable in performance and quality with ready-built units selling for many times the price.

**COMPLETE KIT
ONLY
£168.50 + VAT!**



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

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!



Something Bugging You?

With the increase in telephone tapping and boardroom bugging, Audiotel International have developed a simple to use, yet sophisticated successor to their Scanlock radio surveillance receiver. It is called the Scanlock Mark V8 and is a fast, easy means of detecting and locating an eavesdropping transmitter as well as being capable of routine 'sweep' searches of high level meetings rooms. Carried in a vehicle it can also locate any bleeper bug used for 'trailing'.

The Scanlock is not limited to the conventional radio receiver's range of 88-108 MHz. It covers the wider frequency spectrum of 10-1800 MHz and its automatic 'sweep' mode scans this range four times a minute. Finally all that is necessary is to press the 'Locate' button and use the hand-held wand to guide you to where the bug is located. The kit is the size of a small briefcase, weighing 6.3 Kg, complete with spare battery pack. There is also provision for mains usage. For further information contact Audiotel International Ltd at Saddlers Court, Yately, Surrey, GU17 7RX.

Video Pirates

Victor Company of Japan (JVC), who developed the popular VHS system, are concerned with the increasing number of unlicensed "pirate" VHS blank cassettes that are being imported into the UK. In response, they have issued the following statement to their dealers.

1. JVC hold an exclusive patent of the design, construction and appearance of VHS cassettes in the UK.
2. JVC will protect their rights.
3. JVC is concerned about the importation of unlicensed VHS cassettes into the UK because of their inferior quality as well as their illegality.

Show Time

Virtually every major electronic manufacturer I spoke to at this year's American Summer Consumer Electronics Show claims to be perfecting speech capable products, whilst only a handful are available.

The leader in voice technology manufacturing is Texas Instruments. Two years ago the firm unveiled the industry's first speech capable product, Speak 'n' Spell, and the consumer electronics world hasn't stopped talking about it since. This year, TI introduced two other talking 'electronic learning aids' and is also predicting a bright future for its talking translator. The \$300 unit offers approximately 500 spoken and displayed words.

If you don't know what type of video tape system you should be using, brace yourself because more befuddlement is brewing. Early next year in the States two manufacturers, perhaps even three, mutually incompatible video disc players will be each shouting the virtues of their products whilst cleverly knocking the others.

Pictures that I have seen from the newest Pioneer, Magnavox, JVC and RCA players are all amazingly detailed and noise-free. The Magnavox and Pioneer machines play compatible twelve inch discs by bouncing a focused laser beam from a spiral track of microscopic pits etched onto the disc's reflective surface. A clear plastic coating makes the disc immune to dust and smudges from handling.

RCA's Selecta Vision video disc player has been completely over-

hauled since it was introduced and field tested several years ago. The basic playback principle is unchanged; a stylus electrode replaced every two or three years, senses a TV signal as electrical capacitance variations in disc grooves spinning at 450 rpm. Playing time was boosted to one hour per twelve inch disc side by doubling disc grooves to just under ten thousand per inch. Home tests show that dust and other groove contamination from handling messed up pictures. So RCA's improved Selecta Vision has a sealed disc caddy.

JVC have illustrated a system that combines the low cost aspects of selectavision with the operating options of free flowing slow motion etc. of optical machines. Not only that JVC included options for a super hi-fi audio disc. It calls the whole package its VHD/AHD System (Video/Audio High Density).

Signals are stored as capacitance variations from minute pits in the conductive plastic. The stylus rests over central spiral tracks distributing pressure and minimising wear. (Stylus life is 2,000 hours, roughly 10 times RCA's).

Sony's newest addition to its Beta family of accessories is the Beta stack model AG300. The unit automatically ejects and loads up to 4 Beta Max video cassettes with record, playback and re-wind capabilities; this accessory can be used with the current Beta Max models SL5400 and SL5600 or with the programmable SL5600. When used with the regular Beta Max models it offers a maximum of 20 hours recording time. With a programmable unit the change allows a user to record separate programmes on separate cassettes: up to 4 events on different

channels and different days within a two week period.

A new company, Activision, has released four new cartridges to work with the Atari video computer system; they are dragster, chequers, boxing and fishing derby. The general opinion is that these cartridges have a far higher resolution and superior game content than any of the Atari manufactured units; is this why Atari is suing them for \$20 million? Anyway these cartridges will certainly be available in the UK via at least one well-known mail order house.

Good news for all you home computer owners. At last you can connect with the real world. Yes, the BSR System X10 is going to be available in January 1981. In case you are unfamiliar with the system here is a brief run-down. Just plug in the command console and various modules into the household supply outlets and you're ready to take control. No special wiring is needed. From one convenient location you can control a bedroom light, hall light, television, radio, stereo, porch light, back door light as well as lights in the dining room. The command console comes in two versions, either with or without a cordless controller. The lamp module receives signals from a command console to turn on, off, dim or brighten any incandescent lamp up to 300 W. The wall switch receives signals from the command console to turn on or off or brighten any light or lamp normally operated by a wall switch up to 500 W and the appliance module receives signals from the command console to turn an appliance on or off.

Gerald Chevin

Fly The Flag

The familiar terminals in British Airways reservations offices are getting a bit long in the tooth. They're ten years old. A British company, Videcom, has won the £500,000 contract for terminal replacement, against competition from three other contenders — one British and two American. Videcom supplied a substantial number of the existing BA terminals.

The 280 new keyboard VDUs

are to be installed at 69 sites throughout 15 European countries. Installation started in July in Berlin and should be completed by the end of 1981.

The type 101 VDUs to be supplied were designed specifically for airline operations. They use Hall-effect, contactless, solid state keys for maximum reliability and life expectancy. The VDU is part of an integrated terminal system including cluster control units and terminal drive units, which can support up to 128 terminals.

Eagle Sounds

Eagle International have just introduced their new consumer catalogue for 1980/81. Although it's only 20 pages long it covers a lot of ground — hi-fi separates and rack systems, portable radios, in-car entertainment systems, etc.

You can get hold of a free copy of this full colour guide to Eagle's wares by writing to Eagle International, Precision Centre, Heather Park Drive, Wembley HA0 1SU.

4. These illegal cassettes originate from Taiwan, Singapore and Hong Kong — there are no VHS cassette making licensees in these countries, thus VHS cassettes which are identified as being made in these countries will be subject to legal proceedings from JVC when imported into the UK.
5. These unlicensed products generally do not conform to VHS

standard dimension, construction, mechanical operation and electrical performance. This may affect the overall performance and operation

of VHS recorders for which JVC are otherwise responsible.

So, you've been warned. Beware of cheap tapes and what they might do to your machine.



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ELECTRONIC CAPACITORS: (Values are in μ F) 500V: 10.50p; 47.78p; 250V: 100.65p; 83V: 0.47, 1.0, 1.5, 2.2, 3.3, 4.7, 6.8, 10, 15, 22, 22.1p; 32, 47, 10, 12p; 63, 100, 27p; 50V: 50, 100, 220, 25p; 40, 32p; 1000, 60p; 40V: 2, 3.3, 8p; 100, 12p; 2200, 3300, 85p; 4700, 98p; 35V: 10, 33, 7p; 330, 47p; 32p; 25V: 10, 22, 47, 100, 8p; 160, 220, 250, 15p; 470, 25p; 640, 1000, 35p; 1500, 40p; 2200, 45p; 3300, 77p; 4700, 85p; 16V: 10, 47, 7p; 100, 125, 8p; 220, 330, 14p; 470, 20p; 1000, 1500, 30p; 2200, 3300, 10p; 100, 7p; 640, 12p; 1000, 16p.

TAG-END TYPE: 450V: 100p; 180p; 70V: 470, 165p; 64V: 330, 150p; 250V: 110p; 50V: 4700, 150p; 3300, 135p; 2200, 99p; 40V: 4700, 130p; 4000, 92p; 2200, 92p; 3300, 98p; 30V: 4700, 110p; 25V: 1500, 195p; 640, 120p; 4700, 100p; 3300, 85p; 2000, 60p.

POLYESTER CAPACITORS: Axial lead type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n, 9p; 18n, 10p; 22n, 33n, 11p; 47n, 68n, 14p; 100n, 17p; 150n, 22n, 24p; 330n, 47n, 41p; 680n, 44p; 1.5F, 64p; 2.2, 82p.

POLYESTER RADIAL LEAD CAPACITORS: 250V
10n, 15n, 22n, 27n, 33n, 47n, 68n, 100n, 7p; 150n, 10p; 220n, 330n, 13p; 470n, 17p; 680n, 19p; 1.2, 22p; 1.5, 50p; 2, 234p.

TANTALUM BEAD CAPACITORS
35V: 0.1 μ F, 0.22, 0.33, 0.47, 0.68, 1.0 μ F, 2.2 μ F, 3.3, 4.7, 10, 20, 20V: 6.8, 16V: 2.2, 4.7, 10, 15p.
16V: 22, 28p; 47, 100, 50p; 220, 80p; 10V: 15p; 22p, 33, 24p; 100p, 35p; 6V: 4.7p, 6.8, 10, 20p; 3V: 100, 20p.

MILAR FILM CAPACITORS
100V: 0.001, 0.002, 0.005, 0.01 μ F 6p
0.015, 0.02, 0.04, 0.05, 0.05 μ F 7p
0.1 μ F, 5p; 0.5 μ F, 4.7 μ F 12p

CERAMIC CAPACITORS 50V
Range: 0.5pF to 10,000pF
0.015 μ F, 0.022 μ F, 0.033 μ F, 4p
0.047 μ F, 5p; 0.1 μ F, 0.2 μ F, 5p

SILVER MICA (Values in pF) 3.3, 4.7, 6.8, 10, 12, 18, 22, 33, 47, 50, 68, 75, 82, 85, 100, 120, 150, 220, 11p each
250, 270, 300, 330, 360, 390, 470, 600, 800, 820, 16p each
1000, 1200, 1800, 2000, 25p each

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

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

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

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

JACKSONS VARIABLE CAPACITORS
DILICON 0.2 to 365pF with slow motion Drive 450p
100/300pF 205p; 0.208/1.76 350p
5.0pF Drive 1.1 with slow motion drive 410p
451/4 Drive 410p
1.1/36.1 25p; 50pF 35p
Drum 54mm 55p; 100, 150pF 25p
0.1-365pF 725p; L 3x310pF 725p
0.2 to 365pF 395p; 00-3x25pF 550p

RF CHOKES
75, 100, 150, 200, 300, 470, 1000, 1500, 2.5, 5, 10, 30p each
43mH 100, 60p each

VEROBOARD 0.1, 0.15, 0.1 (copper clad) (plain)
2 1/2 x 3 1/4" 58p; 51p; 42p
2 1/2 x 5" 68p; 51p; 42p
3 1/4 x 3 1/4" 68p; 51p; 42p
3 1/4 x 5" 77p; 86p; 65p
2 1/2 x 1 7/8" 204p; 8p
3 1/4 x 1 7/8" 264p; 229p; 8p
4 1/4 x 1 7/8" 345p; 210p

VERO WIRING
PEN + Spool 350
Spare Spool 85
7 + Spare tip 90

FERRIC CHLORIDE 1 lb bag Anhydrous 225p + 40p P&P
ULTRASONIC TRANSDUCER 40KHz 350p pr

COPPER CLAD BOARDS
Fibre Single-Double-SRBP
Glass sided sided 9 5/8" x 8 5/8"
2 1/4" x 5" 90p; 61p; 82p
2 1/4" x 5" 150p; 95p

DIL PLUGS (Headers) 14 pin 35p; 18 pin 40p; 24 pin 85p; 40 pin 295p.
Solderless pins: 100 60p; 500 275p.

DIL SOCKETS (TEXAS) Low Wire Prof. Wire
8pin 10p; 25p
14pin 12p; 35p
16pin 13p; 46p
18pin 16p; 52p
20pin 22p; 65p
22pin 25p; 70p
24pin 30p; 77p
36pin 35p; 85p
40pin 109p

EDGE CONNECTORS: (Double type)
10 way .1 156
2x10 way .1 85p
2x15 way .1 99p
2x18 way 115p 120p
2x22 way 130p 135p
2x25 way 149p 160p
2x30 way 170p
2x36 way 194p
2x40 way 210p
2x45 way 232p

DIL SOCKETS 3A200V 49
3A400V 50
8A100V 54
8A400V 54
BT116 150

DIAC 20
75 SERIES 350
75108 350
75150 140
75154 140
75155 80
75451 75
75454 224
75459 89
75492 94

TRIACS 3A200V 49
3A400V 50
8A100V 54
8A400V 54
BT116 150

DIAC 20
75 SERIES 350
75108 350
75150 140
75154 140
75155 80
75451 75
75454 224
75459 89
75492 94

DIAC 20
75 SERIES 350
75108 350
75150 140
75154 140
75155 80
75451 75
75454 224
75459 89
75492 94

DIAC 20
75 SERIES 350
75108 350
75150 140
75154 140
75155 80
75451 75
75454 224
75459 89
75492 94

DIAC 20
75 SERIES 350
75108 350
75150 140
75154 140
75155 80
75451 75
75454 224
75459 89
75492 94

DIAC 20
75 SERIES 350
75108 350
75150 140
75154 140
75155 80
75451 75
75454 224
75459 89
75492 94

TRANSISTORS

| | | | | | | | | | | | | | |
|--------|----|--------|-----|--------|----|--------|-----|-------|----|---------|-----|--------|-----|
| AC125 | p | BC182L | 10 | BF179 | 38 | MPP103 | 36 | TS445 | 45 | 2N2214 | 23 | 2N4921 | 40 |
| AC126 | 25 | BC183L | 10 | BF180 | 38 | MPP104 | 36 | TS446 | 45 | 2N2222 | 20 | 2N4922 | 55 |
| AC127 | 22 | BC187 | 25 | BF185 | 25 | MPP105 | 36 | TS447 | 45 | 2N2292 | 45 | 2N4923 | 125 |
| AC128 | 20 | BC212 | 9 | BF192 | 11 | MPSA06 | 22 | TS448 | 47 | 2N2303 | 45 | 2N5135 | 21 |
| AC141 | 27 | BC212L | 9 | BF195 | 12 | MPSA06 | 22 | TS449 | 30 | 2N2368 | 21 | 2N5136 | 28 |
| AC142 | 28 | BC213 | 9 | BF197 | 12 | MPSA55 | 29 | TS450 | 32 | 2N2369A | 17 | 2N5138 | 28 |
| AC176 | 25 | BC213L | 9 | BF199 | 21 | MPSA56 | 29 | TS451 | 32 | 2N2476 | 120 | 2N5172 | 25 |
| AC188 | 26 | BC214 | 10 | BF200 | 21 | MPSA56 | 29 | TS452 | 32 | 2N2483 | 28 | 2N5179 | 60 |
| AC177 | 60 | BC237 | 14 | BF200A | 21 | MPSA56 | 29 | TS453 | 32 | 2N2483 | 28 | 2N5180 | 38 |
| AC18 | 60 | BC238 | 15 | BF244B | 29 | MPSU05 | 50 | TS454 | 32 | 2N2483 | 28 | 2N5191 | 75 |
| AC19 | 60 | BC307B | 14 | BF244B | 29 | MPSU05 | 50 | TS455 | 32 | 2N2483 | 28 | 2N5308 | 20 |
| AC20 | 53 | BC308 | 16 | BF244B | 29 | MPSU52 | 65 | TS456 | 32 | 2N2483 | 28 | 2N5457 | 35 |
| AC21 | 60 | BC327 | 12 | BF256A | 60 | MPSU56 | 60 | TS457 | 32 | 2N2483 | 28 | 2N5458 | 35 |
| AC22 | 60 | BC327 | 12 | BF256B | 45 | MPSU56 | 60 | TS458 | 32 | 2N2483 | 28 | 2N5459 | 35 |
| AC26 | 60 | BC337 | 12 | BF258 | 35 | OC2 | 120 | TS459 | 32 | 2N2483 | 28 | 2N5485 | 40 |
| AC39 | 80 | BC338 | 12 | BF259 | 35 | OC2 | 120 | TS460 | 32 | 2N2483 | 28 | 2N5777 | 45 |
| AC41 | 39 | BC441 | 30 | BF274 | 42 | OC36 | 130 | TS461 | 32 | 2N2483 | 28 | 2N5879 | 140 |
| A0149 | 75 | BC461 | 30 | BF351 | 35 | OC41 | 125 | TS462 | 32 | 2N2483 | 28 | 2N6207 | 40 |
| AD181 | 42 | BC477 | 35 | BF356 | 35 | OC42 | 48 | TS463 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| AD182 | 42 | BC478 | 35 | BF357 | 32 | OC43 | 45 | TS464 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| AF114 | 75 | BC517 | 35 | BF359 | 40 | OC44 | 55 | TS465 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| AF115 | 60 | BC547 | 10 | BF395 | 25 | OC70 | 40 | TS466 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| AF116 | 75 | BC548 | 10 | BF395 | 25 | OC70 | 40 | TS467 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| AF117 | 95 | BC549C | 15 | BF400 | 24 | OC74 | 60 | TS468 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| AF118 | 95 | BC556 | 15 | BF401 | 24 | OC74 | 60 | TS469 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| AF119 | 40 | BC557 | 10 | BF402 | 24 | OC74 | 60 | TS470 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| AF178 | 75 | BC558 | 10 | BF403 | 24 | OC74 | 60 | TS471 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| AF179 | 75 | BC558 | 10 | BF404 | 24 | OC74 | 60 | TS472 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| AF180 | 50 | BC559 | 15 | BF405 | 24 | OC74 | 60 | TS473 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| AF239 | 42 | BCY30 | 80 | BF406 | 24 | OC74 | 60 | TS474 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| AS221 | 60 | BCY34 | 75 | BF407 | 24 | OC74 | 60 | TS475 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC107 | 10 | BCY35 | 50 | BF408 | 24 | OC74 | 60 | TS476 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC108 | 10 | BCY39 | 78 | BF409 | 24 | OC74 | 60 | TS477 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC109 | 10 | BCY40 | 45 | BF410 | 24 | OC74 | 60 | TS478 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC108B | 12 | BCY42 | 14 | BF411 | 24 | OC74 | 60 | TS479 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC108C | 12 | BCY45 | 50 | BF412 | 24 | OC74 | 60 | TS480 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC109 | 10 | BCY50 | 14 | BF413 | 24 | OC74 | 60 | TS481 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC109B | 12 | BCY71 | 18 | BF414 | 24 | OC74 | 60 | TS482 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC109C | 12 | BCY72 | 20 | BF415 | 21 | OC74 | 60 | TS483 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC110 | 10 | BCY78 | 19 | BF416 | 21 | OC74 | 60 | TS484 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC111 | 20 | BD112 | 95 | BF417 | 21 | OC74 | 60 | TS485 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC117 | 20 | BD124 | 115 | BF418 | 21 | OC74 | 60 | TS486 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC118 | 18 | BD131 | 42 | BF419 | 21 | OC74 | 60 | TS487 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC119 | 28 | BD132 | 42 | BF420 | 21 | OC74 | 60 | TS488 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC123 | 10 | BD133 | 50 | BF421 | 21 | OC74 | 60 | TS489 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC238 | 60 | BD136 | 40 | BF422 | 21 | OC74 | 60 | TS490 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC140 | 40 | BD136 | 40 | BF423 | 21 | OC74 | 60 | TS491 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC142 | 26 | BD137 | 40 | BF424 | 21 | OC74 | 60 | TS492 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC143 | 26 | BD138 | 40 | BF425 | 21 | OC74 | 60 | TS493 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC147 | 9 | BD139 | 40 | BF426 | 21 | OC74 | 60 | TS494 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC147B | 9 | BD140 | 40 | BF427 | 21 | OC74 | 60 | TS495 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC148 | 10 | BD144 | 198 | BF428 | 21 | OC74 | 60 | TS496 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC148B | 10 | BD145 | 175 | BF429 | 21 | OC74 | 60 | TS497 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC149 | 9 | BD158 | 60 | BF430 | 21 | OC74 | 60 | TS498 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC149C | 10 | BD205 | 110 | BF431 | 21 | OC74 | 60 | TS499 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC153 | 20 | BD206 | 110 | BF432 | 21 | OC74 | 60 | TS500 | 32 | 2N2483 | 28 | 2N6388 | 126 |
| BC154 | 13 | BD222 | 65 | BF433 | 21 | OC74 | 60 | TS501 | 32 | 2 | | | |

WATFORD ELECTRONICS

COMPUTER CORNER

- **SUPERBOARD II** Ready-built and tested
Only **£150**
- **PSU 5V/3A** (for above incl. RF Modulator) **£25**
- **810 Expansion Board** (8K RAM) expandable to 24K **£150**
- **CHALLENGER 1P** (Superboard cased with PSU) **£188**
- **Extra 4K RAM** (8x2114) **£20**
- **Plastic Case Black**, fits UK101 Superboard, NASCOM II etc **£20**
- **SUPERPRINT 800**, 80 column High Performance Impact Printer Ideal for PET, NASCOM, UK101 Superboard, TRS80 etc **only £349**
- **VIDEO GENIE** based on TRS80, Utilises Z80, 12K level II Basic 16K RAM incl. Cassette Deck **£325**
- **STRINGY FLOPPY**, Combines economy of Cassette with speed & reliability of DISC (incl. 20 wafers) **£169**
- **SOFTY**, Intelligent SPROM Programmer Connects directly to TV. Develop. copy. Burn EPROMS Kit Ready-built and tested **£99**
PSU for above (Built) **£120**
£20
- **UHF Modulators 6MHz** **280p**
UHF Modulators 8MHz **480p**
- **KEYPADS 4 x 4 matrix** **350p**
- **Full ASCII coded 56 Key Keyboard Mod.** 756 **£40**
- **10x C12 Cassettes** in Rack (P&P is extra on all items) Call in at our shop for Demo or write in for leaflets **590p**

SWITCHES
TOGGLE: 2A, 250V
SPST **28p**
DPST **34p**
DPDT **38p**
4 pole on/off **54p**

SUB-MIN TOGGLE
SP changeover **59p**
SPST on/off **54p**
SPST biased **85p**
DPDT 6 tags **70p**
DPDT centre off **79p**
DPDT biased **115p**

SLIDE 250V:
1A DPDT **14p**
1A DPDT c/over **15p**
1/2A DPDT **13p**
4 pole 2-way **24p**

PUSH BUTTON
DPDT Black Body
Red, Blue, Grn., Yell.
SRL Latching **125p**
SRM Momentary **125p**

MINI, Non Locking
Push to Make **18p**
Push Break **25p**

DIL SWITCHES (SPST)
4 way 85p, 6 way 95p, 8 way 115p.

ROTARY: Make your own multiway Switch, Adjustable Stop, Shafting Assembly. Accommodate up to 6 Wafers **90p**
Mains Switch DPST to fit **40p**
Break Before Make Wafers, 1 pole/12 way, 2p/6 way, 3p/4 way, 4p/3 way, 6p/2 way **56p**

Spacer and Screen **8p**

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 **43p**

ROTARY: Mains 250V AC, 4 Amp **52p**

CRYSTALS

| | |
|-----------|-----|
| 100KHz | 323 |
| 455KHz | 383 |
| 1MHz | 323 |
| 1.008M | 395 |
| 1.28MHz | 392 |
| 1.6MHz | 323 |
| 1.9MHz | 323 |
| 1.8432MHz | 362 |
| 2.4576MHz | 362 |
| 3.2768M | 323 |
| 3.57954M | 195 |
| 4.000MHz | 290 |
| 4.032MHz | 323 |
| 4.433619M | 135 |
| 5.0MHz | 355 |
| 5.185M | 323 |
| 5.24288M | 425 |
| 6.0MHz | 323 |
| 6.5536M | 200 |
| 7.680M | 323 |
| 8.0MHz | 392 |
| 8.08333M | 362 |
| 8.867237M | 362 |
| 9.375M | 323 |
| 10.0MHz | 323 |
| 10.7MHz | 323 |
| 12MHz | 392 |
| 14.31818M | 362 |
| 18MHz | 323 |
| 18.432M | 323 |
| 20.0MHz | 323 |
| 27.648M | 323 |
| 38.6667M | 350 |
| 48.0MHz | 323 |
| 100.00MHz | 323 |

TRANSFORMERS (Mains Prim. 220-240V)

| | |
|---|----------------|
| 6.0-6V, 9.0-0V, 12.0-12V 100mA | 95p |
| 3VA: 0-6V 0-6V (PCB mounting) | 150p |
| 8VA: 6V-5A 6V-5A, 9V-4A 3V-4A; 12V-3A | 215p |
| 12V-3A, 15V-2.5A 15V-2.5A | 215p |
| 12V-4A 5V-1.3A 4.5V-1.3A; 6V-1.2A 6V-1.2A; | 235p (30p p&p) |
| 20V-5A 12V-5A, 15V-4A; 20V-3A | |
| 20V-3A | |
| 24VA: 6V-1.5A 6C-1.5A; 9V-1.3A 9V-1.3A; | |
| 12V-1A 12V-1A; 15V-8A 15V-8A; 20V-5A | |
| 20V-6A 320p (55p p&p) | |
| 50VA, 6V-4A 6V-4A, 9V-2.5A 9V-2.5A, 12V-2A | |
| 12V-2A, 15V-1.5A 15V-1.5A; 20V-1.2A 20V-1.2A; | |
| 25V-1A 25V-1A, 30V-8A 30V-8A | |
| 366p (60p p&p) | |
| 100VA: 12V-4A 12V-4A, 15V-3A 15V-3A; | |
| 20V-2.5A 20V-2.5A, 30V-1.5A 30V-1.5A | |
| 30V-1.25A 40V-1.25A, 50V-1A 50V-1A | 695p |
| (74p p&p). (NB: p&p charge to be added above our normal postal charge.) | |

ALUM. BOXES WITH LID

| | |
|------------------------|-----|
| 3x2x1" | 55 |
| 2 1/2 x 5 1/2 x 1 1/2" | 75 |
| 4x4x1 1/2" | 75 |
| 4x2 1/2 x 1 1/2" | 75 |
| 4x5 1/2 x 1 1/2" | 100 |
| 4x2 1/2 x 2" | 100 |
| 5x4x2" | 107 |
| 6x4x2" | 110 |
| 7x5x2 1/2" | 185 |
| 8x6x3" | 185 |
| 10x7x3" | 228 |
| 10x4 1/2 x 3" | 228 |
| 12x5x3" | 230 |
| 12x8x3" | 275 |

PANEL METERS FSD

| | |
|-----------|------------|
| 60x46x6 | 60x46x6 |
| 35mm | 35mm |
| 0-50uA | 0-100uA |
| 0-10mA | 0-50mA |
| 0-5mA | 0-10mA |
| 0-10mA | 0-50mA |
| 0-10mA | 0-100mA |
| 0-1A | 0-500mA |
| 0-2A | 0-1A |
| 0-25V | 0-50V AC |
| 0-50V AC | 0-300V AC |
| 0-300V AC | 0-500V AC |
| 0-500V AC | 0-1000V AC |

ETI Projects: Parts available for: Digital Test Meter, DM900, 60W Amplifier System, Send SAE plus 5p for list.

| | | | |
|--------|------|-----------------|------|
| LM300H | 170p | LM327 | 270p |
| LM305H | 140p | LM723 | 39p |
| LM309K | 135p | TAA550 | 50p |
| LM317K | 360p | TBA625B | 95p |
| LM323K | 560p | TA1412 | 150p |
| LM325N | 240p | 78H05 + 5V/5A | 595p |
| LM326N | 240p | 78HG + 5V to 5A | 650p |

VOLTAGE REGULATORS

| | |
|------------|----------------|
| 1A TO3 +ve | -ve |
| 5V 78L05 | 145p 7905 220p |
| 12V 7812 | 145p 7912 220p |
| 15V 7815 | 145p |
| 10.7MHz | 323 |
| 12MHz | 392 |
| 14.31818M | 362 |
| 18MHz | 323 |
| 18.432M | 323 |
| 20.0MHz | 323 |
| 27.648M | 323 |
| 38.6667M | 350 |
| 48.0MHz | 323 |
| 100.00MHz | 323 |

OPTO

| | |
|---------------------------|-----|
| LEDs with Clips | |
| TIL209 Red | 13 |
| TIL211 Grn. | 17 |
| TIL212 Vlt. | 18 |
| TIL220 2" Red | 14 |
| 2" Green, Yellow or Amber | 18 |
| 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 6" CA | 180 |
| 8" Orange CA | 250 |
| FND357 Red | 120 |
| FND500 | 115 |
| 3" Green CA | 150 |
| 3" Red CA | 215 |
| 3" Green CA | 150 |

ISOLATORS

| | | | |
|----------|-----|------------------|------|
| IL74 | 55 | DVM176 | 1750 |
| TIL111/2 | 85 | LCD 3 1/2 Digits | 875 |
| TIL114 | 95 | LCD 4 Digits | 975 |
| TIL117 | 110 | LCD 6 Digits | 950 |

CMOS

| | |
|------|----|
| 4000 | 18 |
| 4001 | 18 |
| 4002 | 24 |
| 4006 | 92 |
| 4007 | 22 |
| 4008 | 82 |
| 4009 | 40 |
| 4010 | 48 |
| 4011 | 24 |
| 4012 | 24 |
| 4013 | 45 |
| 4014 | 85 |

Audiophile Amplifier

We've collected together all the corrections to the Audiophile Amplifier project in one place for easy reference.

If you've experienced any trouble with RF oscillation causing overheating in the power amplifiers, connect a 1000pF capacitor across the base-collector leads of Q12 and a second 1000pF capacitor across the base-collector leads of Q13 (power amplifier circuit diagram, p.56). As a safety measure, R10 can be increased to 47R to reduce drive current and prevent overheating without loss of performance.

R15, 115 (p.62, Fig.4) mount directly on SW6. In the Parts List on the same page, C10 should be 12nF

polyester (or carbonate). The toggle switch shown on the rear of the power amplifier case (p.63) is a selector switch for the two pairs of speaker output sockets we used. It is a dual, three position, centre-off switch. P.64, Fig.6 — R1 (2k2) in series with LED 1 should be R3 (2k2). The unmarked lead in Fig.8, p.65 (third one down) goes to T1. There are three connections only to the 0 V tag — C3/C4 junction, C103/C104 junction, LED 1 cathode. All other 0 V connections are made to the 0 V junctions of the smoothing capacitors. In Fig.9 on the same page, the foil pattern of the component overlay has been printed upside down.

In the Parts List on p.65, the power amplifier supply transformer should be 25-0-25 V and the transformer for the preamp supply should be 15-0-15 V.

Shocking Truth

Static is a nuisance all of us experience at sometime or other. Often it only appears to be an irritating and uncomfortable surprise; not often enough is it realised that static can damage expensive equipment and lead to fire and other hazards in a working environment. 3M has produced a 14-page booklet outlining these hazards and it is available from Keith Nunn, Static Control Systems Group, 3M United Kingdom, PO Box 1, Bracknell, Berkshire, RG12 1JU.



Kit Update

We're still receiving news of kits, in response to our kit survey, featured in the May issue. Partridge Electronics have introduced a 'Community Mixer Kit', which, they claim, is unique, in that it is the first complete mixer designed specifically for applications like hospital broadcasting. The design and straightforward construction take into account the limited budget available to buy equipment for voluntary broadcasting organisations.

The mixer has been designed in modular form, so that you can buy a basic mixer kit for £250 + VAT (8 input) or £300 + VAT (12 input) plus your choice of meter kit (VU, PRVU or PPM) plus your choice of preamp kit (microphone, disc, tape, cassette, etc). Each preamp kit comes in one of two forms (with or without equalisation). If you have some money to

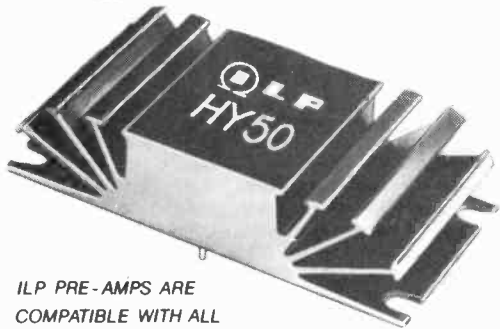
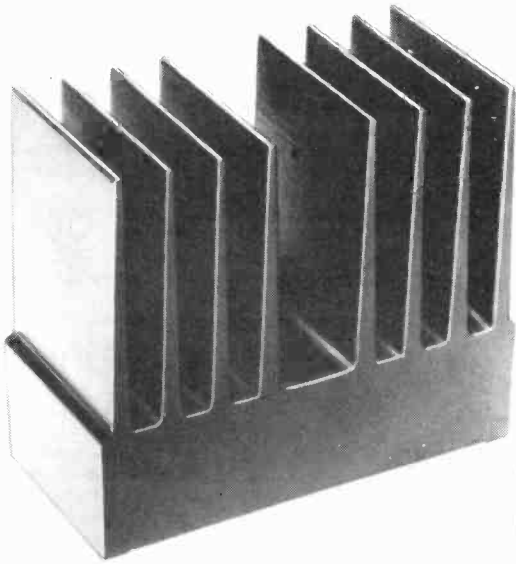
spare, you can also buy a number of extras, such as an autofade unit or a telephone interface studio terminal unit.

For further details contact Partridge Electronics, 56 Fleet Road, Benfleet, Essex SS7 5JN.

Hart Electronics can supply a range of cassette recorder and amplifier kits. Two high quality Linsey Hood cassette recorder kits are available at £81.50 + VAT and £94.90 + VAT respectively. The VFL 910 vertical front-loading deck hardware used in the top range model is available separately at £31.99 + VAT. Two 30 W amplifier kits complete the picture. For further information contact Hart Electronic Kits, Penylan Mill, Oswestry Shropshire.



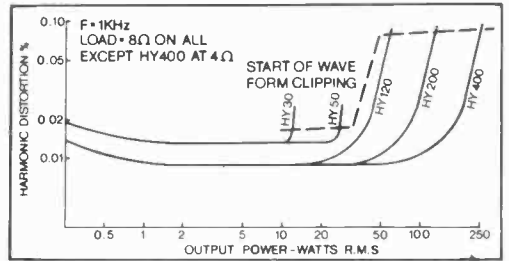
Simply ahead..



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

POWER AMPLIFIERS

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

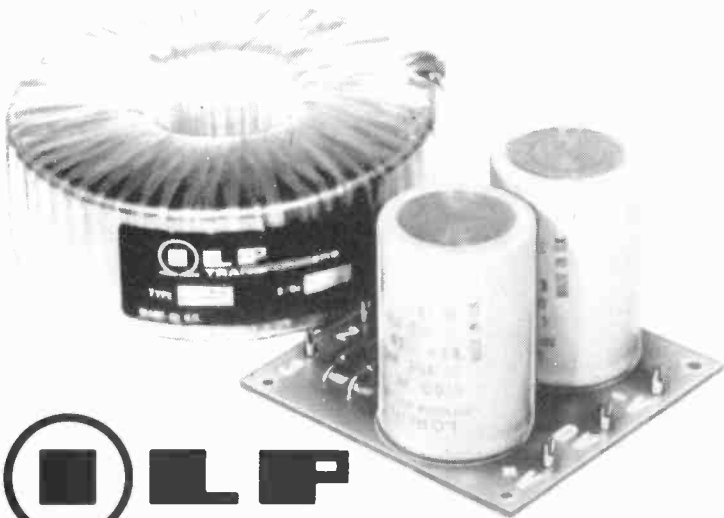
Load impedance - all models 4 Ω - ∞

Input sensitivity - all models 500 mV

Input impedance - all models 100K Ω

Frequency response - all models 10Hz - 45KHz - 3dB

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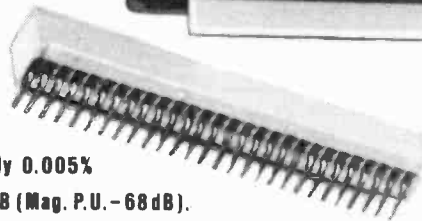
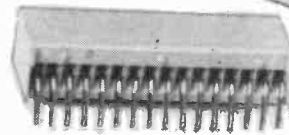
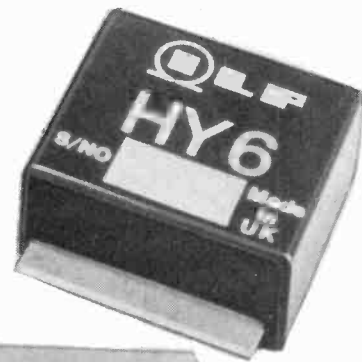
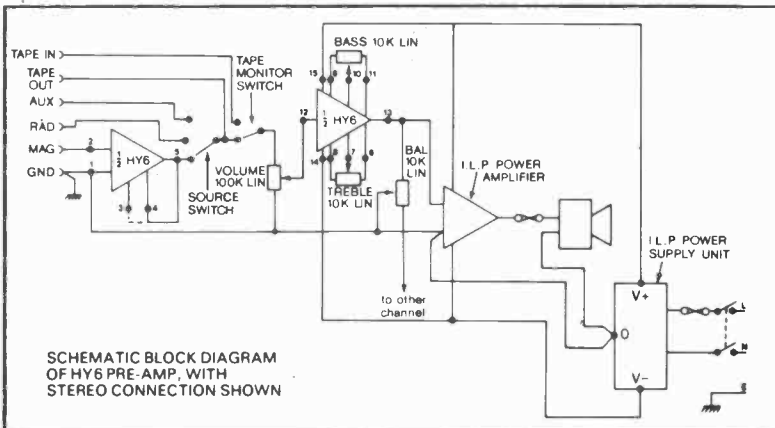
PSU 60 with toroidal transformer for 1 HY120 £9.75 + £1.46 VAT

PSU 70 with toroidal transformer for 1 or 2 HY120s £13.61 + £2.04 VAT

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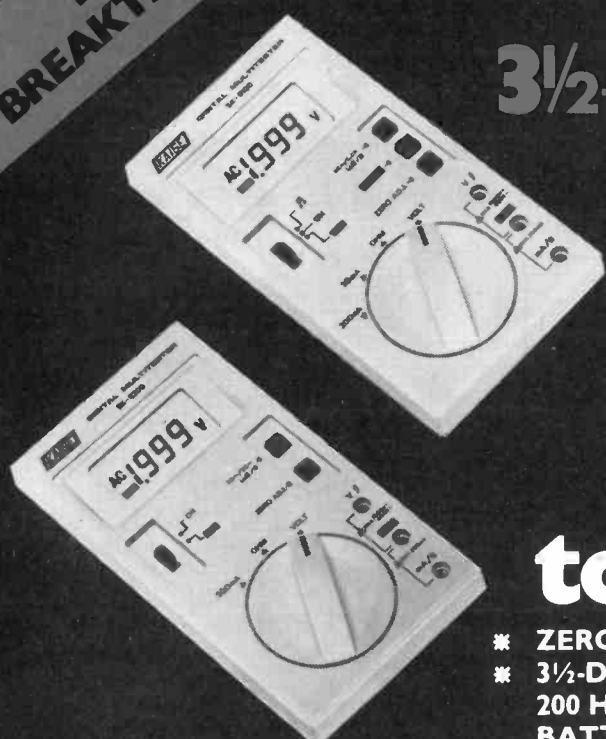
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| FULL AUTO RANGING | ✓ | ✓ | ✓ | ✓ |
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| FUNCTIONS DISPLAYED | Ω, KΩ, AUTO, BATT, ADJ, LO, – and AC | | | |
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| MEASURES AC/DC CURRENT TO: | 200mA | 10A | 200mA | 10A |
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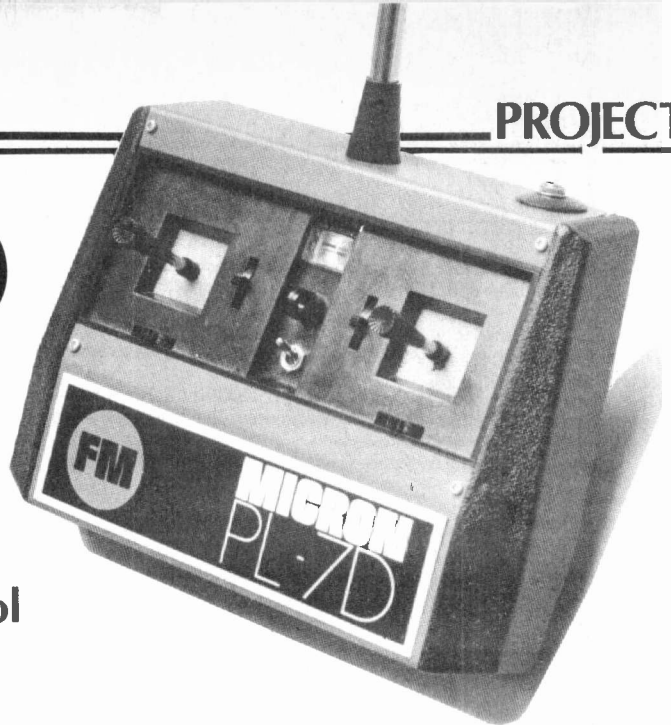
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1ETI

FM RADIO CONTROL

William Poel of Ambit International describes a complete FM radio control link using only two ICs.



Components for radio control systems have been developed very intensively during the past year or so. The evidence is found in the plethora of radio controlled toys available from virtually any toyshop. Many of these systems employ control techniques that are, to say the least, crude. Most seem to rely on control that is virtually 'bistable' ie, all on or all off.

Digital Proportional Control

Despite the name, the 'digiprop' system isn't entirely digital in nature. The control medium is more correctly 'pulse width modulation' since the main information medium is the varying width of individual pulses in a data 'frame'. A remote receiver decodes the frame back into individual pulses and individual servos then compares this decoded pulse against a locally generated standard (1.5 mS nominally) and the error drives the output control medium. Feedback is provided from the control medium in the shape of a potentiometer that adjusts the locally generated reference pulse and varies it until the local pulse and the decoded pulse are exactly coincident (Fig.1). So some parts are digital, but the most important part, the pulse width, is not.

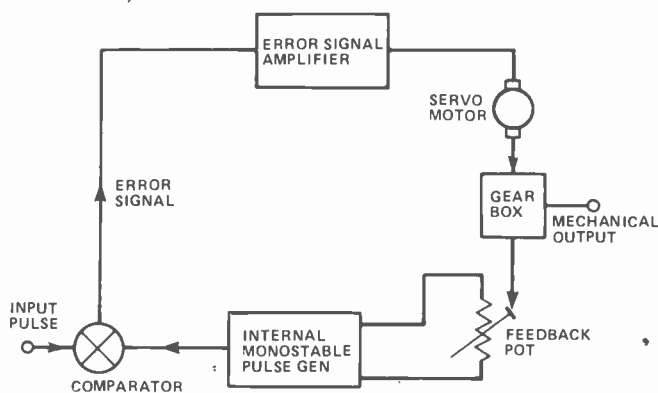


Fig.1 Block diagram of the 'digiprop' control system.

Until Now

This form of pulse width modulation can be transmitted on a variety of carrier systems. Amplitude modulation (AM) had been almost universal until about two years ago, when low power, low voltage ICs for FM were adapted

from communication equipment for the purposes of FM RC. The advantages of FM were quickly appreciated and most serious enthusiast systems use this exclusively.

The major feature of FM is improved immunity to interference from the mainly AM forms of interference around 27 MHz. CB is either AM or SSB and the limiting action of the FM system removes a lot of trouble before it can distort the decoded waveform. FM also means that AGC systems are no longer necessary (except in extreme circumstances). The output waveform of the transmitter can be significantly cleaner (in terms of RF pollution), since the carrier in AM systems is virtually being switched 'on and off' by the data frame (Fig. 2).

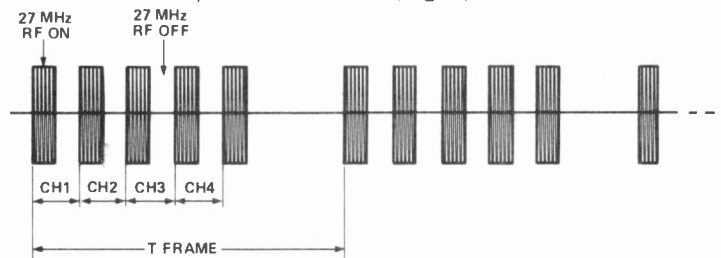


Fig.2 Waveforms associated with AM systems.

Good Ideas

It seems only to be a matter of time before good ideas with market potential get integrated into as few ICs as possible. It's happened with AM radio control (LM1872) and now it's happened to FM digital proportional radio control with a pair of ICs from TOKO that offer a nearly instantaneous solution to providing a fully proportional FM radio control link (Fig. 3).

The KB4445 is a four channel encoder/transmitter (Fig. 4). It would have been a five channel encoder, but for the need to use one of the pins of the package for a decoupling capacitor instead. All the necessary frame timing and control is achieved in this single IC, which also incorporates a crystal oscillator, FM modulator and RF driver.

The output stage of the transmitter is placed outside the KB4445, since requirements in this area will vary quite enormously from the 100 mW for ground based toys to a watt or so for serious airborne applications.

The KB4446 (Fig. 5). provides all receiver functions for a five channel digiprop system, together with an interference rejection comparator and decoder, so that the outputs can be fed directly to the servo decoders. →

HOW IT WORKS

The KB4445 is an I²L bipolar IC, comprising a 4 channel multiplexer encoder, RF oscillator with FM modulator (switch type) with a 30 mW RF output.

It is also provided with an undervoltage warning system using a flashing LED when the supply voltage drops below 4V4 from a nominal supply of 6 V.

The encoder section consists of a string of cascaded RC monostable time constants, determining the pulse width according to the position of the external control potentiometers.

Channel and frame times are similarly externally programmable.

Specification

| Item | Min | Typ | Max | Comments |
|---------------------------|-----|-----|------|--|
| Power supply (V DC) | 4 | 6 | 12 | LED flashes at 4V4 |
| Consumption (mA) | | 20 | | Oscillator stopped |
| Output power (mW) | | 30 | | |
| Dissipation (mW) | | | 450 | 4.5 mW/°C |
| Operation temp (°C) | -10 | | +60 | |
| Storage temp (°C) | -55 | | +125 | |
| Encoder pulse width (µs) | | 200 | | |
| Channel pulse width (mS) | | 1.5 | | |
| Frame pulse width (mS) | | 20 | | |
| Frequency deviation (kHz) | 2 | 4 | | F _o + F _{dev} when modulated |
| Crystal frequency (MHz) | 8 | 27 | 50 | Crystal f = f out/2 |

The KB4445 adopts one of the most universal encoder formats and is thus widely compatible with existing FM systems. The 'on-board' RF section is intended to be used as a driver for an external output stage and where sufficient supply voltage is available, a single power MOSFET may be used to achieve power levels in excess of 2 W.

The external circuit shown on the applications diagram delivers approx 400 mW RF to the antenna, which is sufficient for reliable control over 200 m with the KB4446 at the receiver.

Pin 12 of the KB4445 is the switching point of the modulator and it should be noted that the modulation action is achieved by switching an external capacitor in series with the crystal. Thus the level of deviation (more accurately termed modulation 'on' offset) may be controlled by a trimmable value at this point in the circuit. The capacitors across pins 10 and 11 form the feedback of a Colpitts oscillator and thus also affect the order specification of the transmit crystal in conjunction with the capacitor selected at pin 12.

Adjustment of the capacitor at pin 12 is an essentially iterative adjustment, altering the output frequency at the same time as the deviation

level, so care must be taken when setting up initial values in this part of the circuit

Pin 13 of the KB4445 offers access to the modulator switch filter and may thus be tailored to provide optimum bandwidth by selection of an external value.

KB4446 Receiver IC

Specification

| Item | Min | Typ | Max | Remarks |
|----------------------------|-----|-----|-----|--------------------------|
| Supply voltage (V DC) | 2.1 | 3.0 | 4.0 | LED flashes at 2V2 at 3V |
| Supply current (mA) | 15 | 20 | 25 | 20db S/N |
| Receiver sensitivity (dBu) | | 26 | | |
| Limiting sensitivity (dBu) | | 40 | | |
| Detector output (8) (mV) | | 300 | | 60dBu input |
| S/N at 60 dBu in (dB) | | 40 | | |
| LED drive current (mA) | | 5 | | At V _{cc} 2V2. |
| Std pulse width (µs) | | 200 | | |
| Channel (mS) | | 1.5 | | |
| Frame (mS) | | 20 | | |
| Output source current (µA) | | 100 | | Decoder outputs |
| Output sink current (mA) | | 2.0 | | Int. 20k |

The KB4446 receiver IC uses a third overtone (30pF parallel load) crystal in the local oscillator circuit, selected to be either 455 kHz high or low of the incoming transmitter frequency. Oscillator low is usually preferred.

The mixer output will match either L/C IF filtering or ceramic filter systems in much the same way as the MC3357P. A tuned IFT is however recommended at this point in the circuit, since most ceramic filters will offer little or no attenuation to the local oscillator present at this pin.

The detector uses a standard form of quadrature at pin 2 of the IC — a Q of approx 80 will give results in the above table, although other values may be used if provision is left to include a damping resistor. The choice of the coil will determine the output for a given deviation — in this case 2 kHz is used as the reference (ie 4 kHz total displacement.)

The detector output is fed to a comparator at the decoder input, which provides immunity to noise effects present on the detected signal. The values selected for the inputs at pins 21 and 22 will reject most HF noise and are based on the frame and pulse timing stated here. Other values may be used with non-standard forms of timing sequence.

A good quality capacitor should be used at pin 20 since this is the reset timing capacitor, setting the frame at approximately 20 mS total with the values shown.

Fig.3 (right) Block diagram of the FM Radio Control link.

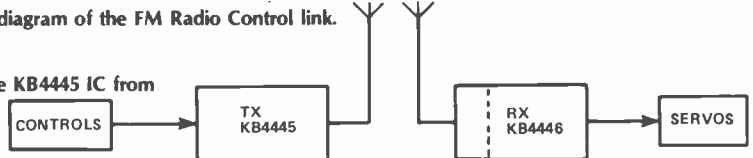
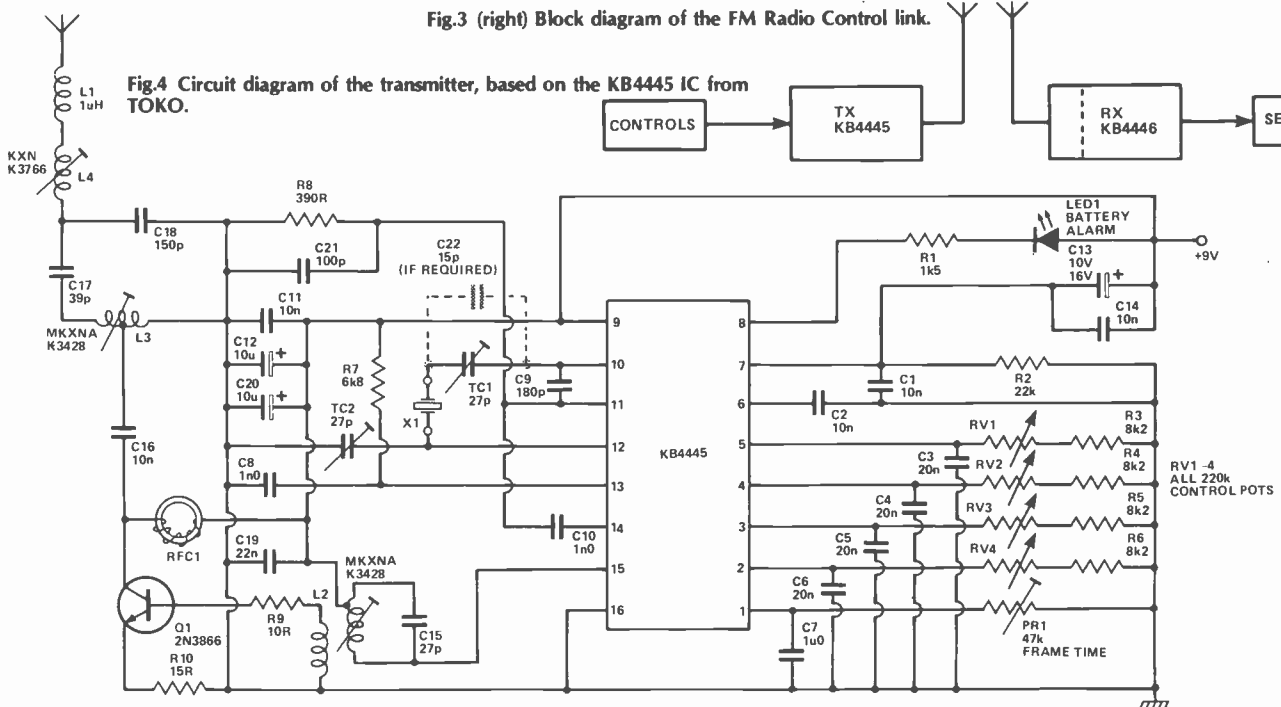


Fig.4 Circuit diagram of the transmitter, based on the KB4445 IC from TOKO.



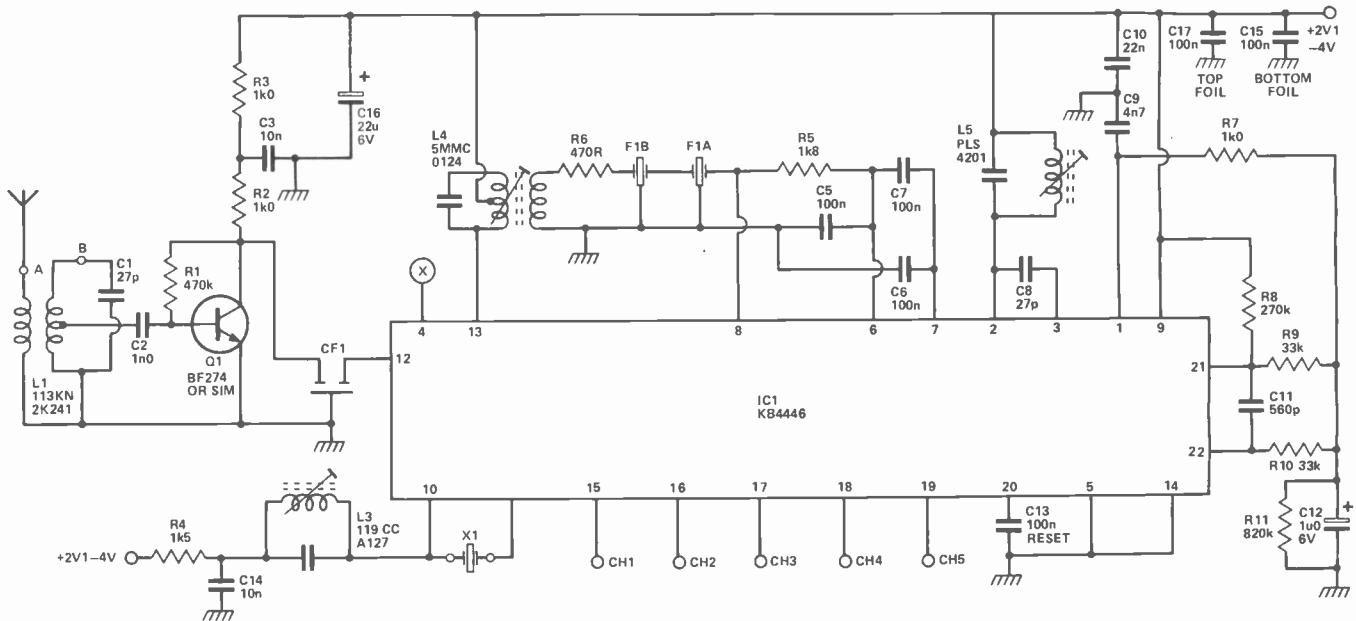


Fig.5 Circuit diagram of the receiver, built round the KB4446 IC, also from TOKO.

Supply And Demand

The KB4446 is designed to work on the exceptionally low voltage supplies (from 2V1 to 4 V) to be precise. This is because the standard servo supply rail of 4V8 is subject to a lot of fluctuation and noise from the effects of the DC motors continually stopping and starting. Despite NiCad batteries being a very low impedance power source, there is nearly always some effect on the supply voltage when the start and stall current of average servos are being drawn, but the difference between 4V8 and the nominal 3V0 of the KB4446 is quite enough to permit stabilisation via a pass transistor.

Both ICs contain an under voltage LED indicator to let you know when the power is approaching a dangerously low level. The indicator need not necessarily be a LED, as the output is available to drive a variety of alternative warning devices. A high efficiency piezo-ceramic resonator may be a more satisfactory system for outdoors applications where the light of a LED is easily flooded by sunlight. A suitable circuit is shown in Fig. 6.

Construction

The PCB and layout (Fig. 7) of the receiver reveals very little, apart from the fact that you will need a steady hand and a fine point on your soldering iron. The receiver was designed to fit into a standard plastic case with the facility to easily swap crystals and servo connections, so some aspects of the layout are not perhaps as ideal as the RF purist would have chosen. Nevertheless, it works.

The transmitter PCB is a straightforward device, since it is not necessary to apply the same size constraints. The board is designed to slot into a standard case made by Micron radio control.

Testing And Setting Up

The first thing to do is to ascertain that the transmitter is working. Those with access to an oscilloscope can check the data frame shape and size. Reference back to the internal

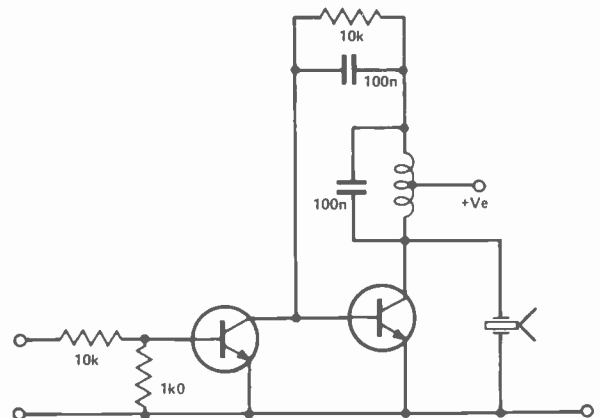


Fig.6 This piezo-electric resonator can be used as a low power alarm instead of a LED.

layout of the KB4445 (Fig.4) shows that the modulating waveform is available at pin 12 of the IC.

Carry out such tests with the crystal removed, since the close proximity of a strong RF field will tend to distort the readings of better (wide bandwidth) oscilloscopes. The frame signal should be set to 20 mS using the preset on pin 1 of the KB4445. If you do not have the necessary equipment to check this, set the 50k preset approximately halfway. The control sticks should similarly be set halfway.

The crystal may now be plugged in and attempts be made to set up the RF output. The best way to do this is with a spectrum analyser (and who hasn't got one these days ??). The next best thing is an absorption wavemeter, which is easily made by using a standard frequency coil and a small meter (Fig. 9).

This is standard procedure in many RC transmitters, although you must be careful where to dangle the pickup section, since it is possible to get misleading results due to localized RF fields that have very little in common with what's actually being transmitted by the antenna. By placing the pickup close by the output of the KB4445 at pin 15, it should be possible to get a reading without too much trouble. If not, the best thing to do is find someone with a known working 27 MHz transmitter and adjust your wavemeter for peak reading with this.

PARTS LIST

TRANSMITTER

Resistors ¼W, 5%

| | |
|----------|------|
| R1 | 1k5 |
| R2 | 22k |
| R3,4,5,6 | 8k2 |
| R7 | 6k8 |
| R8 | 390R |
| R9 | 10R |
| R10 | 15R |

Potentiometers

| | |
|-------|-------------|
| RV1-4 | 220k linear |
| PR1 | 47k preset |

Capacitors

| | |
|---------------|----------------------|
| C1,2,11,14,16 | 10n ceramic |
| C3-6 | 20n ceramic |
| C7 | 1u0 35V tantalum |
| C8,10 | 1n0 ceramic |
| C9 | 180p ceramic |
| C12,13,20 | 10u 16V electrolytic |
| C15 | 27p ceramic |
| C17 | 39p ceramic |
| C18 | 150p ceramic |
| C19 | 22n ceramic |
| C21 | 100p ceramic |
| TC1,2 | 27p trimmer |

Inductors

| | |
|------|---|
| RFC1 | 10 turns 32/36 SWG enamelled copper wire on ferrite |
| L1 | 1uH |
| L2,3 | MKXNA K3428 |
| L4 | KXN K3766 |

Semiconductors

| | |
|------|------------------|
| IC1 | KB4445 |
| Q1 | 2N3866 or 2N4427 |
| LED1 | any LED |

Miscellaneous

| | |
|--|-------------|
| X1 | 13.5740 MHz |
| PCB, Q1 heatsink, joystick pots (x2), telescopic antenna, case to suit | |

RECEIVER

Resistors ¼W, 5%

| | |
|--------|------|
| R1 | 470k |
| R2,3,7 | 1k0 |
| R4 | 1k5 |
| R5 | 1k8 |

| | |
|-------|------|
| R6 | 470R |
| R8 | 270k |
| R9,10 | 33k |
| R11 | 820k |

Capacitors

| | |
|--------------|------------------------|
| C1 | 27p ceramic |
| C2 | 1n0 ceramic |
| C3,4,14 | 10n ceramic |
| C5,6,7,13,15 | 100n miniature ceramic |
| C8 | 27p ceramic |
| C9 | 4n7 ceramic |
| C10 | 22n polyester |
| C11 | 560p ceramic |
| C12 | 1u0 6V tantalum |
| C16 | 22u 6V tantalum |

Inductors

| | |
|----|-------------|
| L1 | 113KN 2K241 |
| L3 | 199CC A127 |
| L4 | 5MMC 0124 |
| L5 | PCS 4201 |

Semiconductors

| | |
|-----|------------------|
| IC1 | KB4446 |
| Q1 | BF274 or similar |

Miscellaneous

| | |
|---|-----------------------------|
| CF1 | SFE27MA |
| F1A | CFM2 455D |
| F1B | NTK LFC6 |
| X1 | 26.640 MHz 3rd order T type |
| 7 way servo connector block, PCB, case to suit. | |

WAVE METER

Potentiometers

| | |
|-----|------------|
| PR1 | 47k preset |
|-----|------------|

Capacitors

| | |
|----|-------------------|
| C1 | 22p (if required) |
| C2 | 10n |
| C3 | 27p trimmer |

Semiconductors

| | |
|----|---------------------|
| D1 | any Germanium diode |
|----|---------------------|

Miscellaneous

| | |
|----|-------------|
| M1 | 100-500 uA |
| L1 | MKXNA K3428 |

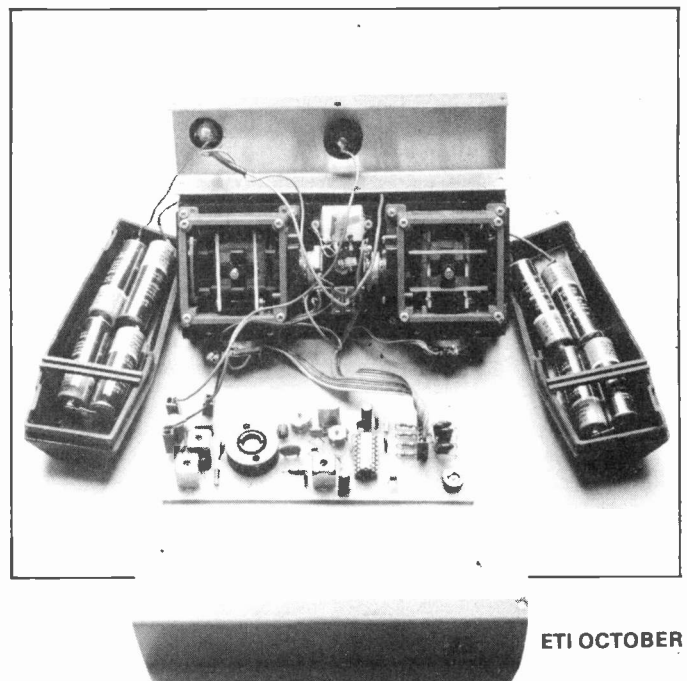
The antenna is a vital part of the output tuned circuit. It is an electrically 'short' transmission antenna, which creates a number of problems for the RF designer, the major one being that it is an integral consideration of the output tuning and so any adjustments really need to be made with the antenna in its finally intended form.

As soon as the first coil peaks, the current drawn by the transmitter should go up fairly dramatically as the output stage begins to warm up. Keep dabbing a finger on the PA stage to check that it does not get too hot. Using the absorption wavemeter placed by the antenna about halfway up and as far away as possible whilst still getting a reading (about 1m should be feasible), peak the coils in the transmitter.

The Receiver

If you have access to a working FM transmitter, use it for setting up the receiver (remember to use the correct crystal pair).

An audio amplifier with high input impedance can be used to monitor the detector of the KB4446 on pin 1, so you can



BUYLINES

Ambit International can supply a kit of parts for the transmitter unit for £6.80 + VAT. The case hardware and crystal are extra. A complete kit of parts for the receiver is also available for £8.00 + VAT. The crystal is extra.
Ambit International, 200 North Service Road, Brentwood, Essex.

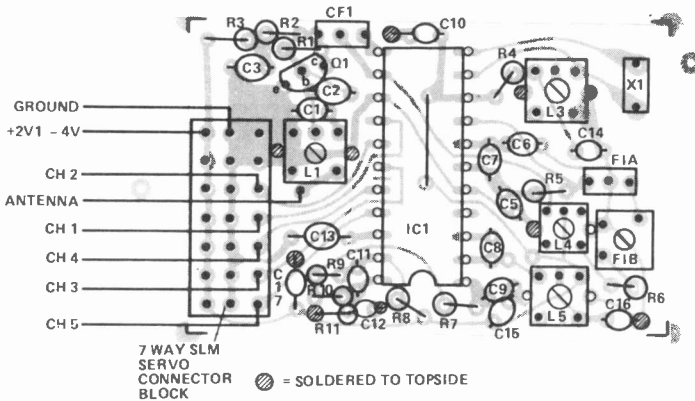
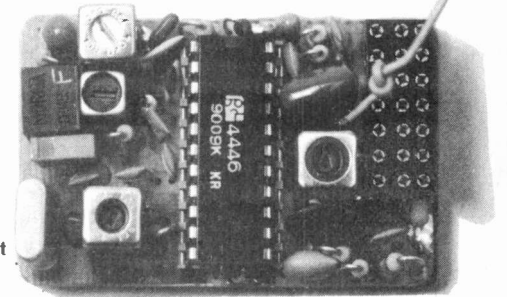


Fig.7 Component overlay of the receiver board (double sided).



(Right) The receiver circuit board (double sided). It's a bit of a squeeze, but it does all fit in.

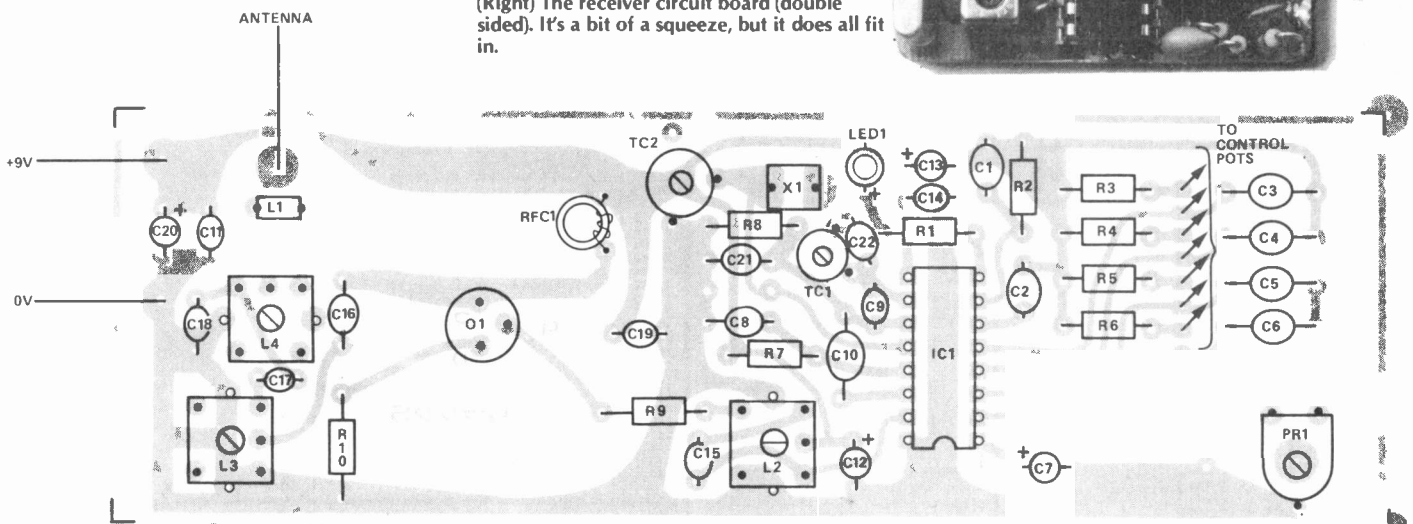


Fig.8 Component overlay of the transmitter board.

hear what is going on whilst tuning up. An oscilloscope at this point will display the detected control 'frame' It should be the same as that appearing at pin 12 of the KB4445 transmitter IC.

By starting with the transmitter and receiver in close proximity, you should have no trouble in getting a signal with which to commence the alignment process. By progressively reducing this input signal and peaking the coils, you will reach an optimum that corresponds to about 2 uV input for a correctly assembled unit. The setting of the crystal oscillator coil (at pin 10 of the KB4446) is critical and may need retrimming as the alignment proceeds to make certain the receiver and transmitter are correctly aligned co-channel. One of the few drawbacks of the FM system is the need for a more carefully matched Rx/Tx frequency than with AM. Stick to one particular make of crystals so that the loading requirements are the same.

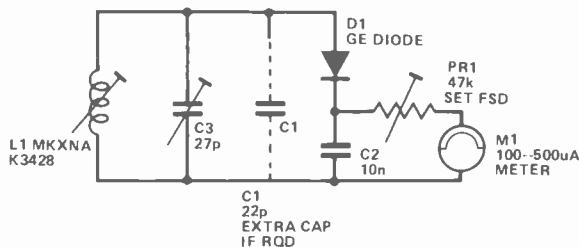


Fig.9 This absorption wavemeter can be used to set up the RF output.

Connect a servo to one of the output pins. It should work in response to adjusting the transmitter control. At least one commercial servo is a must, as this can then be used as a reference for the 1.5 mS channel pulse, ie with the controls at centre, the trimming should be adjusted so that the servo is at mid travel. If this is not possible, then a further preset may be needed in series with the control stick pots to bring them in range. If nothing at all happens with the servo connected, then it may be necessary to fit an external pull-up resistor on the output of the KB4446 (10k) to the supply rail of the servo amplifier IC.

Repeat the check on each channel and carry the transmitter down the garden whilst someone monitors the receiver and servos to ensure that adequate range can be achieved.

Finally

Under no circumstances should any home-made RC equipment be fixed into a model aircraft and flown. Apart from rules preventing flying in parks, the dangers of propelling a few pounds of balsa and metal about at 40-60 MPH demand that a much more cautious approach be adopted. The home made RC can be checked and verified in cars, boats and similar ground-based systems first, or you can have it professionally 'certified'. A licence is required and some experience and training in flying is essential.

ETI

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All our micro chips are at micro prices. Don't be fooled by low prices. We do not offer for sale, surplus, sub-spec or rebranded devices. All our parts are guaranteed new, first quality, factory prime, full spec devices. It is also our policy to offer you the best of new devices that become available and these are featured regularly. Prices are exclusive of p&g and VAT - please refer to "Ordering Information" before ordering. Official orders from Schools, Colleges, Universities and Gov. Authorities accepted.

| DTL | |
|------|-----|
| 930 | 55p |
| 935 | 55p |
| 937 | 55p |
| 944 | 65p |
| 946 | 55p |
| 957 | 55p |
| 967 | 55p |
| 9099 | 90p |

| 7400 | |
|-------|------|
| 7400 | 11p |
| 7401 | 12p |
| 7402 | 12p |
| 7403 | 13p |
| 7404 | 17p |
| 7409 | 18p |
| 7410 | 16p |
| 7411 | 18p |
| 7412 | 28p |
| 7420 | 16p |
| 7430 | 18p |
| 7432 | 25p |
| 7441 | 16p |
| 7442 | 68p |
| 7448 | 75p |
| 7473 | 32p |
| 7474 | 32p |
| 7475 | 40p |
| 7476 | 40p |
| 7490 | 35p |
| 7492 | 50p |
| 7493 | 50p |
| 7496 | 45p |
| 74121 | 35p |
| 74123 | 45p |
| 74154 | 90p |
| 74155 | 90p |
| 74122 | 45p |
| 74125 | 50p |
| 74195 | 100p |
| 74196 | 100p |
| 74283 | 140p |
| 74290 | 120p |
| 74365 | 90p |
| 74366 | 90p |

| 74LS | |
|---------|------|
| 74LS00 | 18p |
| 74LS01 | 12p |
| 74LS04 | 15p |
| 74LS08 | 20p |
| 74LS10 | 19p |
| 74LS11 | 30p |
| 74LS14 | 60p |
| 74LS15 | 38p |
| 74LS20 | 19p |
| 74LS30 | 19p |
| 74LS32 | 25p |
| 74LS40 | 26p |
| 74LS42 | 56p |
| 74LS47 | 78p |
| 74LS48 | 85p |
| 74LS49 | 99p |
| 74LS73 | 30p |
| 74LS74 | 39p |
| 74LS75 | 39p |
| 74LS90 | 40p |
| 74LS107 | 40p |
| 74LS123 | 69p |
| 74LS125 | 50p |
| 74LS138 | 69p |
| 74LS151 | 75p |
| 74LS153 | 75p |
| 74LS155 | 65p |
| 74LS161 | 78p |
| 74LS163 | 90p |
| 74LS164 | 90p |
| 74LS168 | 90p |
| 74LS174 | 99p |
| 74LS175 | 99p |
| 74LS191 | 87p |
| 74LS221 | 110p |
| 74LS244 | 175p |
| 74LS245 | 325p |
| 74LS251 | 120p |
| 74LS257 | 110p |
| 74LS290 | 95p |
| 74LS293 | 120p |
| 74LS366 | 57p |
| 74LS373 | 170p |
| 74LS374 | 170p |
| 74LS375 | 140p |
| 74LS377 | 180p |
| 74LS393 | 135p |
| 74LS490 | 140p |
| 74LS670 | 260p |

| CMOS | |
|------|------|
| 4001 | 18p |
| 4002 | 18p |
| 4006 | 75p |
| 4007 | 19p |
| 4008 | 80p |
| 4009 | 35p |
| 4010 | 45p |
| 4012 | 24p |
| 4013 | 38p |
| 4014 | 70p |
| 4015 | 75p |
| 4016 | 35p |
| 4017 | 60p |
| 4018 | 76p |
| 4019 | 42p |
| 4020 | 88p |
| 4021 | 100p |
| 4022 | 88p |
| 4023 | 22p |
| 4024 | 50p |
| 4025 | 20p |
| 4026 | 130p |
| 4027 | 45p |
| 4028 | 75p |
| 4029 | 80p |
| 4030 | 50p |
| 4031 | 195p |
| 4033 | 145p |
| 4034 | 104p |
| 4036 | 290p |
| 4037 | 105p |
| 4038 | 110p |
| 4039 | 290p |

| MEMORIES | |
|---------------------|------|
| 2114 300NS | 275p |
| 4116 200NS | 300p |
| 4116 150NS | 395p |
| 4315 (4Kx11) CMOS | 995p |
| 450NS | 995p |
| 6514 4K (1Kx4) CMOS | 850p |
| RAM450NS | 795p |

| EPROMS | |
|-----------------|-------|
| 1702A | 450p |
| 2708 450 NS | 425p |
| 2716 5V 450 NS | 850p |
| 2532 32K 450 NS | 2995p |

| UARTS | |
|------------|------|
| AY-5-1013A | 325p |
| AY-3-1015D | 398p |
| IM6402 | 425p |

| CHARACTER GENERATOR | |
|---------------------|------|
| RO-3-2513 UC | 450p |

| KEYBOARD/ENCODER | |
|------------------|------|
| AY-5-2376 | 795p |

| FLOPPY DISK CONTROLLERS | |
|------------------------------|-------|
| FD1771 B-01 S/D Inverted Bus | 2995p |
| FD1791 B-01 D/O Inverted Bus | 4995p |
| FD1792 B-01 S/D Inverted Bus | 3495p |
| FD1793 B-01 D/O True Bus | 5495p |
| FD1794 B-01 S/D True Bus | 3495p |
| FD1795 B-01 D/O Inverted Bus | 5995p |
| FD1797 B-01 D/O True Bus | 5995p |

| SUPPORT DEVICES | |
|-----------------|-------|
| 6520 | 495p |
| 6521 | 230p |
| 6522 | 652p |
| 6523 | 895p |
| 6551 | 1095p |
| 6810 | 375p |
| 6820 | 425p |
| 6821 | 425p |
| 6850 | 425p |
| 6852 | 425p |
| 8212 | 395p |
| 8214 | 450p |
| 8216 | 395p |
| 8224 | 395p |
| 8251 | 495p |
| 8255 | 1125p |
| 8259 | 495p |
| 8257 | 1050p |
| 8259 | 1325p |
| MC14412VL | 595p |
| 280 PIO | 595p |
| 280 CTO | 595p |
| 280A PIO | 695p |
| 280A CTO | 695p |
| 280 DMA | 1995p |
| 280 DMA | 2495p |
| 280 SIO 0 | 2995p |
| 280 SIO 0 | 3495p |
| 280 SIO 1 | 2995p |
| 280 SIO 2 | 2995p |
| 280 SIO 2 | 3495p |

| 74C | |
|--------|------|
| 74C20 | 30p |
| 74C76 | 60p |
| 74C85 | 145p |
| 74C97 | 125p |
| 74C98 | 125p |
| 74C107 | 100p |
| 74C160 | 110p |
| 74C161 | 145p |
| 74C162 | 145p |
| 74C163 | 145p |
| 74C192 | 175p |
| 74C193 | 175p |
| 74C194 | 175p |
| 74C195 | 175p |
| 74C903 | 45p |

| LINEAR IC'S | |
|-------------|-------|
| AY 3 8910 | 69p |
| 709 | 30p |
| 723 | 33p |
| 741 | 18p |
| ICL7106 | 595p |
| ICL7107 | 695p |
| ICL8038 | 295p |
| ICM7216A | 1875p |
| ICM7216B | 1675p |
| ICM7555 | 80p |
| LM301AN | 80p |
| LM311 | 50p |
| LM318 | 75p |
| LM339 | 45p |
| LM380 | 65p |
| LM1496 | 550p |
| LM1871 | 550p |
| LM3900 | 50p |
| LM3914 | 225p |
| LM3915 | 225p |
| LM13600 | 125p |
| NE555 | 18p |
| NE568 | 50p |
| RC4136 | 85p |
| SN76477N | 175p |
| TBA810DAS | 85p |
| TLO71 | 55p |
| TLO74 | 130p |
| TLO82 | 75p |
| TLO84 | 110p |
| TLO90 | 175p |
| XR2206 | 325p |
| XR2707 | 375p |

| INTERFACE LINEAR | |
|------------------|------|
| MC1488 | 90p |
| MC1489 | 90p |
| DMB123 | 125p |
| 75154 | 125p |
| 75182 | 195p |
| 75322 | 250p |
| 75324 | 325p |
| 75325 | 325p |
| 75361 | 350p |
| 75365 | 295p |
| 75451 | 50p |
| 75491 | 275p |
| 8T26 | 175p |
| 8T28 | 175p |
| 8T95 | 175p |
| 8T97 | 175p |

| LEDs | |
|--------|-----|
| TIL209 | 9p |
| TIL211 | 13p |
| TIL212 | 15p |
| TIL220 | 12p |
| TIL222 | 15p |
| TIL224 | 18p |

| DISPLAYS | |
|----------|------|
| FND500 | 80p |
| FND510 | 80p |
| FND567 | 125p |
| DL704 | 85p |
| DL707 | 85p |
| MV57164 | 225p |

| ISOLATORS | |
|-----------|------|
| IL074 | 120p |
| IL074 | 325p |
| MC16 | 90p |
| TIL111 | 75p |

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|------------------------------|-----|
| 8 pin | 7p |
| 14 pin | 9p |
| 16 pin | 10p |
| 20 pin | 12p |
| 24 pin | 15p |
| 28 pin | 18p |
| 32 pin | 22p |
| 40 pin | 28p |

| CPU'S | |
|---------|--------|
| 6502 | 795p |
| 6504 | 795p |
| 6505 | 795p |
| 6800 | 795p |
| 6802 | 995p |
| 8080A | 525p |
| 8085A | 1095p |
| Z80 | 795p |
| Z80A | 995p |
| Z8001 | 12500p |
| Z8002 | 9500p |
| WD9000B | 19900p |

| VOLTAGE REGULATORS | |
|--------------------|------|
| 7805 / 7812 | 55p |
| 7905 / 7912 | 65p |
| 78H055C | 575p |
| 78HGKC | 625p |

| BIPOLAR PROMS | |
|---------------------|--------|
| 93448 512 x 8 40 NS | p.o.a. |
| 93453 1k x 8 40 NS | p.o.a. |
| 93451 1k x 8 45 NS | p.o.a. |
| 93511 2k x 8 50 NS | p.o.a. |

SE 01 Sound Effects Kit

The SE-01 is a complete kit that contains all the parts to build a programmable sound effects generator. Designed around the new Texas Instruments SN76477 Sound Chip, the board provides banks of MINI-DIP switches and pots to program the various combinations of the SELF Oscillator or VCO Noise One Shot and Envelope Controls. A Quad Op Amp IC is used to implement an Adjustable Pulse Generator, Level Comparator and Multiplex Oscillator for even more versatility. The 3 1/4" x 3" PC Board features a prototype area to allow for user added circuitry. Easily programmed to duplicate Explosion, Phaser Guns, Steam Trains, or almost an infinite number of other sounds. The unit has a multiple of applications. The low price includes all parts, assembly manual, programming charts, and detailed 76477 chip specifications. It runs on a 9V battery (not included). On board 100mV amp will drive a small speaker directly or the unit can be connected to your stereo with incredible results! (Speaker not included.)

COMPLETE KIT ONLY £14.99
P&P 67p + VAT

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C106D 400V / 5A Sale 30p

NEW! AY-3-8910 Bang

THE NEW GI COMPUTER SOUND CHIP

The amazing AY-3-8910 is a fantastically powerful sound and music generator, perfect for use with any 8-bit micro processor. Contains 3 tone channels, noise generator, 3 channels of amplitude controls, 16-bit envelope period control, 2 parallel I/O. 3D+ Converters plus much more. All in 40 pin DIP. Super easy to interface to the S-100 or other Busses. Only £8.50 + VAT, including FREE reprint of BYTE 79 article! Also, add £2.25 for 60-page data manual.

Perhaps the next famous composer will not direct a 150-piece orchestra but, rather, a trio of microprocessors controlling a bank of AY-3-8910s. BYTE July 79.

MUSIC FOR YOUR EARS

Bullet's Electronic Music Maker™ Kit has a single 28 pin Microprocessor Chip with ROM that has been programmed to play the first 6 to 10 notes of the 25 popular tunes listed below. Each tune can easily be addressed individually or played sequentially at the push of a button. The 3 chime sequences are activated at any time by separate switch closures, so when used as a doorbell, one door can play songs while two others will play different chimes. The unit has a 5 watt audio amp and will run on either 12 VAC or 12 VDC. Construction is very simple, works with any 8 or 16 ohm speaker, or horn speaker (not included). Tunes can be remotely programmed using a single rotary switch (not included). If desired, Complete Kit £9.95 240 V Transformer optional.

NEW FROM EXAR:

The XR2266 Decoder/Sense & Drive Chip for toy cars that DRIVE LIKE REAL! ONLY £5.45!

This versatile 18-pin dual in-line IC combines both the decoder and the sense and drive functions to cut remote control car circuitry by at least a factor of two! Steering, lights, indicators, speed control — all from the new XR2266 at only £5.45!

SPECIAL OFFER! 4K CMOS RAM (1K x 4) 450 NS ONLY £6.95! (8 for £45)

The TC 5514P from Toshiba, CMOS equivalent of the 2114!

- Low Power Dissipation
- 10pW/BIT (TYP) @ 3.0V (STANDBY)
- 10uW/BIT (TYP) @ 5.0V (OPERATING)
- Data Retention Voltage 2V to 5.5V
- Single 5V Power Supply
- 18 PIN Plastic Package
- Full Static Operation
- Three State Output
- Input/Output TTL Compatible
- Fast Access Time 450NS

Toshiba's TC5514P (industry type 6514) is a full static read write memory organised as 1024 words by 4 bits using CMOS technology. Ultra low power dissipation means it can be used as battery-operated portable memory system and also as a non-volatile memory with battery back-up. Operates from a single 5V power supply with static operation, hence no refresh periods and a much simplified power supply circuit design. Three state outputs simplify memory expansion for minimum data retention voltage is 2V, the battery back-up systems needs only simple circuit. Toshiba's original CMOS technology also means wide operating and noise margins. The TC5514P is moulded in a dual-in-line 18 pin plastic package 0.3 inch in width.

NEW STEREO! S100 SOUND COMPUTER BOARD!

At last, an S-100 Board that unleashes the full power of two unbelievable General Instruments AY-3-8910 NMOS Computer sound ICs. Allows you under total computer control to generate an infinite number of special sound effects for games or any other program. Sounds can be called in BASIC, ASSEMBLY LANGUAGE etc.

KIT FEATURES

- Two GI Sound computer ICs (AY-3-8910)
- Four parallel I/O ports on Board
- Uses on Board audio Amps or your STEREO
- On Board proto typing area
- All sockets, parts and hardware are included
- PC Board is soldermasked, silk screened with gold contacts
- Easy, quick and fun to build, with full instructions
- Uses Programmed I/O for maximum system flexibility
- Both BASIC and ASSEMBLY language programming examples are included

COMPLETE KIT ... ONLY £59.96, includes 60 page data Manual
BARE BOARD ... ONLY £25.00, includes 60 page data Manual
AY-3-8910 chip special price with purchase of BARE BOARD (2 chips) £15.

SOFTWARE

SCL is now available! Our Sound Command Language makes writing Sound Effects programs a SNAP! SCL also includes routines for Register-Examine-Modify, Memory-Examine-Modify and Play-Memory. SCL is available on CP/M compatible diskette or 2708 / 2716 Diskette — £19.95, 2708 — £14.95, 2716 — £24.95. Diskette includes the source. EPROMs are ORG at E000H.

BOOKS

- Please order books by reference no. and title, and add 50p post & packing for each book ordered.
- 21168 Active Filter Cookbook £10.95
 - 21440 Aviation Electronics 3rd Ed £8.75
 - 21559 Audio IC Op Amp Applications 2nd Ed. £8.95
 - 21524 The Cheap Video Cookbook £4.50
 - 21398 CMOS Cookbook £7.75
 - 21539 Design of Active Filters with Experiments £6.95
 - 21537 Design of Op Amp Circuits with experiments £6.95
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NEW TUNES SYNTHESIZER

The AT3-1350 is a CMOS microcomputer synthesizer of programmed tones for applications in toys, music boxes and door chimes. The standard device has a set of 25 different popular and classical tunes. In addition there are 3 chimes making a total of 28 tunes.

FEATURES

- Minimal external components
- Automatic switch-off signal at end of tone for power saving
- Envelope control to give organ or piano quality
- Sequential tone mode
- A door capability when used as door chime
- Operation with tones in external PROM if required (2708)
- Simple supply (+5V) operation
- Tunes include: STAR WARS, BEETHOVEN'S 9TH and 5TH JINGLE BELLS, YANKEE DODDLE, STAR SPANGLED BANNER, CLEMENTINE, GOD SAVE THE QUEEN, O SOLE MIO, WEST INDIAN CHIMES, and DECKCHOWN OCTAVE CHIME. PLUS MANY MORE!

With detailed specs and instructions. **£6.95**

THE NEW ULN-2232A INTEGRATED MOTION DETECTOR

The most SOPHISTICATED MOTION DETECTOR available!

- Automatic Timed Reset
- 100mW Audio Output
- 120 Hz Rejection
- Visible or Infra-red Response
- Two Sound Patterns
- Long Range Operation

Combining 12L and Bipolar circuitry, the ULN-2232A Motion Detector is a complex optilinear IC which includes an on-chip photodiode, high gain logarithmic and linear amps, extensive digital circuitry for sound generation and timing, and high-current output drivers. Add on five small capacitors, a speaker and power source and you turn this state-of-the-art device into a complete Motion Detector sensitive to small changes in light level as a function of time. DETAILED DEVICE DESCRIPTION AND APPLICATIONS INFORMATION INCLUDED WITH EVERY ULN-2232A ONLY £7.60!

Ordering information: Unless otherwise stated, for orders under £50 add 50p p&p. Add 15% VAT to total (no VAT on books). All devices are brand new, factory prime and full spec and subject to prior sales and availability. Prices subject to change without notice.

Minimum telephone order using ACCESS is £10. If ordering by post with ACCESS, include name, address and card no, written clearly. Please allow 4/6 weeks delivery on books.

**NEXT
MONTH**

electronics today

INTERNATIONAL

Look out for the November issue —
on sale October 3rd.



SPACE INVADERS

In the past few months we've seen all manner of Space Invaders games — from enormous pub machines to programs on tape cassette for home computers. We've spent many a long hour researching the game in pubs and clubs from Land's End (Watford) to John O' Groats. Next month we present the ETI Space Invaders game for you to build. Plug the lead into the back of your telly and sit back with the box of tricks on your lap. Off you go — blasting aliens out of existence (with full sound effects, of course). World War III's OK, but there's nothing like the real thing — ETI Space Invaders — a computer game with a trick or two up its sleeve, as you'll find out next month.



Photos courtesy of Twentieth Century Fox.

FREE PCB

As we finish printing each issue of ETI with our John Bull set, we're sticking a free, gratis, no-more-to-pay printed circuit board on the cover. It has a million and one uses — you can prop up a wobbly coffee table, make a shower for the budgie . . . OR build the five projects we've designed for your free PCB. There's an RIAA equalised preamp, a 2 W amplifier, a touch doorbell, a light switch and a metronome. We give you the PCB; we give you the project designs . . . it couldn't be easier.

RADIOACTIVITY

Know your alpha, beta, gammas? If it's all just radiation to you, you could learn a thing or two from A.S. Lipson's excursion into that fantastic, frazzling, phenomenon of modern physics — Radioactivity. What makes something radioactive? What exactly is radioactivity? All will be revealed next month.

EVEN MORE PROJECTS

Not satisfied with bringing you our amazing Space Invaders game and FIVE projects for your free board, we've also got a doorbell with a difference (it plays tunes) and a straightforward, no frills Bench Amplifier for your test bench. It's all in ETI November.

AND THAT'S NOT ALL

Data Sheet puts in an appearance with all you need to know about a family of monolithic switched capacitor filter chips and a speech generator chip (a very clever little block of plastic). Talking of blocks of plastic, voltage regulators this time — we look at a very simple discrete component regulator design (for when you don't have the necessary chip to hand then and there). We know now that the Space Shuttle launch has definitely been postponed until at least next March. Astrologer explains why.

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



SPOT DESIGNS

Six pages of Spot Designs — a bumper bundle of tried and tested circuits with the ETI stamp of approval.

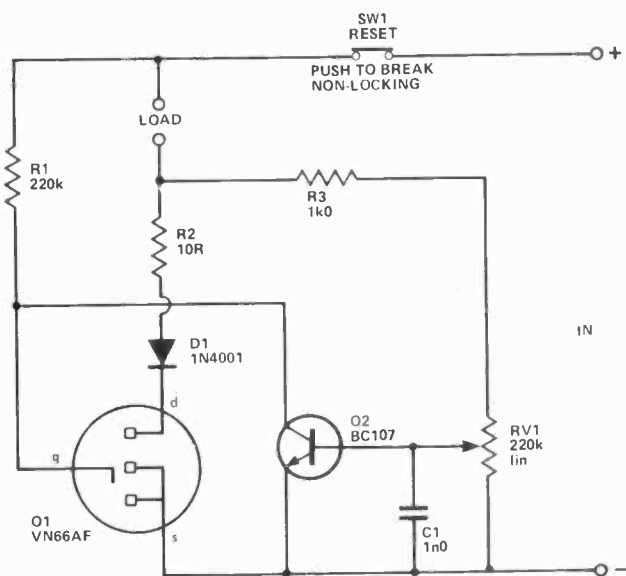
Overload Current Trip

Most power supplies incorporate some form of protection circuitry so that an excessive output current cannot flow in the event of an overload. However, these protection circuits are often designed merely to prevent the supply circuitry from sustaining damage, and in the event of an overload permit a level of current flow that is sufficient to damage the circuit being powered. This overload current trip can be used between the powered equipment and the power supply and will cut off the supply almost instantly if a preset threshold current is exceeded. The trip current can be varied from just a few to a few hundred milliamps. The unit will work with supply voltages of 5-40 V.

When power is first applied to the circuit, power FET Q1 will be biased hard into conduction by bias resistor R1. Power is, therefore, supplied to the load via Q1, D1 and R2. There will be a voltage drop across these components, and to some extent this varies with changes in the supply current. At low output currents there is likely to be a voltage drop of something in the region of 0V7, but this increases to a volt or so at high currents.

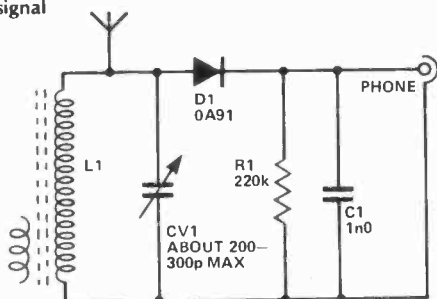
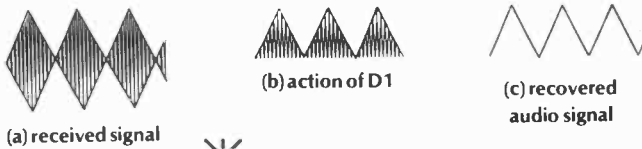
RV1 is adjusted so that at output currents below the required threshold level the proportion of the voltage dropped across Q1, D1 and R2 (and fed to Q2's base terminal) is not sufficient to switch on Q2. If the threshold current is exceeded, the voltage fed to Q2's base is then adequate to switch the device on and it diverts the bias current that formerly went to Q1's gate terminal. Q1 then switches off and cuts the supply to the load. Q2 remains switched on as it receives a strong base bias from the positive supply through the load, current limiting resistor R3 and RV1. Once tripped, the circuit thus latches in the "off" state. It can be returned to the "on" state by clearing the overload and then briefly operating SW1 so that the supply is momentarily disconnected from the unit. When the supply is restored it then starts at the "on" state once again. C1 ensures that the circuit does always initially assume the correct state and it also helps to prevent spurious triggering of the unit.

When using the unit it should be kept in mind that about 1 V is lost through the device and the output voltage from the supply must be adjusted to compensate for this. The current trip inevitably causes some loss of regulation efficiency, but this is only marginal. If the unit is to have a trip current of about 100 mA or more, R2 can be reduced to about 1R8 in order to maintain the low voltage drop and marginal degradation of regulation efficiency.



Crystal Set

The most simple form of radio for receiving broadcast stations is the crystal set, or more precisely, a modern equivalent using a semiconductor diode to provide detection. This simple set covers the normal medium wave broadcast band, has an output for a crystal earpiece and, in most areas, should give reception of Radios 1, 2 and



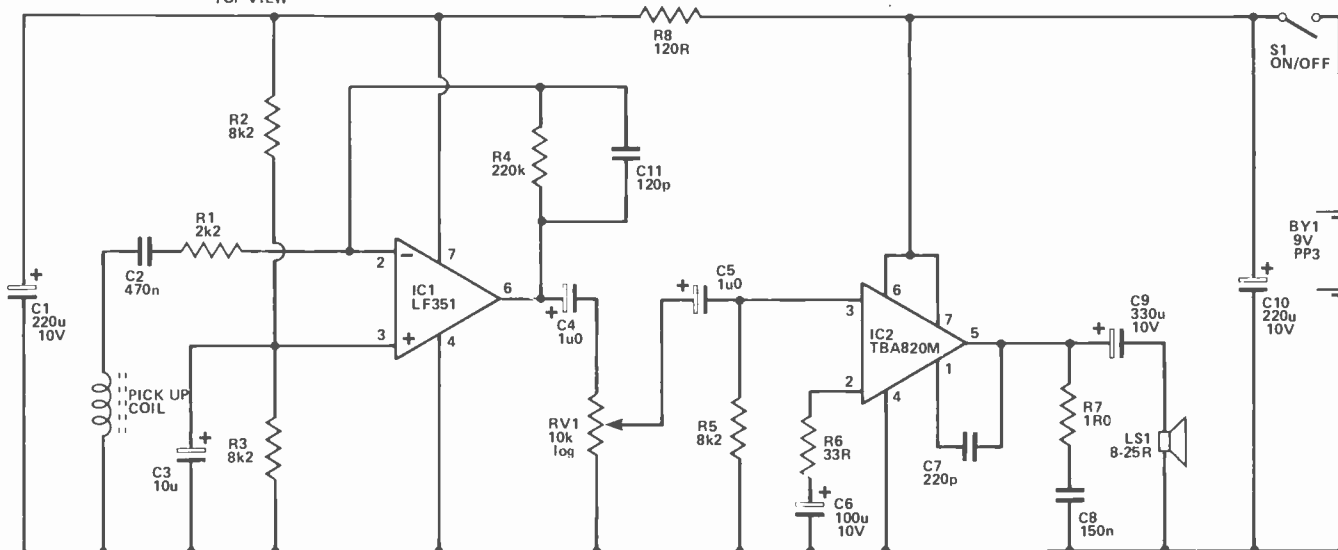
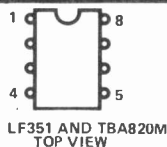
NOTE:
L1 IS DENCO MW5FR FERRITE
AERIAL OR SIMILAR.

3 at reasonable volume (plus any local radio stations where these are in operation on the medium waveband). It requires no battery or other form of power source since energy derived from the received transmission is used to drive the earpiece. However, this does bring the disadvantage of needing an external longwire aerial to operate the set, as an ordinary ferrite aerial does not give sufficient pick up.

The tuned circuit is formed by L1 and CV1. This selects the desired transmission and rejects other stations. CV1 permits full coverage of the normal medium wave broadcast band to be achieved. In order to obtain good volume from the unit it is necessary to directly couple the aerial to the tuned circuit. For the same reason it is necessary to take the output to the detector direct from the tuned circuit. This inevitably gives the set rather poor selectivity, but it should still be adequate in this respect.

The form of modulation used on the medium wave band is AM (amplitude modulation). This consists of varying the strength of the RF signal in sympathy with the amplitude of the modulating audio signal. D1 half wave rectifies the RF signal to leave only the positive half cycles. R1 and C1 are used to smooth the RF half cycles, but their time constant is too short to produce a steady DC output. Instead the output rises and falls in sympathy with the mean RF signal level, so that the original audio signal is recovered at the output and fed to the earpiece.

The only adjustment the finished unit requires is to slide the aerial coil (L1) along the ferrite rod to find a position that permits full coverage of the medium wave band. The coil is then taped or glued in this position. The smaller winding of the ferrite aerial is not required and is either removed or just ignored. The aerial should preferably be an outdoor type about 10m or so long, but a few metres of hook-up wire fixed around the walls of a room or in a loft should give reasonable results.



Telephone Amplifier

A telephone amplifier enables more than one person to follow a telephone conversation. The unit described here, in common with all normal units of this type, requires no direct connection to the telephone. Instead, the special pick-up coil has a built-in rubber suction cup that enables it to be easily attached to the telephone base. This produces only a very weak signal from the magnetic field radiated by an inductive component inside the telephone, but satisfactory results can be obtained if it is fed to low noise, high gain amplifier. It would of course be possible to use a much simpler circuit if a direct connection to the telephone were to be made, but this would make installation more difficult and it is ILLEGAL to make a direct connection to a Post Office telephone anyway.

The preamplifier stage of the unit is based on IC1 which is a low noise op amp having a FET input stage. This is used in the conventional inverting audio amplifier mode and the negative feedback network, R1,4, sets the voltage gain at about 40 dB. (100 times). C11

reduces the gain slightly at high frequencies in order to obtain an improved signal to noise ratio.

C4 couples the output from the preamplifier to volume control, RV1, and from here the signal is coupled to the power amplifier by C5. The output stage uses the TBA820M. This is a class B amplifier which will give an output power of a few hundred milliwatts RMS. The closed loop voltage gain of the device is determined by the value of R6, about 25 dB. (180 times) with the specified value. This gives the required very high overall gain in conjunction with the preamplifier's gain. C7, R7 and C8 are needed in order to maintain stability.

The quiescent current consumption of the unit is only about 5 mA, but this rises to as much as 50 mA or so at high volume levels. The best position for the pick-up coil on the telephone base (not the handset) can be located with a little experimentation. Be careful not to place the handset near the amplifier's loudspeaker or advance the volume control too far as this will cause a howling sound due to acoustic feedback.

D.M.M. To Stopclock Converter

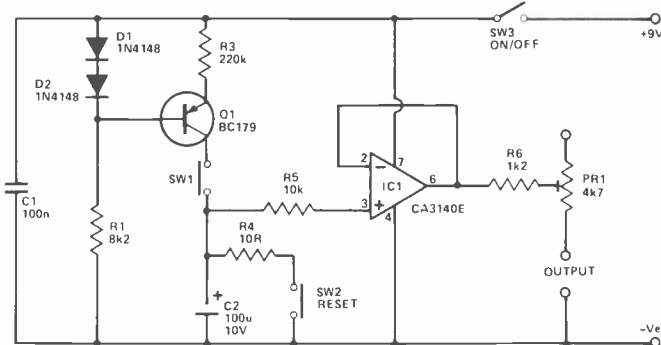
This simple add-on circuit can be used with a DMM switched to the 1 mA range to give a stopclock having a range of 0-99 S (or 0-199 S for a 3½ digit instrument). It can also be used with an ordinary analogue multimeter or panel meter, giving a range of 0-100 S, but the resolution will be lower than with a digital instrument.

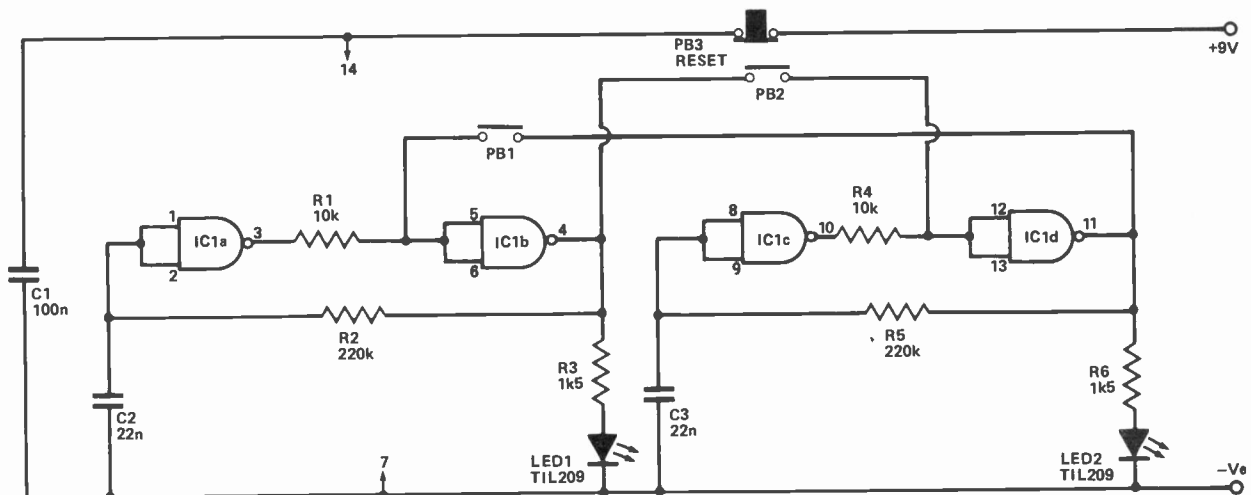
The unit relies on the fact that a linear rise in voltage is produced across a capacitor if it is fed with a constant charge current. The

capacitor (C2) must be a high quality type. The use of a tantalum bead component is, therefore, recommended. C2 cannot simply be charged from the supply lines via a resistor, since the voltage across the resistor would drop as the voltage across C2 increases. This would give a decreasing charge current as C2 charges exponentially and the required linear voltage slope would not be produced. C2 is, therefore, charged from a conventional constant current source which is based on Q1. D1, D2, and R1 form a simple shunt regulator circuit which bias the base of Q1 approximately 1V3 below the positive supply potential. There is a voltage drop of about 0V65 across the base emitter terminals of Q1, giving about 0V65 across emitter resistor R3. This gives an emitter current of roughly 3 uA and, as the collector and emitter currents of a high gain device (such as the BC179 used in the Q1 position) are virtually identical, a constant charge current of about 3 uA is fed to C2 when SW1 is operated. This low charge current together with the fairly high value of C2 produces a suitably long time constant.

It is essential that the voltmeter circuit takes no significant current from C2 as this would affect accuracy and would result in a decaying reading at the end of a timing run. Operational amplifier IC1 is, therefore, used as a unity gain buffer stage which gives an input impedance of about 1.5 million megohms and ensures that there is no significant loading on C2. PR1 enables the sensitivity of the voltmeter circuit to be adjusted to the correct level. In practice, SW1 is depressed for (say) 90 S and then PR1 is adjusted for the appropriate reading on the DMM.

SW2 is a reset switch and this discharges C2 (via current limiting resistor R4) if it is briefly operated. SW3 is an ordinary on/off switch. The current consumption of the circuit is only about 4.5 mA.





Quiz Monitor

This circuit is useful when playing "snap" or TV quizzes where the first person to have an opportunity of answering the question is the first to operate their push button switch. Operating it causes an indicator light to switch on and prevents the opponent's switch and indicator light from working. Thus, there is no doubt as to which push button switch was operated first.

The circuit is based on a CMOS 4001 quad two input NOR gate, but all of the gates have their two inputs connected together so that they, in fact, operate as simple inverters. The circuit has two identical sections, one for each player, each using two of the gates.

If we consider gates 1 and 2, at switch on C2 is in a discharged state and, therefore, takes the input of gate 1 low. This causes the output of gate 1 to go high, taking the input of gate 2 to the same state due to the coupling through R1. The output of gate 2 then goes low and feedback through R2 holds the input of gate 1 in its original low state, thus latching the circuit in this condition. LED 1 is driven from the output of gate 2 via current limiting resistor R3. At first it

will obviously be switched off. So will LED 2 which is the indicator light for the other player. It is driven from an identical arrangement.

If PB1 is activated, the input of gate 2 is taken low, since it will be taken to the low output of gate 4. This sends the output of gate 2 high, the input of gate 1 high (due to the feedback through R2) and the output of gate 1 low. The circuit will hold itself in this state even if PB1 is released. Operating PB2 will have no effect now, since this will merely connect the high output of gate 2 to the high input of gate 4, producing no changes in logic state. Thus the required blocking is obtained. Of course, if PB2 was operated first, LED2 would switch on and PB1/LED1 would be disabled, with the basic circuit action being the same as described above. The operating speed of the circuit is extremely fast and even with a very small gap between the two switches being operated, the unit is capable of determining which was operated first and there is no danger of both LEDs switching on.

The circuit is reset by briefly operating PB3 so that power is removed from the circuit and it starts once again from the beginning when PB3 is released. No on/off switch is required as the unit has a negligible quiescent current consumption.

Simple Preamplifier

This preamplifier has two inputs; one for a magnetic cartridge and the other is an "Aux" input for a tuner, tape deck, etc. Although the circuit is very simple, it uses an IC which is specifically designed for this application and provides low levels of noise and distortion. The unit is suitable for stereo operation and both the required amplifiers are contained within a single LM382 IC.

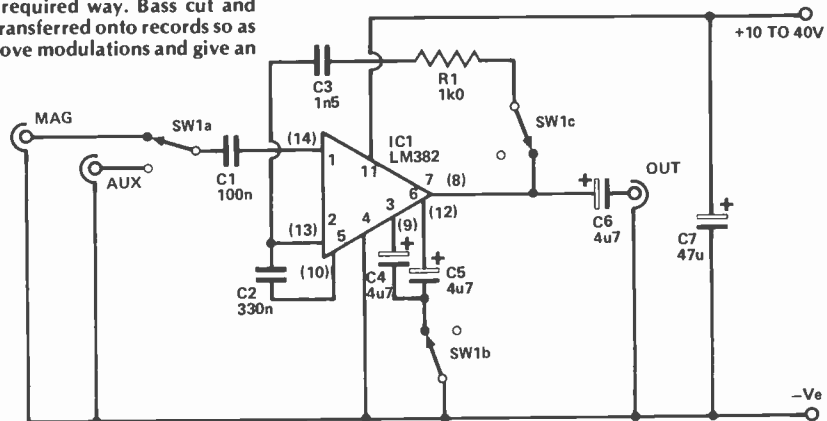
The circuit diagram is for one channel only, but apart from the IC pin connections the other channel is identical. The numbers in brackets show the pin connections for the other channel. The supply connections of IC1 are common to both channels.

The LM382 has an internal biasing circuit which sets the quiescent output voltage at approximately 6 V and no discrete biasing components are required. C6 provides DC blocking at the output. When switched to the "Mag" mode, external feedback components are required in order to shape the frequency response characteristic of the amplifier in the required way. Bass cut and treble boost are applied to the signals transferred onto records so as to prevent excessive low frequency groove modulations and give an

improved signal to noise ratio. The preamplifier must give corresponding bass boost and treble cut in order to give a flat overall frequency response to the system. C2, C3 and R1 are the discrete feedback components and the LM382 itself contains some feedback resistors. C4 and C5 provide DC blocking for two shunt resistors in the feedback network.

When switched to the "Aux" mode, most of the feedback components are not required and are switched out of circuit by SW1a and SW1c. C2 is left in circuit, but is superfluous. In this mode the circuit has a voltage gain of only about four and is really just operating as a buffer stage. SW1a connects the input of the amplifier to the appropriate input socket and C1 provides DC blocking at the input. Of course the input wiring must all be screened to prevent stray pick-up of mains hum, etc.

The current consumption of the circuit is about 12.5 mA. Due to the high supply ripple rejection of the LM382, it is not necessary to have a highly smoothed and decoupled supply.





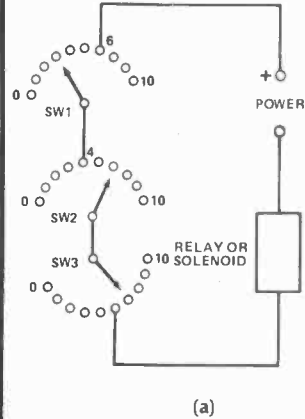
Combination Lock

Most combination locks are based on the simple arrangement shown in (a). This merely consists of three ten way rotary switches wired in such a way that they will connect power to the relay or solenoid if the correct combination is set on them (6-4-5 in this case). This basic circuit is not often used in practice since it does not take very long to quickly adjust the switches through all the 1,000 possible combinations (0-0-0 to 9-9-9 inclusive) if it is done in a logical manner.

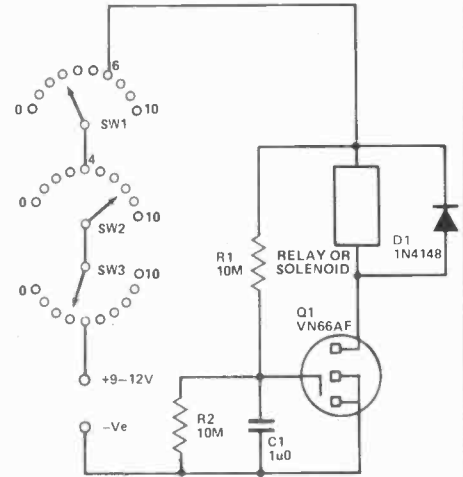
One of the simplest and best methods of overcoming this problem is simply to build a delay circuit into the unit so that power is not supplied to the solenoid or relay until the correct combination has been present for a few seconds. Quickly running through all the possible combinations is then ineffective at "cracking" the unit, as the delay circuit will prevent the unit from responding when the correct combination is briefly present. Anyone trying to "crack" the unit is very unlikely to succeed unless they know of the delay circuit and are prepared to devote a good deal of time to finding the correct combination.

Circuit (b) has an additional time delay circuit which is based on VMOS device Q1. When the correct combination is set on SW1 to SW3 and power is supplied to the circuit, C1 will be uncharged, giving zero gate bias to Q1. Q1 is, therefore, switched off and no significant current is supplied to the relay or solenoid which forms its drain load. C1 slowly charges via R1 and after about 4S the charge voltage on C1 will be large enough to bias Q1 into conduction and switch on the relay or solenoid.

R2 discharges C1 when the unit is reset, so that it is quickly ready to operate properly once again. R2 limits the maximum gate voltage of Q1 to only about half the supply voltage, but this is more than adequate to bias the device hard into conduction and is of no practical consequence. D1 suppresses the high back EMF produced across the relay or solenoid when it switches off and prevents possible damage to Q1.



(a)



(b)

Reverberation Unit

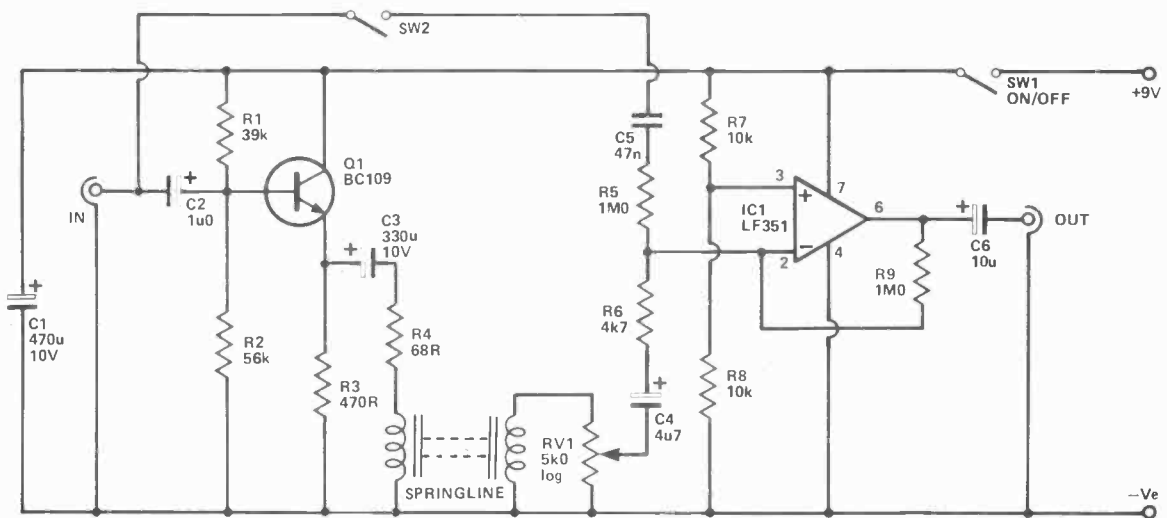
This unit simulates the long reverberation time of a large hall (usually around 2 S or so) and can be employed as a musical effects unit or to improve certain types of home-recording. Reverberation is caused by sounds being reflected around the interior of a room and in the case of a large hall the sounds are usually reflected many times before losing sufficient energy to render them inaudible. This, coupled with the fairly long distances covered by the sound waves between reflections, gives the long reverberation time and reverberant sound of a large hall.

There are several ways of simulating reverberation, but the simplest and most commonly used is probably the springline based system. A springline consists of two transducers linked by one or two long springs. If a signal is fed into one transducer it produces a corresponding audio signal which is transmitted down the spring to the second transducer. Here it is reconverted into an electrical signal again. However, the sound signal travels down the spring relatively slowly, and the signal is reflected backwards and forwards

along the spring many times before it decays to an insignificant level. Thus, the output from the second transducer is a good simulation of natural reverberation.

In this circuit the input signal is fed to the low impedance input transducer of a short springline via an emitter follower which gives a reasonably high input impedance of about 10k or so. This uses Q1 in a conventional configuration. The output of the springline unit is fed to one input of a mixer circuit. This is based on IC1 and again uses a conventional and well known arrangement. There are substantial losses through the springline and so the mixer is designed to boost the output of the springline by over 46 dB (200 times). The other input of the mixer is fed with the input signal, but the high value of R5 gives only about unity voltage gain at this input, so that the main signal does not overwhelm the reverberation signal.

RV1 enables the amount of reverberation signal mixed into the main signal to be controlled. It can be reduced right down to zero by fully backing off RV1. SW2 can be used to cut out the main signal so that only the reverberation signal appears at the output, if desired. The only other control is on/off switch SW1. The current consumption of the unit is approximately 10 mA.



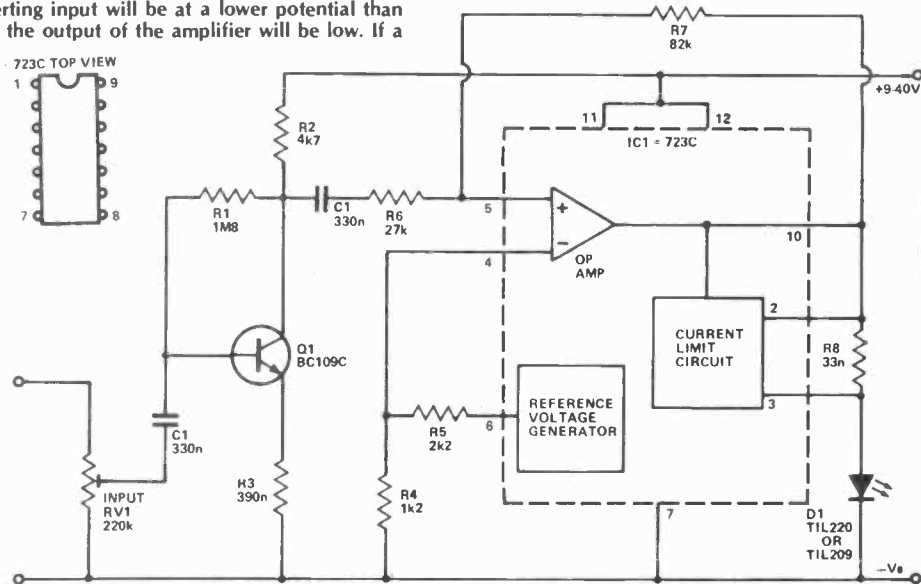
Peak Level Indicator

Peak audio level indicators can be used in tape recorders, amplifiers, mixers, and other radio equipment to provide a visual overload warning, and unlike slower responding VU meters, they produce a proper response to fast transients. This circuit is based on the inexpensive 723C device which, although primarily intended for use as a voltage regulator, can be adapted to work well in many other applications.

The 723C has a highly stable 7 V (nominal) reference voltage available at pin 6. This is coupled to the inverting input of an operational amplifier (which is also part of the 723C device) via an attenuator, R4,5. This gives a stable reference potential of a little over 2 V at the inverting input. The input signal is coupled by way of sensitivity control RV1 to a common emitter amplifier based on Q1 and fed to the non-inverting input of the operational amplifier by C2 and R6. Under quiescent conditions or with a negative going signal at Q1 collector, the non-inverting input will be at a lower potential than the inverting one, and the output of the amplifier will be low. If a

positive going signal reaches a high enough amplitude, though, the non-inverting input will reach a higher potential than the inverting one causing the output to go high. D1 is then switched on with a current that is determined by the output of the amplifier and which is largely independent of the supply voltage. Discrete resistor R8 actually sets the output current. The specified value gives a nominal 20 mA LED current. R7 provides positive feedback which ensures that D1 is either fully on or off. It also tends to hold D1 in the on state for slightly longer than would otherwise be the case, thus giving a clearer indication of a brief overload.

The unit can be adjusted to respond to input levels down to about 100 mV RMS, which should be more than adequate for all normal requirements. RV1 is adjusted for the lowest sensitivity that causes D1 to come on with an input signal level equal to the lowest overload level. Quiescent current consumption is only about 4 mA.



I.F. Alignment Oscillator

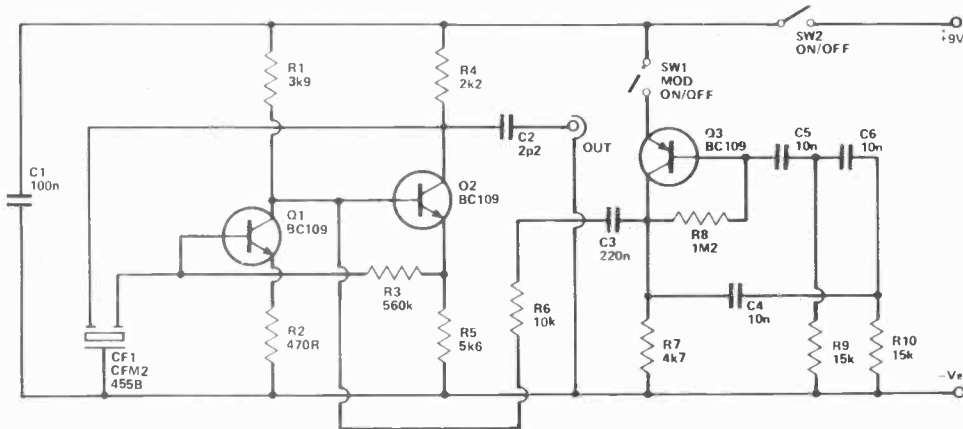
This simple piece of test equipment can be very helpful when aligning or realigning an AM superhet receiver. It provides an output at 455 kHz, which can be modulated by an audio tone if the set is being adjusted for maximum AF output. The modulation can be switched off if the IF transformers are to be adjusted for maximum AGC voltage.

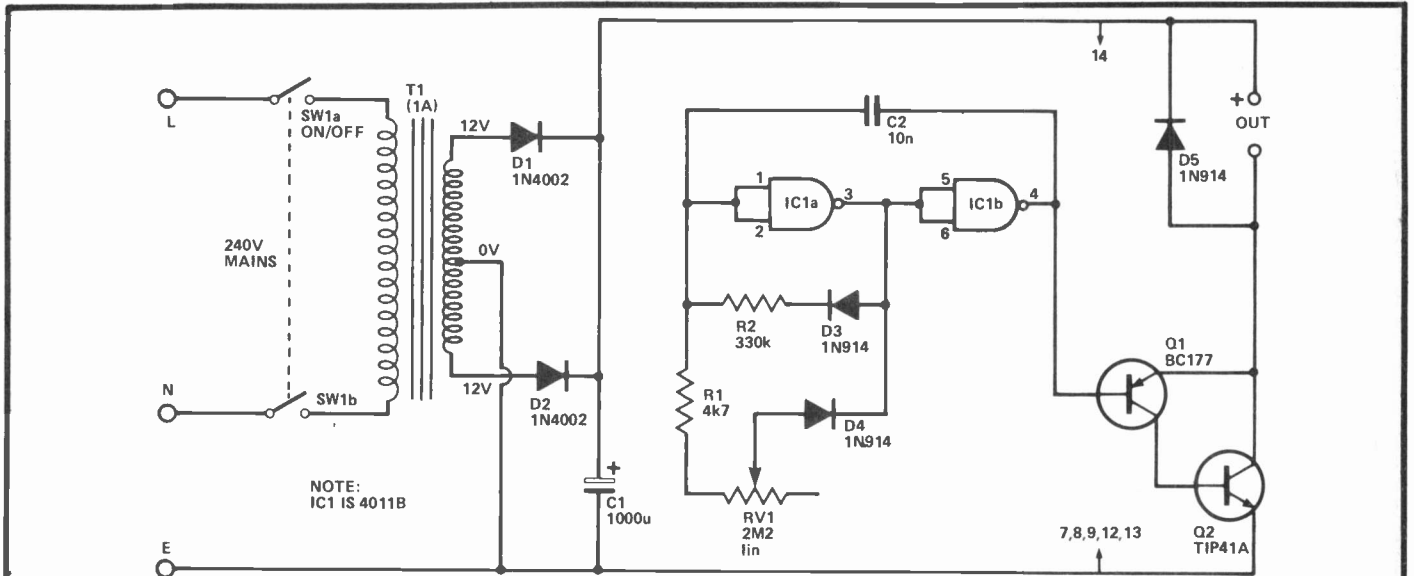
The circuit consists of two oscillators, Q1 and Q2 being used in the one which generates the 455 kHz signal and Q3 in the one which provides the modulation signal. Q1,2 are connected in a straightforward two stage, direct coupled, common emitter configuration. However, neither of the emitter resistors are bypassed in this case as only a low voltage gain is required. The input and output are in phase and positive feedback between the two is provided by ceramic filter CF1 (available from Ambit Interna-

tional). A significant amount of feedback is only provided at the 455 kHz operating frequency of the filter and so the circuit oscillates at this frequency.

A ceramic filter gives good frequency stability, requires no adjustment in order to produce the correct output frequency and is cheaper than using a crystal. C2 provides DC blocking at the output, although it should normally only be necessary to connect the "hot" output to the receiver, no chassis connection being necessary.

A straightforward phase shift oscillator is used to provide the modulation signal and the specified C-R values give an operating frequency of about 500 Hz. C3 and R6 couple this signal to the base of Q2 where it amplitude modulates the 455 kHz signal. SW1 can be used to cut the supply to Q3 and thus remove the modulation. Current consumption is about 2.5 mA with the modulation switched on and approximately 1.7 mA switched off.





12V DC Motor Speed Controller

This motor speed controller is of the type where the motor is fed with a series of pulses of fixed duration and the power fed to the motor is varied by altering the frequency of the pulses. The higher the frequency, the greater the power fed to the motor, up to the point where there is virtually no gap between the pulses and the motor is operating at full speed. A useful characteristic of this type of controller is that it gives relatively good results at low speeds and wastes little power with consequent low dissipation in the circuit. This circuit is for 12 V DC motors having a maximum current consumption of up to 1 A (or 2 A if the secondary current rating of T1 is raised accordingly).

T1, D1, D2 and C1 form a simple DC supply which gives a loaded voltage of just over 12 V (just over 17 V unloaded). This is used to drive a CMOS astable multivibrator which is based on two of the gates in a 4011B device. The two gates that are used each have their

two inputs connected together so that they act as inverters and are connected in what is basically just the standard CMOS astable circuit.

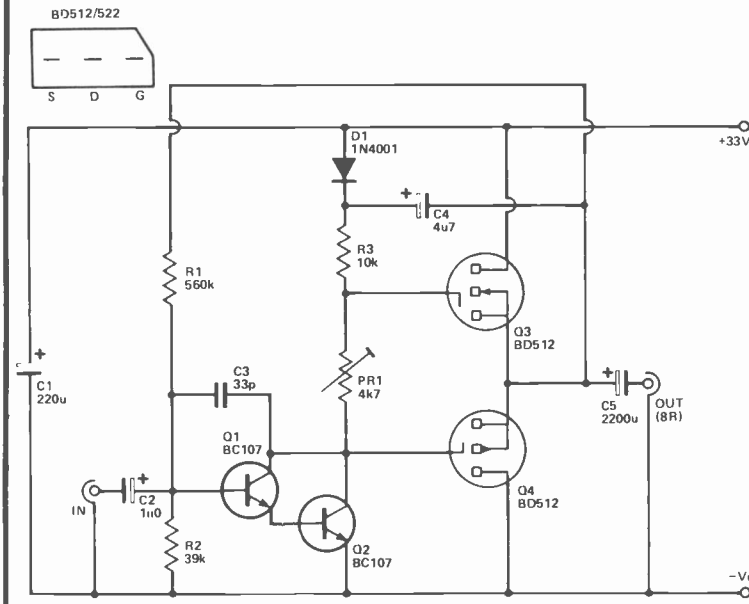
The circuit differs from the standard configuration in that there are two timing resistances; one formed by R2 and the other by the series resistance of R1 plus RV1. D3 and D4 are steering diodes. In effect, R2 forms the timing resistance when the output of the astable is high and gives an output pulse of fixed duration. RV1 and R1 act as the timing resistance when the astable's output is low and the duration between output pulses can, therefore, be varied using RV1.

With RV1 at minimum resistance there is a negligible gap between the output pulses, giving maximum speed from the motor. Increasing the resistance of RV1 increases the duration between the pulses, giving decreased average output power or no significant output power at all with RV1 at maximum resistance.

Since the astable has only a low output current capability, the motor must be driven via a buffer amplifier. This uses Q1 and Q2 in the common emitter mode, with 100% overall negative feedback so that unity voltage gain (but a high current gain) is obtained.

VMOS 10 Watt Amplifier.

At first sight this circuit may seem to be a straight forward Class B design having an emitter follower, complementary output pair and Darlington Pair common emitter driver stage. However, the output devices are, in fact, complementary VMOS transistors used



in the source follower mode (the FET equivalent of the emitter follower). In most other respects the design is quite conventional.

R1 and R2 are used to bias the unit to give the optimum quiescent output potential and they provide overall negative feedback, which improves the quality of reproduction. D1 and C4 are bootstrapping components, enabling the gate drive voltage to Q3 to go above the positive supply potential, giving improved efficiency to the circuit. R3 is the main collector load for Q2 and PR1 is used to give a standing bias on the output transistors that gives a quiescent current consumption of about 25 mA. The thermal compensation circuitry normally used is totally unnecessary in this circuit, since VMOS devices do not suffer from thermal runaway. In fact the quiescent bias current will drop slightly as the output devices heat up, but not sufficiently to give rise to significant cross-over distortion.

C2 and C5 provide DC blocking at the input and output respectively, while C1 is a supply decoupling component. C3 gives a degree of high frequency attenuation and aids the stability of the circuit.

Although the current in the driver stage, only about 1 mA, may seem to be totally inadequate, it is in fact more than sufficient since the VMOS devices have extremely high input impedances and consume no significant input current. This is one of their main advantages over bipolar devices. One disadvantage in this particular application is lower efficiency due to the higher threshold voltages and on resistance of VMOS transistors in comparison to bipolar devices. However, the circuit will give an output of 10 W RMS using a supply voltage of about 33 V or so (with a current drain of up to about 600 mA). An input of about 500 mV RMS is needed for maximum output.

Note: The output devices do not have internal zener protection diodes and the appropriate handling precautions should be taken. These devices are available from J.W. Rimmer, 367 Green Lanes, Harringay, London, N4 1DY.

QUARTZ LCD 11 Function Slim Chronograph

12:30^{pm} 45

Hours mins secs

8 14TH

Month date day

0:00⁰⁰

Min secs 1/10 1/100



Price only
£8.95

Also available:
SOLAR CHRONOGRAPH
M9 Price £11.95

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

M3 Price includes POST & PACKING

QUARTZ LCD ALARM with Snooze Alarm

12:30^{pm} 45

Hours mins secs

8 14TH

Month date day

7:30^A

Alarm



Price only
£9.95

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

SAME DAY DESPATCH.

M4 Price includes POST & PACKING

QUARTZ LCD ALARM CHRONOGRAPH with 12/24 display

12:30^{pm} 45

Hours mins secs

8 14TH

Month date day

0:00⁰

Min sec 1/10th

7:30^A

Alarm



Price only
£13.95

Also available:
SOLAR ALARM CHRONO
M7 Price £17.95

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

M64 Price includes POST & PACKING

QUARTZ LCD Ladies Day Watch

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

12:30

Hours mins

8 14

Month date

:45

Secs



Price only
£7.95

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

M15 SAME DAY DESPATCH. P.&P. included

QUARTZ LCD Ladies Cocktail Watch

Beautifully designed with a very thin bracelet.

12:30

Hours mins

8 14

Month date

:45

Secs



Price only
£14.95

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backlight and autocalendar.
Bracelet fully adjustable to
suit slim wrists.
State Gold or Silver finish.
Only 25 x 20 x 6mm.

M18 SAME DAY DESPATCH. P.&P. included

HANIMEX Electronic LED Alarm Clock

Features and Specification:

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



M13

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£10.20 Mains operated.
Thousands sold!

QUARTZ LCD 5 Function GENTS/BOYS

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

12:30

Hours mins

8 14

Month date

:45

Secs



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CENTRES AND SEE ONE OF THE MOST
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**QUARTZ MELODY
Alarm Chronograph**

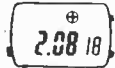
INCREDIBLE WATCH 34 Functions



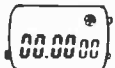
Count-down Timer



Alarm



Time Zone



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

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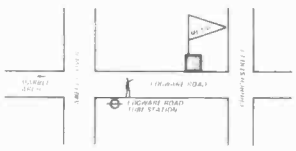


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**SAME DAY
DESPATCH.
M10**

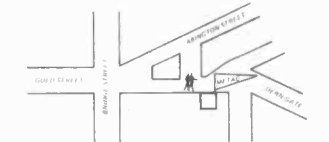
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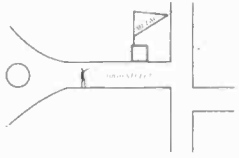
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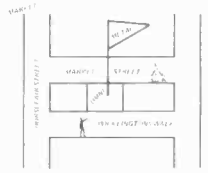
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FLASH TRIGGER

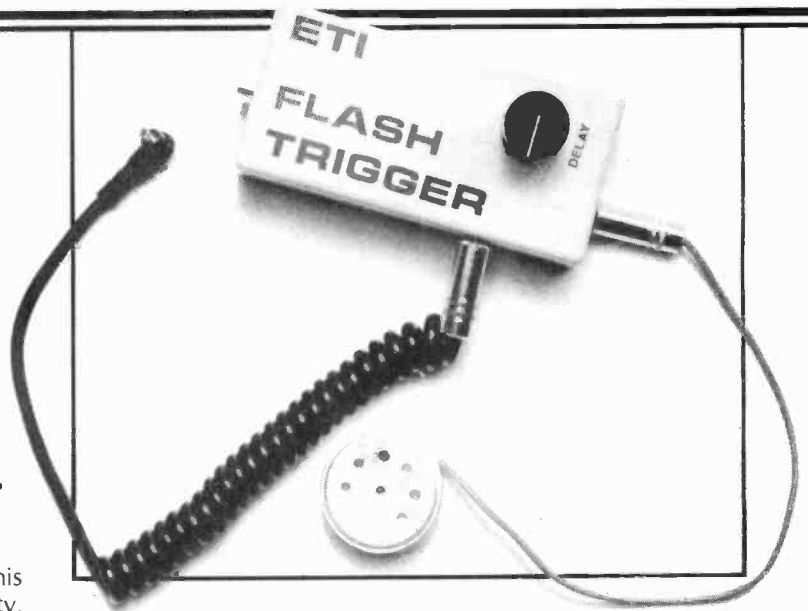
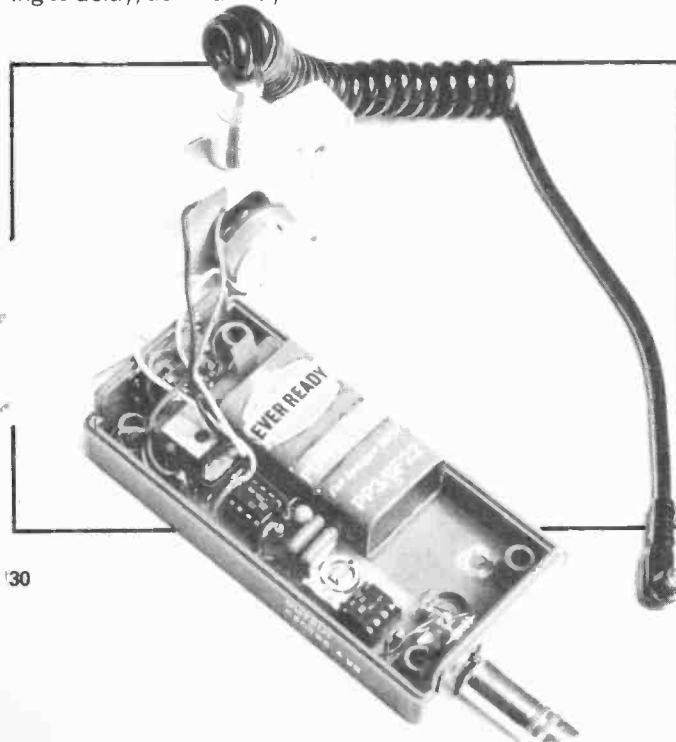
This versatile unit fits in your pocket — ready for use in a flash.

Flash triggers have been with us for a few years now. This design offers all the usual features plus pocketability. Only a couple of cheap chips are used with a careful (check the photos) of other components. Using the specified component values, the unit may be employed either as a direct slave or may introduce a delay variable between 10 mS and 200 mS. Other delay times may be achieved by a single component change.

A number of devices may be used to trigger the unit. Operation as a sound operated flash requires only one extra component, a crystal insert or microphone.

Construction

Our PCB design will enable you to build the unit into a compact case. A preset component was used for PR1, though a standard potentiometer can be substituted if you have room and require adjustable sensitivity. If you do use our PCB then construction will be straightforward. Just follow our drawings and PCB overlay. As usual, insert the low-profile components first taking care to orient the semiconductors correctly. If you do not have a BC184L, almost any other small NPN silicon transistor can be substituted. However, note the TO92A pin configuration which differs from that of many popular transistor types. We included a power 'on' LED indicator in our design next to the input socket. A word of warning: remember that the trigger leads of many flash guns may have a potential of up to 200 V across them. This is usually low current but may give the clumsy constructor a tingle. This versatile unit should find a place in every photographer's grab-bag, so if you are going to delay, do it our way!



HOW IT WORKS

The flash gun is discharged by short circuiting its trigger contacts. This is usually achieved by a mechanical contact closure operating synchronously with the camera shutter release. In this design, the camera contacts are replaced by an electronic switch, thyristor Q2. This device is turned on, simulating a contact closure, by application of a positive-going pulse to the gate.

With SW1 in the 'direct' position, the thyristor will be triggered from the output of IC1, a 741 op-amp configured in the variable gain non-inverting mode. The use of C1 gives the amplifier a high available AC gain while minimising the effects of amplifier offsets. Gain is preset to the desired level by adjustment of PR1. For a straightforward sound operated flash, the input to IC1 may consist of a simple crystal insert connected between the junction of R1, 2 and ground. Any device capable of producing a small pulse may be employed at the input. Note that the unit will trigger from positive going edges in the 'direct' mode and from negative edges when switched to 'delay'.

A negative going output from IC1 will trigger the 555 timer, IC2. The delay introduced by this chip is variable between about 10 mS and 200 mS by adjustment of RV1. Other delays may be achieved by changing the value of C4. As the delayed trailing edge output from IC2 is of the wrong sense, it is inverted by Q1 to provide a suitable trigger pulse for Q2. Capacitor C3 provides overall decoupling.

There isn't a lot of space to spare inside the case. Make sure you leave a corner free for the potentiometer body, or the case won't close properly.

PARTS LIST

| | |
|------------------------|------------------------|
| Resistors all 1/4 W 5% | |
| R1,2,3,4 | 39k |
| R5,6 | 100k |
| R7 | 10k |
| Potentiometers | |
| PR1 | 100k horizontal preset |
| RV1 | 2M0 |
| Capacitors | |
| C1,2,4 | 100n polyester |
| C3 | 4u7 tantalum |
| C5 | 10n polyester |
| Semiconductors | |
| IC1 | 741 |
| IC2 | 555 |
| Q1 | BC184L |
| Q2 | C106D |
| D1 | 1N4148 |

NOTE:
Q1 IS BC184L
Q2 IS C106D
IC1 IS 741
IC2 IS 555
D1 IS 1N4148

Fig.1 Circuit diagram. Any device capable of producing a small pulse can be used at the input.

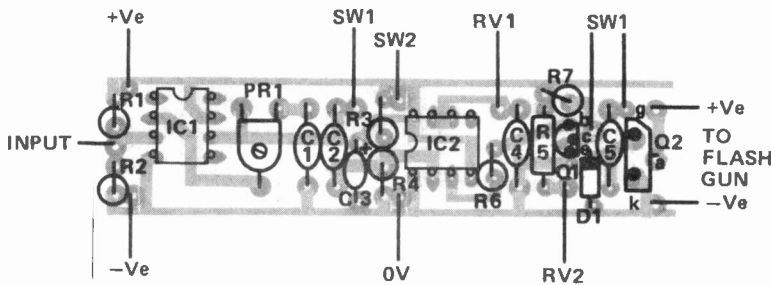
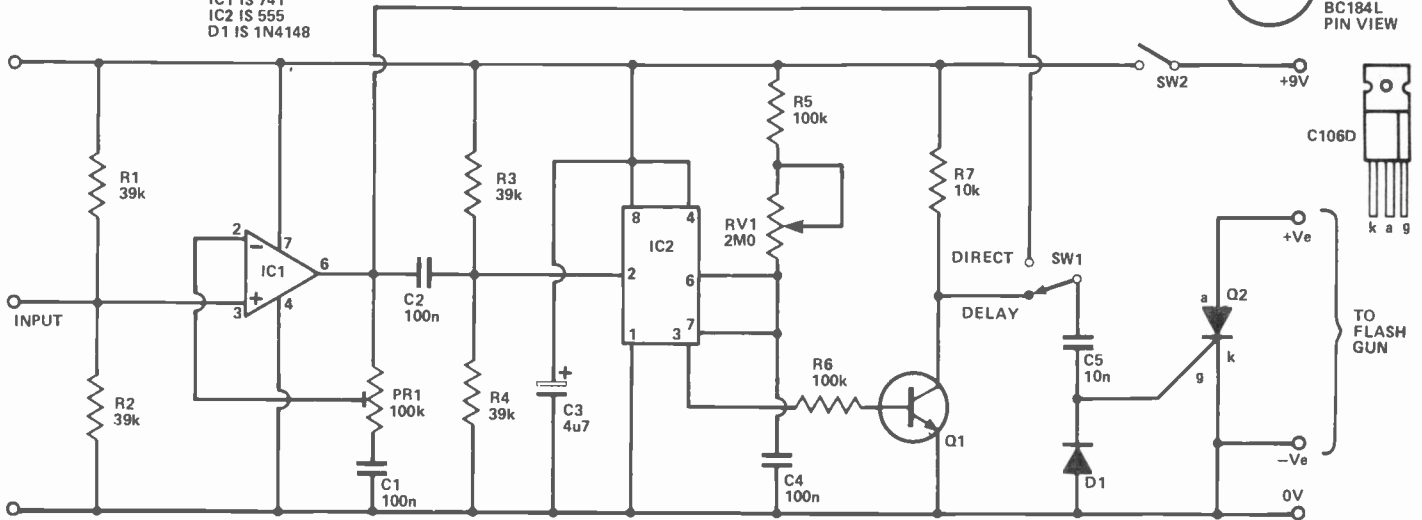


Fig.2 Component overlay.

BUYLINES

All the electronic components should be readily available from your usual supplier or see the adverts in this issue. The Vero plastic box we used is their stock number 202-21027E.

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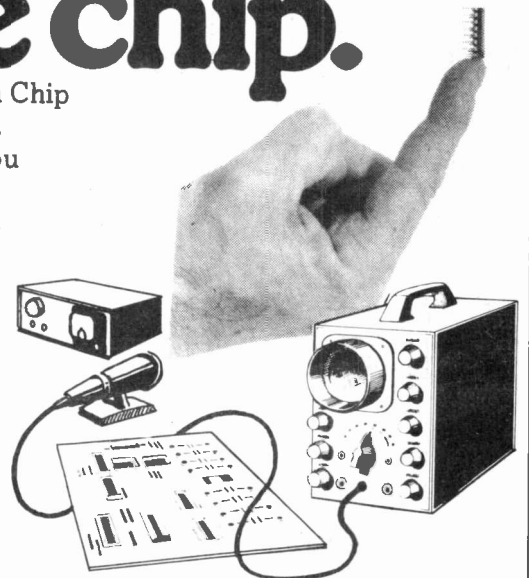
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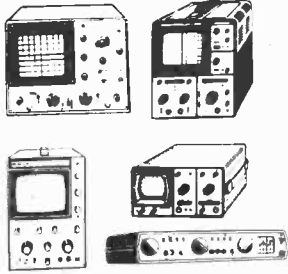
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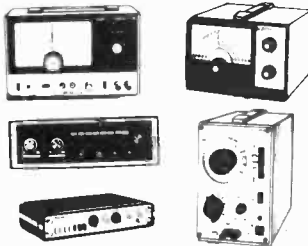
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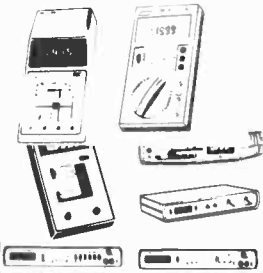
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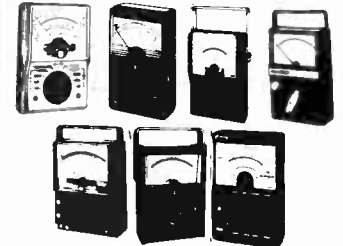
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Freezer Alarm

Still in the kitchen, we've cooked up another winner for you with this little freezer alarm circuit. Should the temperature rise above a pre-determined level then the alarm will sound. Anyone who has ever seen a freezer full of unfrozen food will know how valuable this little project could be!

Light Dimmer

Here's one for those afraid of bright lights. This all new dimmer circuit will fit into the standard light switch socket. It'll let you control your lighting from a harsh glare to a warm seductive glow, just right for those long winter evenings in front of the telly. It might even save a few bob on the electricity bill too!

Doorbell

Just in case you've fallen asleep, safe in the knowledge your freezer's OK, the lights are low (courtesy the HE Light Dimmer), the meal was perfect (thanks to the HE Kitchen Timer), you'll be glad to know that the HE Nobell Doorbell will wake you up. This novel little circuit faithfully re-creates the sound of a mechanical door-knocker. No prizes for guessing why we called it the Nobell.

Temperature Controlled Soldering Iron

If we've tempted you into building any of these projects then you should know about our Temperature Controlled Soldering Iron project next month. You'll be able to build all of the projects without worrying about burnt out bits anymore.

Home Electronics

To round it all off we will be taking a look at some of the benefits electronics has brought to the home. The homely Tina Boylan looks at some of the gadgets on sale today and some of the labour saving devices we can expect in the next few years.

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

3½ DIGIT LCD MULTI-METER KIT

NEW

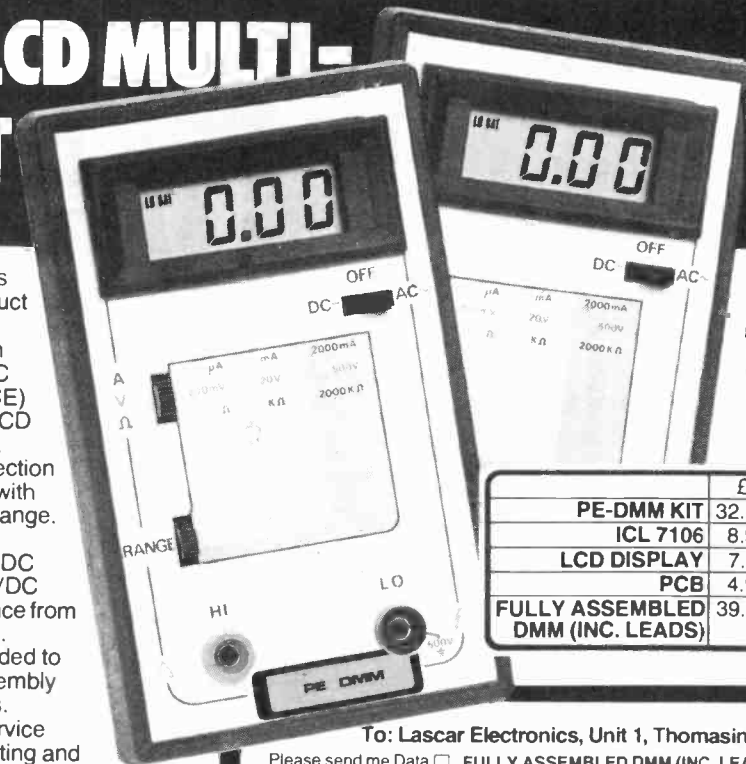
Build the Practical Electronics handheld DMM. This superb product offers professional precision with extended battery life. Five function operation (AC and DC VOLTS, AC and DC CURRENT, RESISTANCE) with ability to check diodes. 0.5" LCD display with 'Battery Low' warning. Auto-polarity, Auto-zero. Full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

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SPECIAL RELATIVITY

Einstein ranks as one of the giants of physics. A.S. Lipson looks behind the equations and tells the story of the special theory of relativity.

In 1905, Einstein published three papers. It was the third of these which was concerned with special relativity. In this paper — "On the Electrodynamics of Moving Bodies" — he set out by making two apparently innocent assumptions; that the velocity of light as measured by some inertial observer does not depend on the velocity with which this observer is moving, but will only be affected if the observer is accelerating or decelerating (an inertial observer is one who travels with constant velocity, without accelerations or decelerations) and that the laws of physics as measured by the observer are also independent of his velocity. From these assumptions, Einstein produced — using the most beautifully simple arguments — conclusions that rocked common sense and upset people's basic ideas about space and time.

If the laws of physics, *all* laws of physics, are the same, no matter what the velocity of the observer measuring those laws is, then there is no way in which that observer can tell with what velocity he is moving, or even if he is moving at all, just by performing an experiment in his own reference system, which is moving along with him.

Relative Motion

If, for instance, you are in a smoothly-running train, with all the windows covered over, and without noises from outside, such as the sounds of the wheels on the tracks, then you cannot tell by any means whether the train is in uniform motion, or standing still. However, should one of the windows be uncovered, so that you can see outside, you can then tell whether or not the train is moving by whether or not the buildings outside appear to be passing you at high speed.

Even so, information from the outside world can be very difficult to interpret sometimes. If your train is in a station, with another train on the line just next to it, then when your train pulls out, it can be very difficult to decide whether the motion you observe is due to the other train travelling slowly in one direction, or your own train travelling slowly the other way.

Ether It's There Or It Isn't

Since Newton, there had been a running debate among physicists as to whether light consisted of a wave or a beam of particles. These days, it is believed that it actually consists of a sort of cross between the two, which is virtually impossible to visualise, but is extremely useful for explaining various phenomena. However, by the second half of the nineteenth century, everyone was pretty certain that it was a wave. Maxwell had predicted the theoretical speed of electromagnetic waves and it had turned out to be pretty nearly the same as the experimentally measured speed of light and that was that — light was probably an electromagnetic wave. The one problem was that all other known waves travelled through a medium of some kind; sound waves through air, water waves

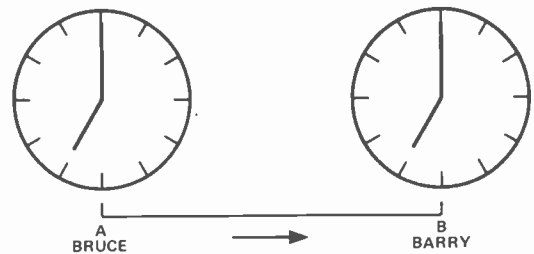


Fig.1 To Bruce it appears that Barry's timescale is 'running slow'. To Barry it appears that it is Bruce's timescale that is slow.

(obviously) through water, and so on. Light seemed to travel through a vacuum — for instance, from the Sun to the Earth. It didn't seem to need a medium. So they invented one; the ether

The ether supposedly filled all space, acting as a medium for light, but not interacting with matter. (So, for instance, it didn't slow down the Earth in its orbit around the Sun.) The fact that there was no experimental evidence for this ether did nothing to change physicists' minds.

Now we can see why Einstein's ideas were so radical and unpalatable to scientists of the time. He, a mere patent clerk at the time, was daring to challenge the scientific principles laid down by Isaac Newton, acknowledged as the greatest scientist of all time. What Einstein was saying was that there was no need for an 'absolute' reference system — or even for the concept of the 'ether'. In order to make these statements logically consistent, though, he had also to abolish the concept of absolute time.

Time

Time, according to the special theory of relativity, is dependent on velocity. This is best explained by giving an example. Consider two inertial observers, moving rapidly towards each other. For the sake of argument we can call them Bruce and Barry. Let us imagine that Bruce and Barry are approaching each other with a velocity v , and that each of them has a very accurate clock, which they carry along with them. Now according to relativity, if Bruce looks at Barry's clock and compares it with his own, it will appear to him that Barry's clock is running fractionally slower. Not only that; Barry himself will also be 'running slower' — his breathing, pulse rate, and so on will all have slowed down by just the same amount. In fact, it will appear to Bruce that Barry's time scale has slowed down! Well, if this is so, then it follows that it appears to Barry that Bruce's clock will be running fast. Or does it? Unfortunately not. If Barry looks at Bruce's clock, he will observe the same effect — that Bruce's clock is running slower; in fact, that Bruce himself will be running slower. Each of the two observers appears to the other to have a slower timescale. →

And That's Not All

Time wasn't the only thing that took a bashing from Einstein, though; he had something to say about space, as well. If you are travelling at high speeds, the way you perceive objects will also change. Originally, it was thought that relativity theory stated that objects appeared shorter at high speeds. In fact, this is not quite accurate. If objects moving at high speeds are looked at, then they actually appear rotated, rather than contracted in length. If the objects are measured, however, allowing for the travel time of light, then they do appear to be contracted. This decrease in length at high speeds is known as the 'Lorentz Contraction', after a scientist who suggested it (although for different reasons than those of Einstein) shortly before Einstein's paper, in 1895.

We can calculate the apparent length of an object and draw out a table of it against velocity. If l_0 is the length of the object measured at rest, and l is the length measured at some velocity v , then $l = l_0 \sqrt{1 - v^2/c^2}$, where c is the velocity of light. In the table below, v is expressed as a fraction of c , and l as a fraction of l_0 .

| Velocity(v) | l/l_0 | Velocity(v) | l/l_0 |
|-------------|---------|-------------|---------|
| 0 | 1.0 | 0.9c | 0.4359 |
| 0.4c | 0.9165 | 0.95c | 0.3122 |
| 0.8c | 0.6 | 0.99c | 0.1411 |

You can see that, as v gets close to c , the apparent length of an object drops dramatically, although at low speeds, less than $0.4c$, the effect is fairly small. In fact, this is why we don't notice relativistic effects in normal life and why it took a mind like Einstein's to point them out. Even the fastest speeds that we normally come across are such small fractions of the velocity of light that the relativistic effects are too small to be measured.

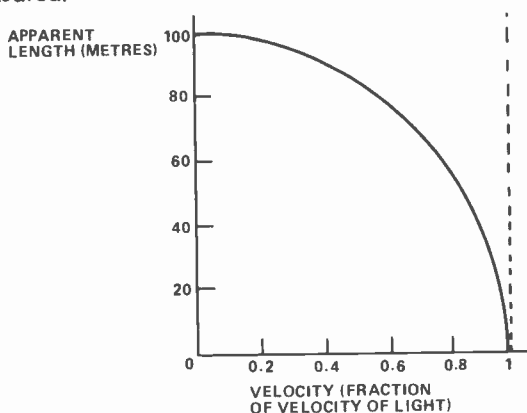


Fig.2 Objects appear to grow shorter at high speeds.

Time Dilation

The same arguments apply to the peculiar 'time dilation' effects we looked at earlier. At the sorts of velocities we are used to, the effects are too small to notice. Timescales, in fact, are related by exactly the same formulae as are lengths. Going back to Bruce and Barry, if t is the time Barry measures by his own clock, then $t' = t \sqrt{1 - v^2/c^2}$.

At this stage, it might appear, looking at the equations, as though, if we could reach the velocity of light; that is, if v was equal to c , then time would appear to stop altogether and objects would appear to be so shortened as to be totally flat. In fact, this does not happen, and for a simple reason — the speed of light cannot be reached.

Weight A Minute

Physics is concerned mainly with the study of four quantities and the interactions between them. These four quantities are distance, time, electric charge and mass. So far, we've seen that distance and time are both affected by high velocities. What about the other two? Well, electric charge doesn't seem to be changed, however fast you move it, but mass, on the other hand, can be very significantly changed.

The change that occurs is very similar to those with distance and time. If we measure the mass of something when it is at rest with respect to us as m_0 — the 'rest mass', as it is called — then when it is travelling relative to us with a velocity v , we will find its mass to be given by $m = m_0 / \sqrt{1 - v^2/c^2}$ and, hardly surprisingly, we see that this equation is strikingly similar to those giving time dilation and Lorentz contractions. The only difference being that m_0 is divided by $\sqrt{1 - v^2/c^2}$ whereas l_0 and t were multiplied by it.

The acceleration (that is, the rate of increase of velocity) of an object is given by the force applied to it, divided by its mass. Hence, as velocity increases, so does mass, and for a set applied force, acceleration becomes smaller. As v gets close to c , mass gets very close to infinity and the force needed to accelerate the body also gets higher and higher. To accelerate a body to the velocity of light would require an infinite force applied over a finite time, and hence would take infinite energy. Such an acceleration, then, is not possible. Although we can, in theory, get as close as we like to the velocity of light, we can never actually reach it.

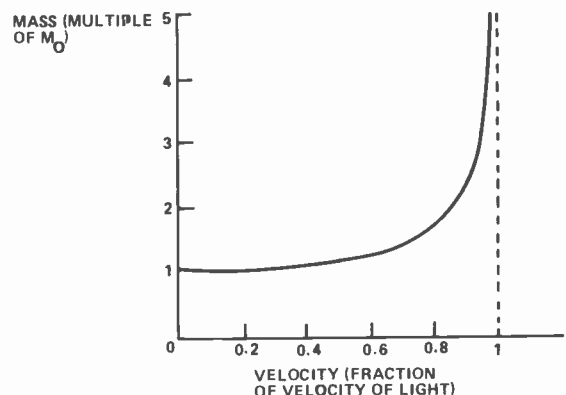


Fig.3 Mass increases at high velocities.

So Where Does It All Come From?

All right. So an object's mass increases as it travels faster (Fig.3). Where does all this mass come from, though? Well, it originates in the energy that we put into the object while accelerating it and this is where what is possibly the best known equation in physics comes in:

$$E = mc^2$$

Energy equals mass times the square of the velocity of light. The extra mass actually is all the energy that was put into the acceleration. Because of this, when we slow the object down again, it loses all the excess mass, because in decelerating it, we extract all the energy again.

Unfortunately, the equivalence of mass and energy has another application. It is the conversion of mass to energy that forms the basis of operation of the atom bomb. And because c is so large, it requires only a little mass to make an incredibly large quantity of energy. A match-head if totally converted into energy, could keep a 100 W bulb shining for about 500 years!

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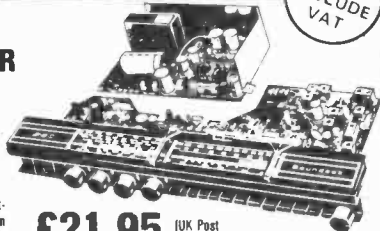
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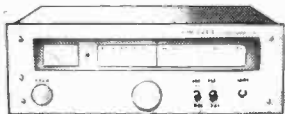
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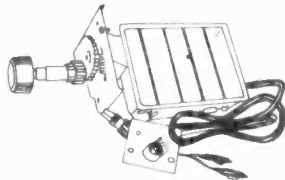


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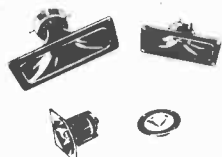
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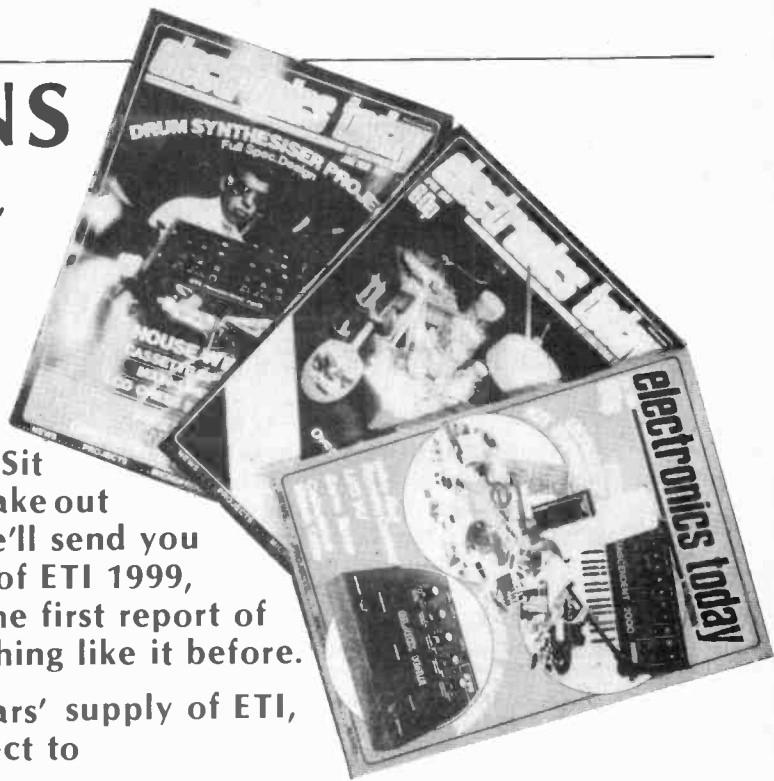
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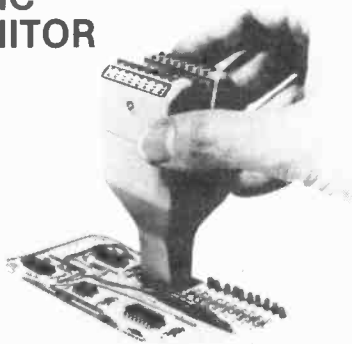
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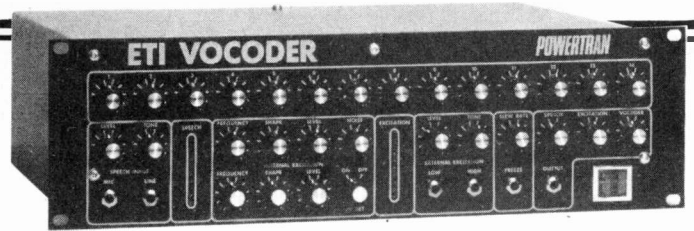
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VOCODER



In the concluding part of the ETI Vocoder, Richard Becker deals with construction and setting up

Start construction with the power supply PCB and bolt this onto the rear panel with mica washers between the panel and transistors, which are on the underside of the board. Silicone grease will keep the washers in place during fitting. Wire up and check all is well when operating into 1k Ω resistors as temporary loads.

Build up the rest of the boards. Use insulation on any links which touch the leads of components. On the LED PPM boards, fit the connector pins for the connector to the component side of the board for the excitation meter and the non-component side for the speech meter. Where there are jack sockets, solder short lengths of bare wire to the boards and fit both board and socket to the front panel before soldering the wires to the sockets, which then become firmly attached parts of the board assemblies. On the internal excitation board of the three controls with mounting frames fit to the underside of the board. The other four controls fit on the top side of the board. To get the correct spacing between the top and bottom controls the top ones are soldered to pins such that the tags just touch the top of the board.

Split Supply

The analysis/synthesis board is split in two halves to simplify manufacture. When the two halves are completed, fit the boards to the panel by means of the controls. Fit wire links between the boards and solder the two halves together by use of a bared length of wire along the joint. Fit the spacers to the back of the board and drop it into the chassis so that it can sit

PARTS LIST • Slew Rate Control

Resistors all 2% metal oxide

| | |
|----------|------|
| R1, 2 | 15k |
| R3, 6, 8 | 2k2 |
| R4, 5, 7 | 10k |
| R9, 10 | 47R |
| R11 | 220R |
| R12 | 470R |
| R13 | 1k0 |

Potentiometer

| | |
|-----|-----------------------------|
| RV1 | 1M0 log with mounting frame |
|-----|-----------------------------|

Capacitors

| | |
|-------|---------------|
| C1, 5 | 10n ceramic |
| C2, | 33n polyester |
| C3 | 100p ceramic |
| C4 | 560p ceramic |
| C6, 7 | 22u 25V |

Semiconductors

| | |
|------|--------|
| IC1 | 556 |
| Q1 | 2N3904 |
| Q2 | 2N3906 |
| D1 | 1N4148 |
| LED1 | TIL220 |

Miscellaneous

Footswitch, Footswitch box, stereo jack plug and socket, 5 way connector, IC socket

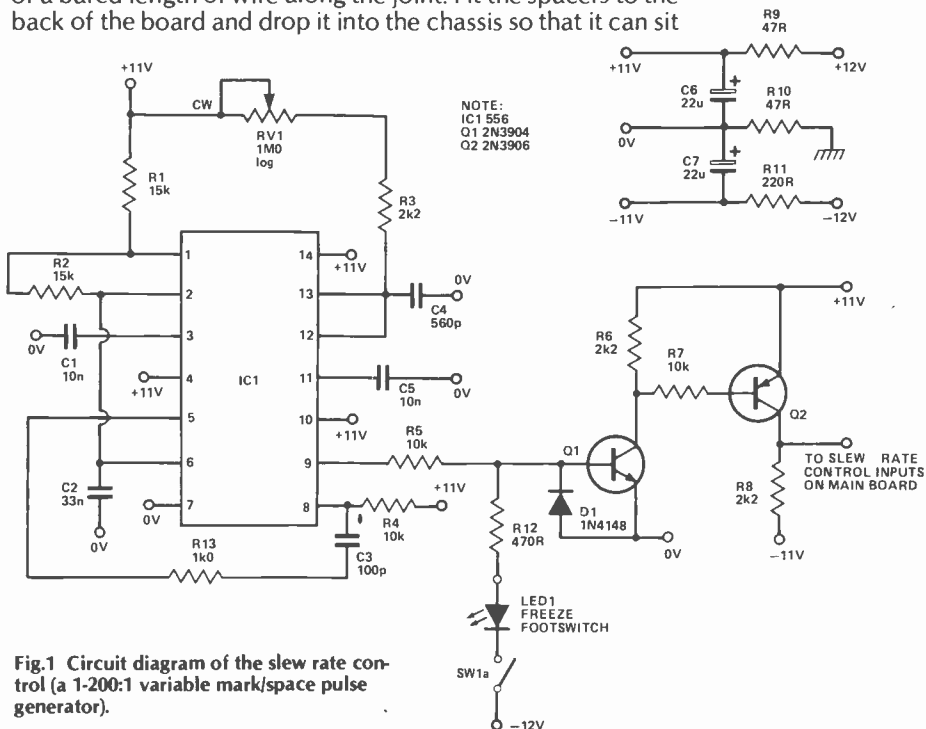
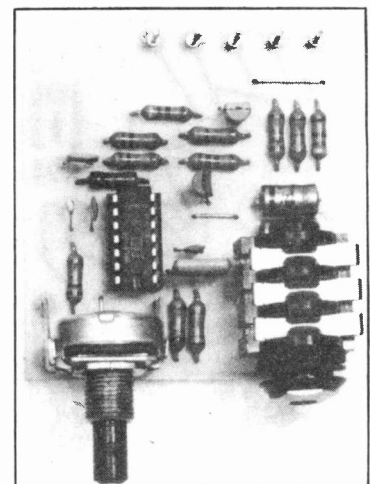


Fig.1 Circuit diagram of the slew rate control (a 1-200:1 variable mark/space pulse generator).



Slew rate control board.

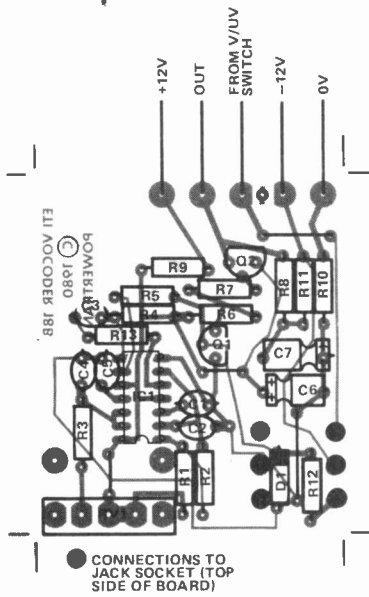


Fig.2 Component overlay of the slew rate control board.

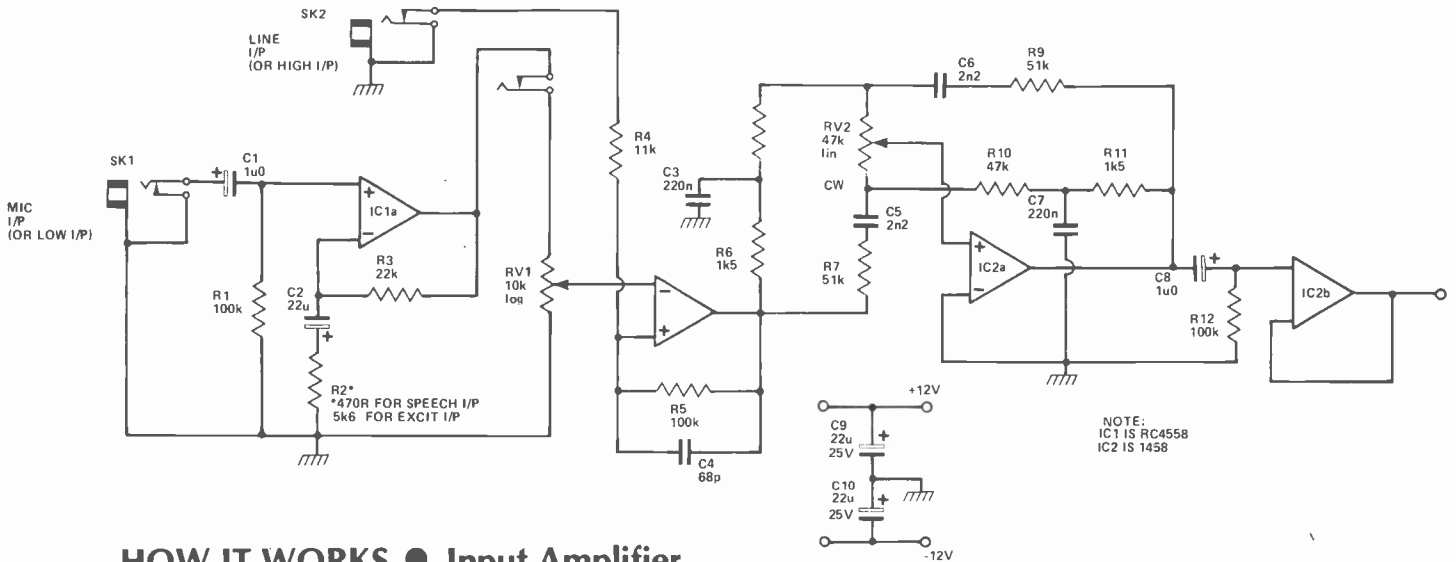
on its back edge whilst wiring up and setting up. Link together with a stretched length of wire on the back of the board all the excitation input pins and also the other inputs and outputs (a total of seven rails).

Make up the wiring loom and connect up all the boards.

HOW IT WORKS • Slew Rate Control

This is a pulse generator of variable mark/space ratio. IC1 is a 556 which is a dual timer. Pins 1-6 form a 1 kHz 2:1 mark/space ratio pulse generator, its frequency being determined by R1, R2, C2. Its output is used to trigger via C3 and a monostable built round pins 8-13. The width of the output pulse is determined by C4, resistors R3, RV1. The output is buffered by Q1. Q2 is the output driver, switching from +11 V to -11 V. The freeze switch forces the output to -11 V thereby turning off all the FETs of the analysis/synthesis section. To isolate the heavy switching surges on the power rails from the rest of the machine the rails are decoupled by R9, 10, 11 and C6, 7.

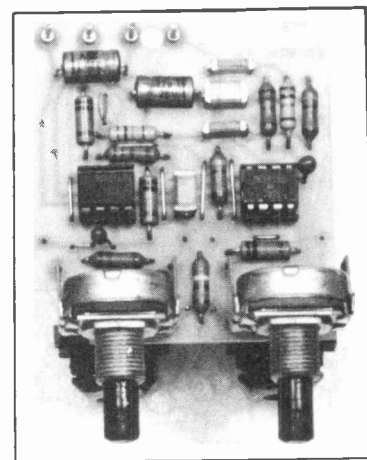
Fig.3 Circuit diagram of the input amplifier



HOW IT WORKS • Input Amplifier

The preamplifier uses an RC4558, which is a low noise version of the 1458, for IC1. The overall gain of the stage is dependent on which input is used, being unity for SK2 and for SK1 it is 500 (speech) or 50 (excitation). The gain is distributed between IC1a and IC1b. If SK1 is used and SK2 is not, then amplified signal from IC1a is connected to RV1 via the switched contact SK2. Also R4 is connected to ground, through the other switched contact of SK2, giving IC1b a voltage gain of ten. If SK2 is used then IC1a is isolated and R4 is disconnected from ground making IC1b now have unity gain.

IC2 is a rather complex tone control stage giving, with a single control knob, treble boost with bass cut or bass boost with treble cut. R7, C5 and R9, C6 form high pass filters whilst R6, C3 and R11, C7 form low pass filters. When the wiper is clockwise the input of IC2 is connected to the input of the stage via C5, R7 whilst RV2 is in series with the feedback thereby boosting the gain at high frequencies. At the same time, bass from feedback path R11, C7, R10 is dominant over bass from the input, which has to pass through RV2. Therefore, the bass is cut. The opposite occurs when the wiper is anticlockwise.



Input amplifier board.

Setting Up

Check the power lines are still correct when all the boards are connected, set all presets to the centre of their travel and apply a sinusoidal signal to the speech line input. (If no oscillator is available use the cheap little circuit shown.) Set the level to where the sixth LED up just flickers, corresponding to 400 mV. Measure the AC voltage on pin 6 of IC1 channel 2. Adjust the frequency until the voltage reaches a peak, turn PR1 fully clockwise and turn it back slowly until 4 V RMS is measured at the resonant peak of the filter. Repeat this for the other analysis filters.

Connect a 56R resistor between the bias rail and +12 V, turn the slewing rate control fully clockwise, check the pulse generator is operating by listening for a whistle when the input

jack of an amplifier is placed near the slewing rate control board, switch off the unvoiced detector, plug the oscillator into the external excitation HIGH input and set up channel 2 excitation filter as for the analysis filters (except that now the point to measure is pin 1 of IC7 and the potentiometer to adjust is PR5). With RV1 fully clockwise adjust PR2 so that 4 V RMS is also at the output of the OTA buffer (IC6 pin 8). Repeat this for the other filters including channels 1, 14 where there is only PR2 to adjust.

Plug the vocoder into an amplifier, turn up all channel volume controls and the vocoder output control. Turn down the speech and the excitation inputs. Turn up one of the oscillators and adjust RV5 or RV6, as appropriate, so that the signal is heard to just disappear when the width control is anticlockwise. Repeat for the other oscillator.

PARTS LIST • Input Amplifier

Resistors all 1/4 W 5%

| | |
|-----------------|------|
| R1, 5, 12 | 100k |
| R2 (speech) | 470R |
| R2 (excitation) | 5k6 |
| R3 | 22k |
| R4 | 11k |
| R6, 11 | 1k5 |
| R7, 9 | 1k |
| R8, 10 | 47k |

Potentiometers

| | |
|-----|-----------------------------|
| RV1 | 10k log with mounting frame |
| RV2 | 47k lin with mounting frame |

Capacitors

| | |
|--------|----------------------|
| C1, 8 | 1u0 16V tantalum |
| C2 | 22u 16V tantalum |
| C3, 7 | 220n polycarbonate |
| C4 | 68p ceramic |
| C5, 6 | 2n2 polycarbonate |
| C9, 10 | 22u 25V electrolytic |

Semiconductors

| | |
|-----|--------|
| IC1 | RC4558 |
| IC2 | 1458 |

Miscellaneous

5 way connector, connector pins, IC sockets, jack sockets.

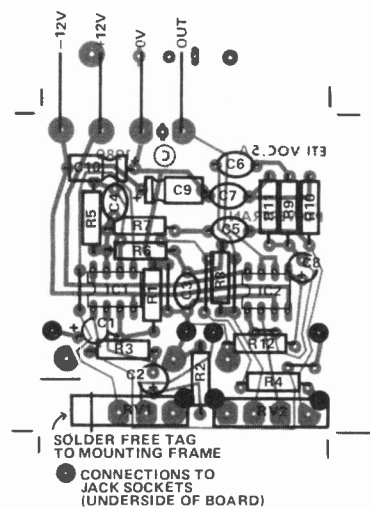
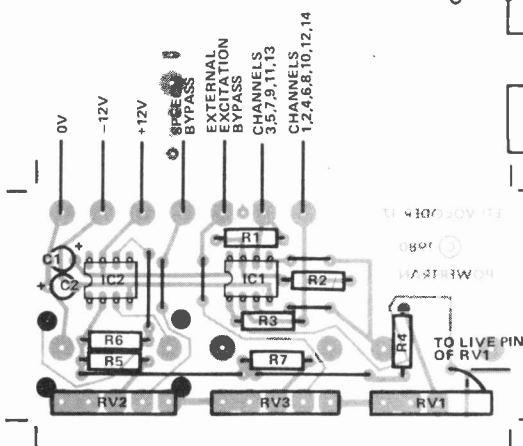


Fig.4 Component overlay of the input amplifier board.

Fig.5 (below) Component overlay of the output amplifier board.



● CONNECTIONS TO JACK SOCKET (UNDERSIDE OF BOARD)

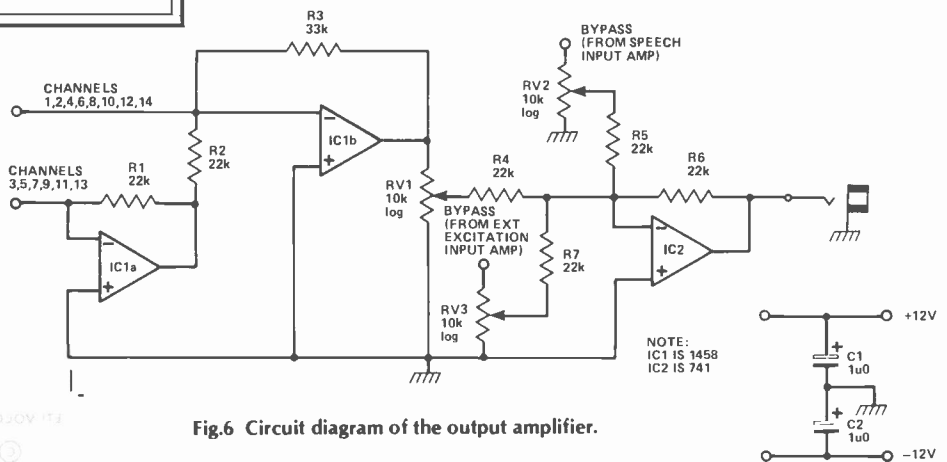


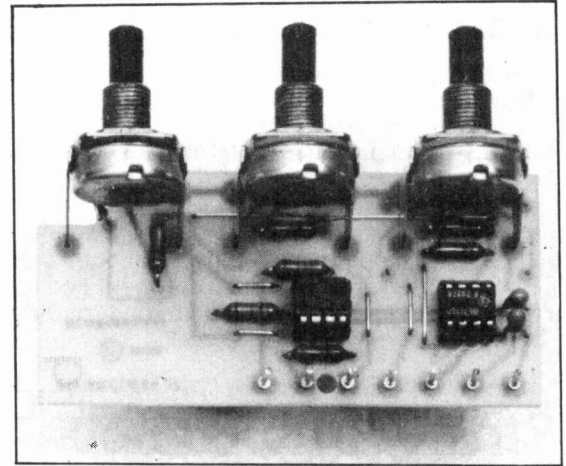
Fig.6 Circuit diagram of the output amplifier.

HOW IT WORKS • Output Amplifier

Outputs from channels 3, 5, 7, 9, 11, 13 are mixed by IC1a and the inverted output mixed with the outputs of channels 1, 2, 4, 6, 8, 10, 12, 14, by IC1b. The output of this is then mixed with the speech and external excitation signals by IC2.

PARTS LIST • Output Amplifier

| | |
|---|------------------------------|
| Resistors ¼ W 5% | |
| R1, 2, 4, 5, 6 | 22k |
| R3 | 33k |
| Potentiometers | |
| RV1, 2, 3 | 10k log with mounting frames |
| Capacitors | |
| C1, 2 | 1u0 16V tantalum |
| Semiconductors | |
| IC1 | 1458 |
| IC2 | 741 |
| Miscellaneous | |
| Jack socket, 7 way connector, connector pins, IC sockets. | |



Output amplifier board.

Fig.7 Circuit diagram of the LED PPM display.

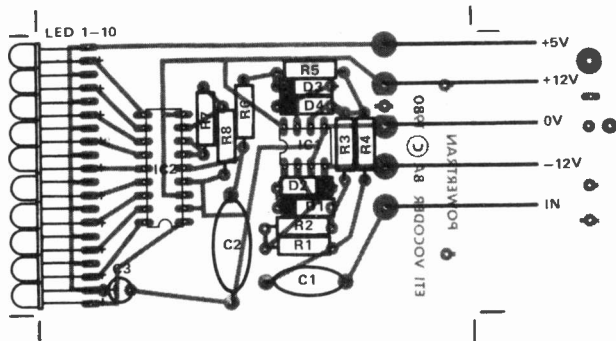
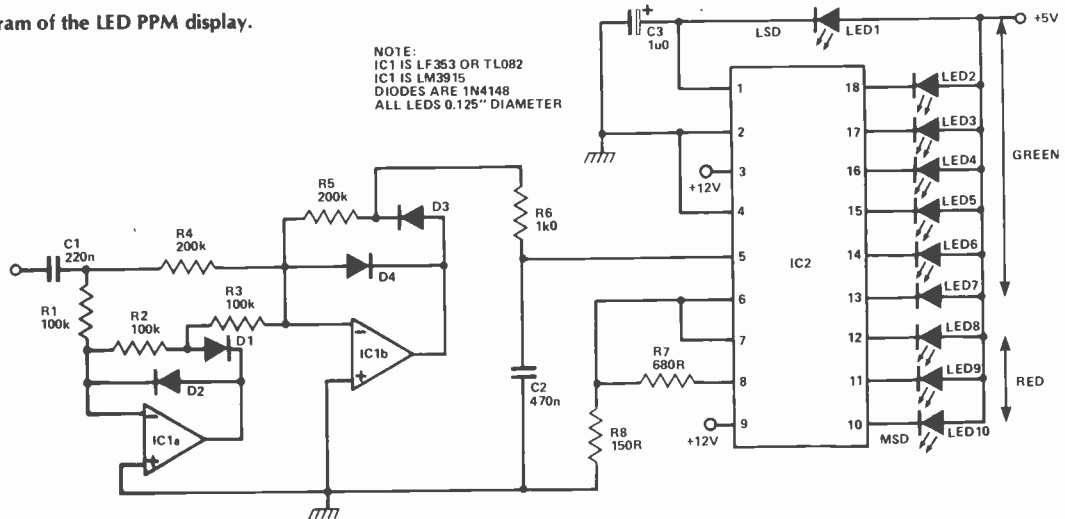


Fig.8 Component overlay of the LED PPM display board.

HOW IT WORKS • LED PPM Display

IC1 is a full wave rectifier with peak detector charging C2 to the peak voltage of the input signal. IC2 is a logarithmic display driver, the sensitivity of which is determined by R7, 8. The LEDs are at 3 dB spacing. The red LEDs illuminate when the filters overload. The LEDs have their own power supply.

PARTS LIST • LED PPM Display

| | |
|--|------------------|
| Resistors ¼ W 5% | |
| R1, 2, 3 | 100k |
| R4, 5 | 200k |
| R6 | 1k |
| R7 | 680R |
| R8 | 150R |
| Capacitors | |
| C1 | 220n polyester |
| C2 | 470n polyester |
| C3 | 1u0 16V tantalum |
| Semiconductors | |
| IC1 | TL082 or LF353 |
| IC2 | LM3915 |
| D1-4 | 1N4148 |
| LED 1-7 | TIL211 (green) |
| LED 8-10 | TIL209 (red) |
| Miscellaneous | |
| 5 way connector, connector pins, IC sockets. | |

Noise Abatement

Remove the 56R resistor, turn down all the channel volume controls and the oscillators. Turn up the noise level to maximum, turn up channel 1 and adjust PR3 to the point just before the noise disappears. Repeat this for the other channels.

Disconnect the excitation and speech inputs from the analysis/synthesis board and temporarily connect the excitation to the speech input of the board so that noise can be applied to the analysis section. Turn up channel 1 and the noise control. Adjust PR4 for minimum breakthrough of the control

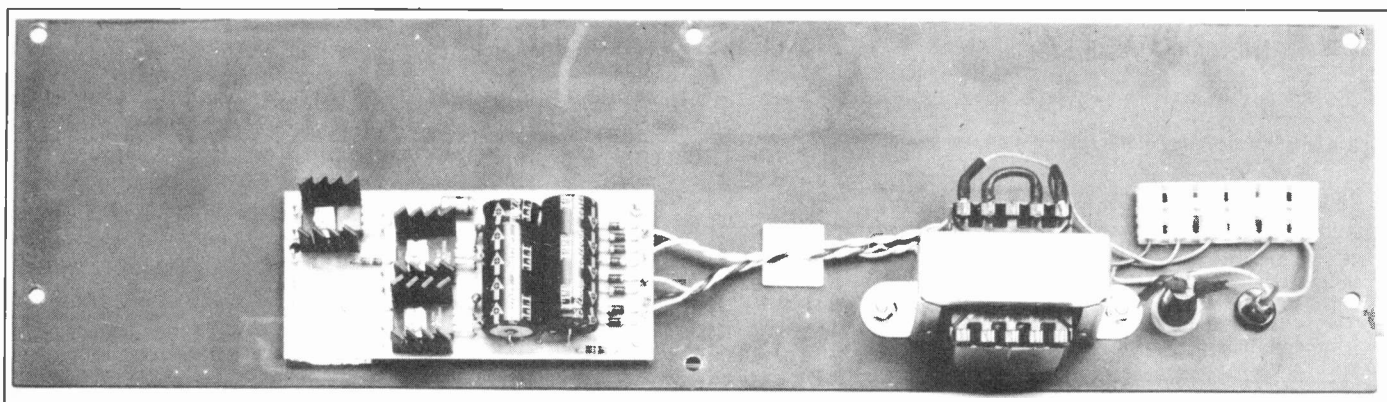
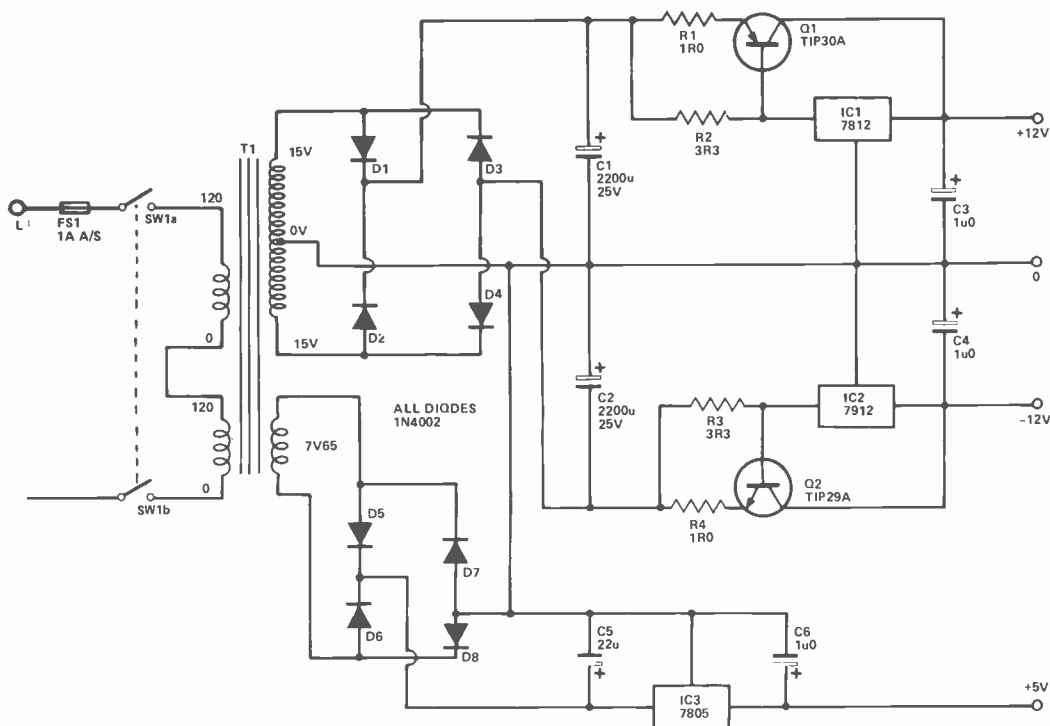
signal which will be heard as a low rumble. Repeat this for the other channels and then re-connect the inputs.

Turn on the voiced/unvoiced detector, apply a high frequency signal to the speech input and the V/UV LED will light up. Turn up all the channel volume controls and the noise control and noise will be heard. Adjust PR2 to halfway between the points where the noise is heard to start limiting. Turn down the noise control and adjust PR1 to the point where noise is just heard to disappear. Turn up the noise again and alter the frequency of the test oscillator. Adjust PR3 to where the noise level drops by about 6 dB, as indicated on the LED PPM, when the V/UV LED is illuminated.

HOW IT WORKS • Power Supply

Raw positive DC is regulated by IC1. To reduce heat dissipation the current is shared with Q1 roughly in the proportion of R2 to R1. The negative supply is similar. The LEDs of the PPM meters have their own supply. This can be very raw indeed and smoothing capacitor C5 is very small. IC3 is used simply to limit the voltage and not regulate it.

Fig.9 Circuit diagram of the power supply unit.



The power supply unit mounted on the rear panel.

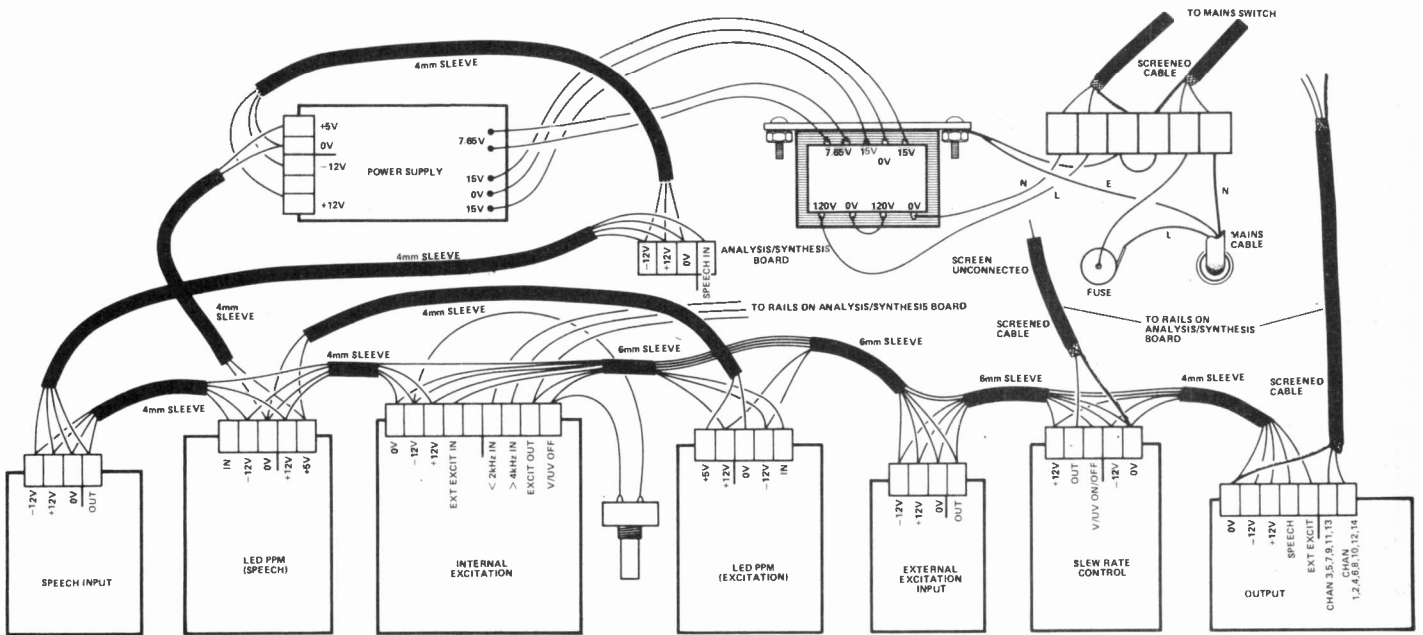


Fig.10 The job of wiring all the boards together is best tackled methodically and double checked by an impartial pair of eyeballs.

PARTS LIST • Power Supply

Resistors ½ W metal glaze

R1, 4 1R0
R2, 3 3R3

Capacitors

C1, 2 2200u 25V electrolytic
C3, 4, 6 1u0 tantalum
C5 22u 25V electrolytic

Semiconductors

D1-8 1N4002
IC1 7812
IC2 7912
IC3 7805
Q1 TIP 30A
Q2 TIP 29A

Miscellaneous

Transformer 15-0-15 V at 1 A, 7V65 at 0.4 A, 5 way connector, connector pins, finned heat sinks, mica washers.

BUYLINES

Powertran Electronics, Portway Industrial Estate, Andover, Hampshire, are supplying a complete kit of parts for this project at £195.00 plus 15% VAT. Delivery by Securicor is £2.50 extra. Everything is included in the kit down to the last nut and bolt. They even give you a 'Freeze' footswitch and a test oscillator for setting it up!

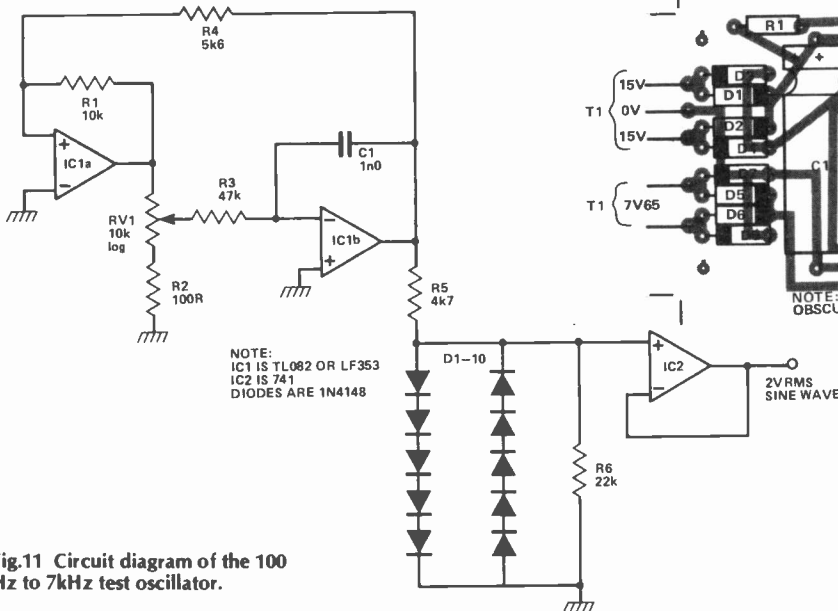


Fig.11 Circuit diagram of the 100 Hz to 7kHz test oscillator.

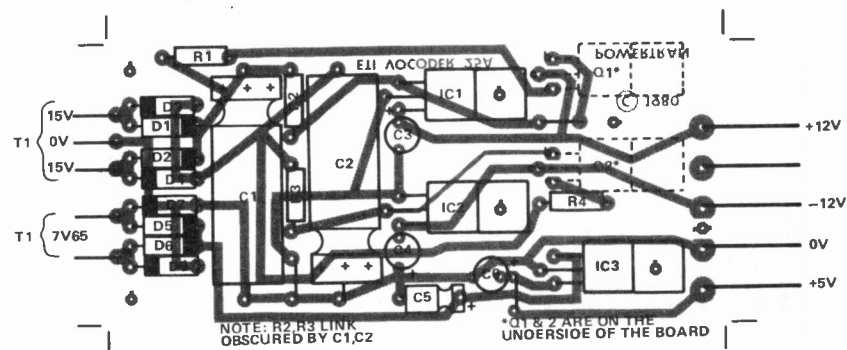


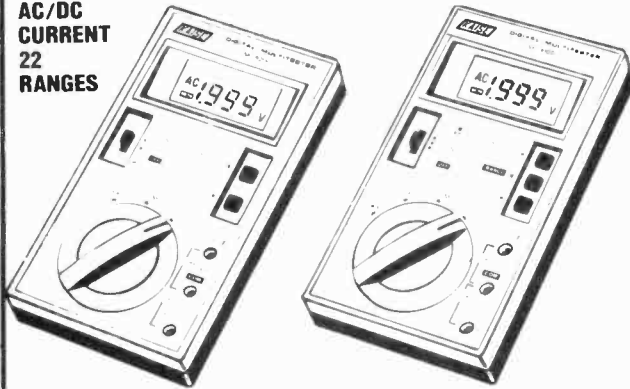
Fig.12 Component overlay of the power supply.

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| 0-8-9, 0-8-9 | 1A 1A | 208 | 3.80 | .70 |
| 0-15, 0-15 | 200 200 | 236 | 2.10 | .65 |
| 0-20, 0-20 | 300 300 | 214 | 2.70 | .85 |
| 20-12-0-12-20 | 700(DC) | 221 | 3.45 | .85 |
| 0-15-20, 0-15-20 | 1A 1A | 206 | 4.55 | 1.00 |
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| 2.0 | 3 | 5.55 | 1.00 |
| 3.0 | 20 | 6.25 | 1.15 |
| 4.0 | 21 | 6.55 | 1.15 |
| 5.0 | 51 | 9.55 | 1.15 |
| 6.0 | 117 | 11.05 | 1.15 |
| 8.0 | 88 | 14.30 | 1.45 |
| 10.0 | 89 | 16.55 | 1.45 |

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|------|----------|---------|------|
| 0.5 | 102 | 3.55 | .85 |
| 1.0 | 103 | 4.55 | 1.00 |
| 2.0 | 104 | 7.25 | 1.15 |
| 3.0 | 105 | 8.55 | 1.15 |
| 4.0 | 106 | 10.80 | 1.25 |
| 6.0 | 107 | 15.05 | 1.45 |
| 8.0 | 118 | 20.15 | 1.65 |
| 10.0 | 119 | 24.05 | 2.15 |

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|------|----------|---------|------|
| 0.5 | 124 | 3.80 | .85 |
| 1.0 | 126 | 5.55 | 1.00 |
| 2.0 | 127 | 7.50 | 1.15 |
| 3.0 | 125 | 11.05 | 1.25 |
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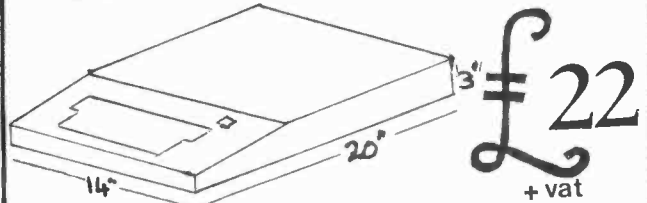
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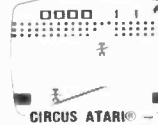
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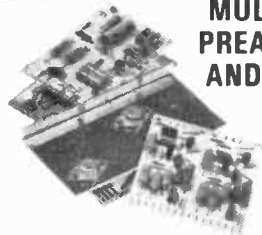
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AS FEATURED IN PRACTICAL ELECTRONICS OCTOBER ISSUE

DIY STEREO BARGAIN PACKS FEATURING FAMOUS BUILT MULLARD PREAMP MODULES

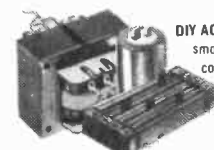
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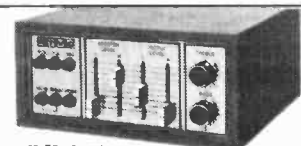
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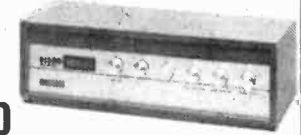
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AUDIOPHILE

Ron Harris returns to his roots — well almost — for a look at a very promising new Thorens TD 160S turntable and has a severe shock in store for headphone owners!

Ashes to ashes. Dust to dust. Thorens to Thorens. Having launched off down the path to hi-fi many years ago in the august company of a TD 150 II turntable, it brought a whiff or two of nostalgia drifting back to lay hands on this new TD 160S.

Thorens have received an indifferent press of late, mainly because some of their decks have failed to match the very high standards set in earlier days, by the 150 and 125 machines.

The standard 160 has been enthusiastically received, however, even by the usually isolationist 'cult' press. There was, though, a lot that could still be done to improve things and after some years of watching other people make money doing them, Thorens have decided enough is enough — and the TD 160S is born.

Vive La Difference

Compared to a standard 160, the 'special' is more solidly constructed all around, has a massively heavy chipboard base, a better bearing system, thoroughly damped sub-chassis and improved suspension. The arm-board is also much heavier, but we'll come to that again later.

The standard Thorens mat has been dumped overboard and a much more sensible specimen is fitted in its place. The emphasis of the work has been upon suppression of resonance and isolation from feedback. I think the changes made show a clear enough improvement in the final sound to be immediately obvious in an A - B test, even in a crowded dealer's. Taking this into account, therefore, one is forced to consider the 160S in a higher league entirely — so it was with the greatest of expectations that I approached the packing case...

Set Up By The Setting Up

The deck employs the (by now) well known Thorens three point spring suspension. This method of 'floating' a sub chassis away from the base on springs has been employed by Thorens for many years, long before either the Linn or the Ariston arose to dazzle the eyes of belt-driven enthusiasts. The intent is to isolate the turntable and arm assembly from the rest of the known universe. And very effective it is too, I may say.

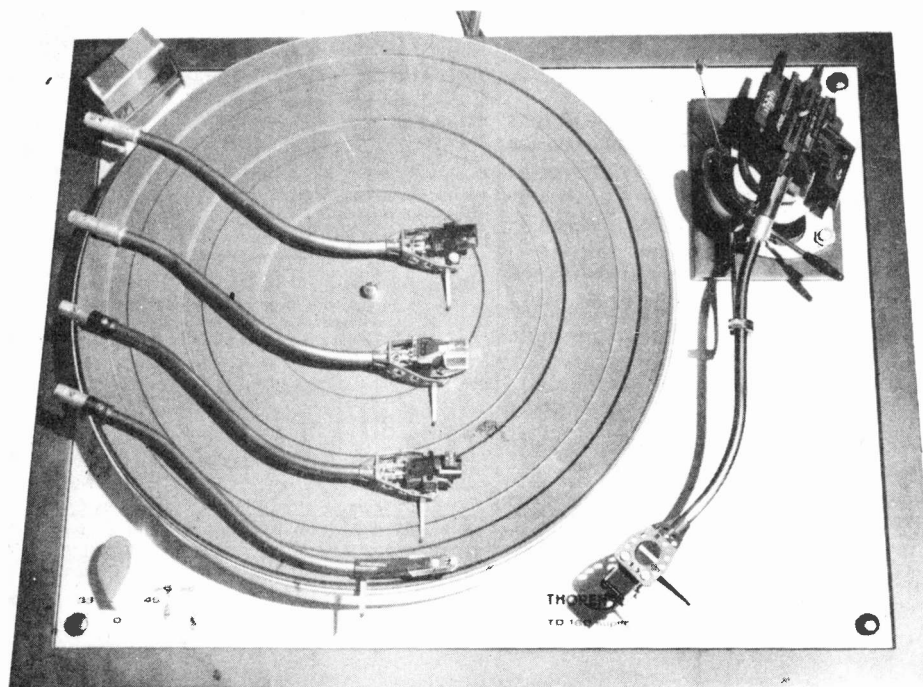
However, this apparently ultimate solution is not without some practical drawbacks. Once the chosen arm is fitted, the whole assembly must be levelled by adjustment of the three springs, which are situated beneath the deck. Which means at every step:- removing the outer turntable, upending the deck, removing the base, replacing the outer turntable and checking with a spirit level. If it is *still* not right, then it's remove the outer turntable, upend the deck... and so on and on ad frustratum maximum.

Once this has been achieved, the arm leads must be arranged within the plinth so that they do not re-couple the sub-chassis to the base, thus negating a large portion of the benefit gleaned from the spring suspension. This is fairly straightforward at least, but with an SME the leads are very stiff indeed, making the adjustment critical. Naturally though, SME can supply a flexible link if your patience falls short of the task.

Things That Go Bump In The Night

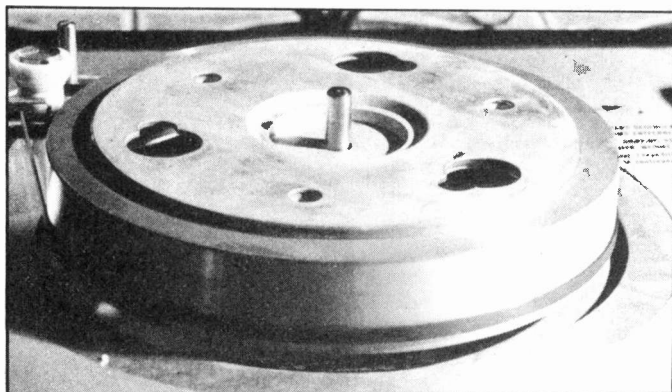
Mention of the magnificent SME brings me onto the subject of fitting said arm to this deck.

'Difficult' sums it up nicely.



Left: The 160S with SME/V15 IV installed. Note the improved turntable mat and relatively small arm-board. The base is much more massive than the standard version and the base-plate is of thick chipboard. A slot will need to be cut through this to clear an SME lead, however. The two small openings Thorens provide are simply not big enough!

Arranged across the deck are some of the pickups used in evaluating the 160S. Top to bottom these are: Goldring G900 IGC, Coral MC81, Empire 600LAC and the elegant Ortofon/SME 30H. The variation in type of sound between these units was most helpful in identifying which effects were caused solely by the 160S!



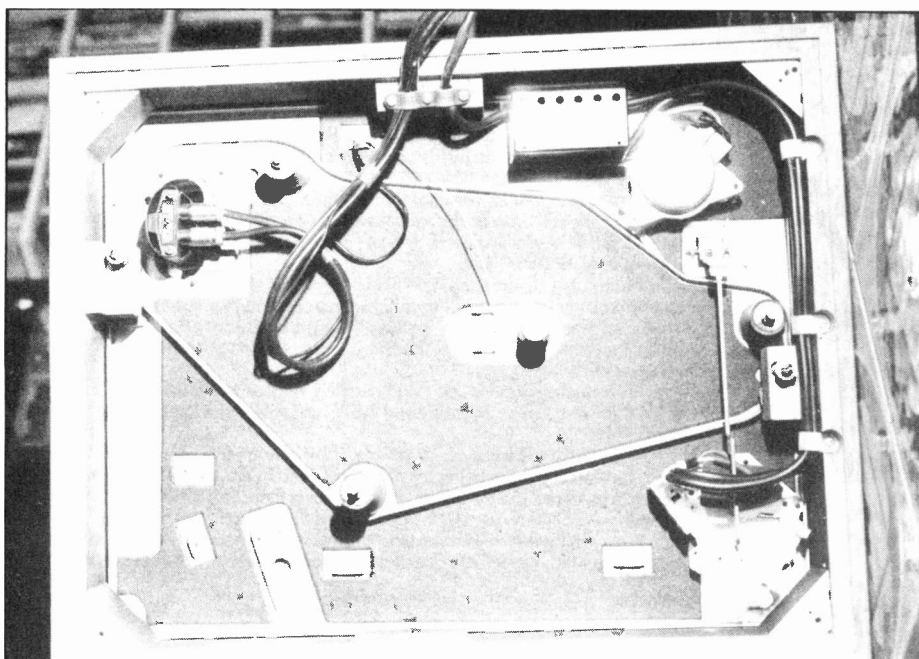
Above: The Thorens sub-chassis with outer turntable removed. Note the position of the drive belt.

The 'new improved' arm-board fitted here — and the sub-chassis — have barely enough room to accept the SME III. Barely in this case means slightly less than 1/10th of a gnat's whisker. I would strongly advise any prospective owners of this combination to shell out the required sum of £8.62 and let SME send you a fully cut board. I assure you it is a miserly sum indeed, when weighed against the blood, sweat and tears you will expend trying to be a DIY hero. You have been warned.

Come to think of it, how about supplying the SME board with the 160S, eh Thorens? All else is but dross anyway!

Failure to line up the arm *exactly* will result in the pillar not clearing the sub-chassis cut-out, which is every bit as generous as the pickup board, or just as musically, bumping away at the base every time someone breathes on the turntable.

All in all then, an enthusiast's — or a dealer's — task. Patience is the order of the day and if you fancy a TD 160S, but don't fancy setting it up, then your friendly neighbourhood dealer *should* do it for you. If he doesn't, simply find another (more) friendly neighbourhood dealer.



Above: The TD 160S revealed. The dark areas are damping compound, not applied to the standard 160. Top right is the drive motor and below that the speed change mechanism. Note the loop in the arm lead to keep the sub-chassis decoupled.

Down To Earth

Earthing the sub-chassis and arm means linking the earth of this to the base earth point beneath the turntable, from where a lead can be run to the amplifier — a point not well explained in the literature, I feel.

I earthed my Decca cleaning arm to the same point to keep down the number of wires trailing around. I have heard it said that use of these 'in-play' brush cleaners re-couples the turntable in the same manner as a badly arranged output lead beneath the base. Frankly, I don't go along with that at all. If the tracking brush is set up properly to a very small down force, then I cannot see that it will affect matters significantly. During listening tests I tried to identify any audible effect produced by employing the brush — and found only that it removed the dust! Really exciting that, huh?

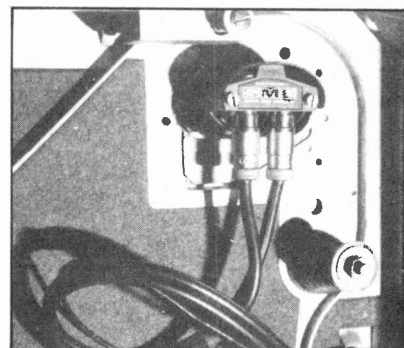
All Hands On Deck

Listening to the TD 160S was carried out with an SME III on the arm-board, and a variety of cartridges, including a Goldring G900IGC and a Coral MC81. Also a Shure V15 IV was used on most comparisons as was an Ortofon/SME 30H. Regular readers will have seen this little lot before!

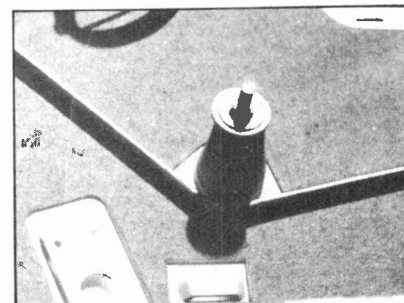
Incidentally I have had some letters questioning my continued use of an SME III as a reference, when as one reader put it, "there are stacks of better arms around."

The answer to all these people lies in the fact that I personally don't think there are ANY better arms around.

The SME is an excellently engineered, universal pick-up arm, which is as neutral as any on the market and a damn sight easier to use than most. Don't be fooled into equating tedious setting up with final quality. It does not automatically follow. The SME is a *dream* to use and offers facilities that allow for useful optimisation of the pickup cartridge in use.



Close-up of the arm pillar. There is not a great deal of room here so if you are fitting your own pickup — beware.



Above: The fixing of the sub-chassis suspension springs. The foam plugs have been sensibly removed on this model.

A small number of top-end pick-ups have been specifically designed for arms other than the SME and will thus operate better in the designed-for carrier.

However, for universal application and sheer engineering excellence, I don't think anyone has gotten near SME yet!

So there.

Back to the plot. After the setting-up was finally concluded and the cartridges aligned I could gratefully sink into the armchair — brandy in hand — and, wiping the sweat from the editorial brow, settle down to some music.

The biggest surprise was the mid-range. With all the cartridges the 160S produced a cleaner and clearer sound than I had heard from them before. Bass was firm and well-controlled, albeit with a nagging doubt concerning the extension. Treble was unimpeachable.

Continued listening has largely removed that doubt over the bass extension and I realised on a direct A - B it was the reference deck that had a slight upper bass prominence compared to the Thorens, which set me onto the thought in the first place! Instructive things comparisons. Learn something new every time.

A Right Little Belter

This comparison was set up with two SME III arms and two Shure V15 IV cartridges — and my warmest thanks to both firms for helping out at short notice so graciously — on the Thorens and the reference.

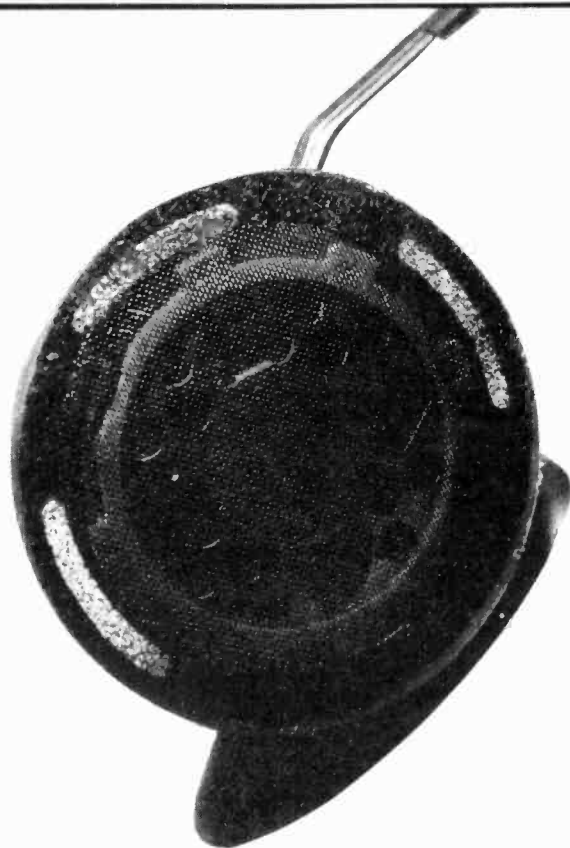
Even after several hours of this switching back and forth between decks I am left with nothing to be able to criticise in the TD 160S sound! It comes very, very close to being the best turntable I've ever heard and even changing the mat for a GA Audio Soundisc failed to make any improvement. If anything it muddled up the mid-range detail. Some may find it a little bland methinks — but look ye to your references gentlemen!

Taking price into account, the 160S is an excellent buy. It offers superb performance for its £140 price tag and should make prospective purchasers of decks twice the price stop and think very carefully indeed. To its price must be added, however, the need for precise setting up and a new arm-board! Still, with a good dealer neither should deter a single true audiophile.

An important addition to the ranks of hi-fi then, and I urge you to go and hear for yourself.



The reference cartridge for the comparisons was a Shure V15/IV.



Above: Close-up on the MDR-7 drive unit. The fine film driver is behind the mesh protection and can be clearly seen here. The foam earpads clip around the whole assembly and a spare set is provided.

Big Brother Is Here!

Perhaps the best-selling headphones so far in 1980 have been the Sony MDR-3s. And quite right too, many of you will say. Good value for money, they certainly are, and up to the 21st of last month I would have said the best value under £50. Alas this is true no longer. There is now a unit on the market whose performance far surpasses the MDR-3, adding to it a wealth of bass extension and clarity, sufficient by far to justify an asking price of around £30. These new phones are little larger than the MDR-3 and not noticeably heavier. The fit is comfortable and the sound dynamic. Their name? Why the MDR-7 of course! What else?

Since they fell into my hands I have been using them in preference to my own Koss ESP-10 electrostatics a lot of the time — and there is no better recommendation than that.

Comparing against the ESP-10s shows the MDR-7s to have a better bass extension than the Koss and to be able to accept higher levels without distress. Their mid-range is coloured with a slight warmth that can add a 'weight' to some music that is simply not there. The treble is smooth and goes a long way past your powers of hearing.

Overall, the sound is lively and detailed without being intrusive. It is easy to listen through them to the music and the comfortable fitting greatly assists matters here.

The MDR-7 will be widely available in this country from September 1st. At the same time an MDR-5 is being released which fills in the considerable gap in price between the three and the seven. I haven't heard them, but on the strength of those on both sides of them, the MDR-5s should not disappoint.

Sony apparently have no plans to bring out an MDR-9. At least not yet. At least that is what they tell me now. I can just see Audiophile in a year's time...

Conclusions

A nice production yet again. Well built and well presented. A spare set of earpads are included in the price — for when you forget to wash your ears — or just want a change of colour! Selling tag will lie around £30-35 and no doubt the MDR-7 will quickly repeat the sweeping success of its little brother. It deserves to do so, no doubt about it.



Above: The MDR-7 in use. Only one earpiece is adjustable, the other being fixed to a swivel joint to better align with the user's head. Cable entry is side-on and much more convenient than on the MDR-3 where it hangs awkwardly, stethoscope-like, behind the ear pieces.

The MDR-7 is very comfortable in action, but must be precisely aligned with the ear for best performance.

Odds And . . . Pieces Of Turf

Next month I hope to be able to offer you a complete — cassette based — stereo system at a ludicrously low price. Negotiations continue to bring about an offer on the launch of a new range of budget hi-fi from regions east of Suez! The importers are Videotone and a pair of their excellent GB2 loudspeakers will provide the voice for the system. Everything else — amp, tuner and cassette deck bear a name you will not have heard before, Seoum, and offers 30 W RMS per channel, with good transient delivery, M/C input, FM/AM with good sensitivity, LED level metering on tape and input power and best of all a good sound quality.

Price will be under £300 complete, so if you're looking for equipment in this price area hold on a little — you could save yourself some money!

Also next month I'll be starting to run some of your letters to Audiophile as a regular feature, be they queries or just communications! So if you've anything to say on matters even vaguely hi-fi let's hear from you.

The Audiophile enquiry service will still operate for anyone with a hi-fi problem. Don't forget to give details of the full system you're using and to mark the envelope for 'Audiophile'.

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| | |
|---|----------------|
| (With 6 Lang. Module — French / Italian / German / Spanish etc) | £115.00 |
| Ring Translator | £115.00 |

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| SARGON. The most advanced chess game yet with add on module availability for other games | £234.70 |
| (Our price inc. FREE rechargeable battery pack) | £134.75 |
| Super System 3 (as recommended by ETI) | £134.75 |

ATARI TV GAMES £98.50 inc. VAT. Philips G7000 P.O.A.

| | |
|---|---------------|
| TEXAS DATAMAN (Number Games-Table learning etc. 5 / 10 yrs) | £18.00 |
| TEXAS SPELLING B (Spelling Games ideal 5 / 10 years) | £22.50 |
| TEXAS SPEAK AND SPELL (for older children 8 / 13 years) | £39.95 |

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| | |
|--|---------------|
| ALL WITH LCD DISPLAY | |
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| TEXAS T138 (Sci /Con Mem-Pole Rec Cony Dec Deg conv / Deg Min Sec) | £19.95 |

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

| QUICK BLOW 20mm | | | | | |
|-----------------|--------|------|--------|------|---------|
| Type | No. | Type | No. | Type | No. |
| 150mA | 711 7p | 1A | 615 6p | 3A | 619 6p |
| 250mA | 612 6p | 1.5A | 616 7p | 4A | 620 10p |
| 500mA | 613 6p | 2A | 617 6p | 5A | 621 6p |
| 800mA | 614 8p | 2.5A | 618 7p | | |

| ANTI-SURGE 20mm | | | | | |
|-----------------|-----|------|-----|-------|-----|
| Type | No. | Type | No. | Type | No. |
| 100mA | 622 | 1A | 625 | 2.5A | 628 |
| 250mA | 623 | 2A | 626 | 3.15A | 629 |
| 500mA | 624 | 1/6A | 627 | 5A | 630 |

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

NUTS AND BOLTS

BA BOLTS — packs of BA threaded cadmium plated screws slotted cheese head. Supplied in multiples of 50.

| Type | No. | Price | Type | No. | Price |
|------------|-----|-------|------------|-----|-------|
| 1in. OBA | 839 | £1.38 | 1/2in. 4BA | 846 | £0.37 |
| 1/2in. OBA | 840 | £0.86 | 1/4in. 4BA | 847 | £0.29 |
| 1in. 2BA | 842 | £0.75 | 1in. 6BA | 848 | £0.46 |
| 1/2in. 2BA | 843 | £0.52 | 1/2in. 6BA | 849 | £0.24 |
| 1/4in. 2BA | 844 | £0.60 | 1/4in. 6BA | 850 | £0.20 |
| 1in. 4BA | 845 | £0.51 | | | |

BA NUTS — packs of cadmium plated full nuts in multiples of 50.

| Type | No. | Price | Type | No. | Price |
|------|-----|-------|------|-----|-------|
| OBA | 855 | £0.83 | 4BA | 857 | £0.35 |
| 2BA | 856 | £0.55 | 6BA | 858 | £0.28 |

BA WASHERS — flat cadmium plated plain stamped washers supplied in multiples of 50.

| Type | No. | Price | Type | No. | Price |
|------|-----|-------|------|-----|-------|
| OBA | 859 | £0.16 | 4BA | 861 | £0.14 |
| OBA | 860 | £0.14 | 6BA | 862 | £0.14 |

SOLDER TAGS — Hot tinned supplied in multiples of 50.

| Type | No. | Price | Type | No. | Price |
|------|-----|-------|------|-----|-------|
| OBA | 851 | £0.46 | 4BA | 853 | £0.25 |
| 2BA | 852 | £0.32 | 6BA | 854 | £0.25 |

TRANSFORMERS

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

| MINIATURE MAINS Primary 240V with two independent secondary windings | | | |
|--|-----------------------|-------|--|
| No. | Type | Price | |
| 2024 | MT280-0-6V 0-6V RMS | £1.84 | |
| 2025 | MT150-0-12V 0-12V RMS | £1.84 | |

| 1 AMP MAINS Primary 240V | | | |
|--------------------------|-----------------|-----------------|--|
| No. | Secondary | Price | |
| 2026 | 9V-0-9V 1 amp | £2.88 P & P 45p | |
| 2027 | 9V-0-9V 1 amp | £2.30 P & P 45p | |
| 2028 | 12V-0-12V 1 amp | £2.00 P & P 55p | |
| 2029 | 15V-0-15V 1 amp | £3.16 P & P 65p | |
| 2030 | 30V-0-30V 1 amp | £3.97 P & P 86p | |

STANDARD MAINS Primary 240V
 Multi-tapped secondary mains transformers available in 1/2 amp, 1 amp and 2 amp current rating. Secondary taps are 0-19-25-33-40-50V. Voltages available by use of taps.

| No. | Rating | Price |
|------|-----------------------------------|-----------------|
| 2031 | 1/2 amp | £3.91 P & P 85p |
| 2032 | 1 amp | £5.06 P & P 95p |
| 2033 | 2 amp | £6.27 P & P £1 |
| 2035 | 240V Primary 0-55V @ 2A Secondary | £7.30 P & P £1 |

SPECIAL OFFER

2042 240V Primary 0-20V @ 2A Secondary. By removing 5 turns for each volt from the secondary winding, any voltage up to 20V @ 2A is easily obtainable. Ideal for the experimenter. No. 2042. **£1.50 P & P 86p**

SPECIAL OFFERS

MINIDRILL 12V hand held battery-operated mini drill. 7,500 r.p.m. Collet chuck. Ideal for drilling printed circuits or model making. No. 1402. **£7.79**

TRANSFORMER 240V Primary 0-20V @ 2A Secondary. By removing 5 turns for each volt from the secondary winding, any voltage up to 20V @ 2A is obtainable. Ideal for the experimenter. No. 2042. **£1.50 + 86p P & P**

ANTEX MLX Soldering Iron. Sturdy 25 watt iron complete with 4 1/2 metres of 2-core cable. Works off a 12 volt battery. Ideal for Car, Boat, Caravan. No. 1724. **£5.29**

TANTALUM CAPACITORS

| | | | | | |
|------|------------|-------|------|------------|-------|
| 3137 | 1MFD 35V | £0.13 | 3157 | 3.3MFD 25V | £0.21 |
| 3138 | 22MFD 35V | £0.13 | 3143 | 10MFD 35V | £0.25 |
| 3139 | 47MFD 35V | £0.13 | 3144 | 22MFD 16V | £0.25 |
| 3140 | 1.0MFD 35V | £0.13 | 3145 | 47MFD 6.3V | |
| 3141 | 2.2MFD 35V | £0.14 | 3156 | 33MFD 35V | £0.13 |
| 3142 | 4.4MFD 35V | £0.21 | | | |

ELECTROLYTIC CAPACITORS

| | | | | | |
|------|-------------|-------|------|-------------|-------|
| 3185 | 1.00uF 25V | £0.32 | 3190 | 4700uF 25V | £0.92 |
| 3186 | 1.00uF 63V | £1.27 | 3191 | 4700uF 63V | £2.42 |
| 3187 | 2200uF 25V | £0.69 | 3192 | 2200uF 100V | £2.88 |
| 3188 | 2200uF 40V | £0.69 | 3196 | 100uF 100V | £0.09 |
| 3189 | 3300uF 100V | £3.61 | | | |

POTENTIOMETERS

CARBON POTS (Linear Track)

Single gang with wire and terminations, 6mm x 50mm plastic shaft 10mm bushes supplied with shake proof washer and nut. Tolerance 20% of resistance.

| | | |
|---------------|----------------|-----------------|
| 1831 1k ohms | 1835 22k ohms | 1839 470k ohms |
| 1832 47k ohms | 1836 47k ohms | 1840 1 Meg |
| 1833 4k7 ohms | 1837 100k ohms | 1841 2M2 |
| 1834 10k ohms | 1838 220k ohms | All et 30p each |

CARBON POTS (Log Track)

Designed to fit 2.54mm pitch board. All tracks are linear law.

| | | |
|---------------|----------------|-----------------|
| 1816 100 ohms | 1822 10k ohms | 1828 1 Meg ohms |
| 1817 220 ohms | 1823 22k ohms | 1829 2M2 ohms |
| 1818 470 ohms | 1824 47k ohms | 1830 4M7 ohms |
| 1819 1k ohms | 1825 100k ohms | All et |
| 1820 2k2 ohms | 1826 220k ohms | 10p each |
| 1821 4k7 ohms | 1827 470k ohms | |

DUAL CARBON POTS (Log Law)

| | | |
|---------------|----------------|----------|
| 1860 4k7 ohms | 1864 100k ohms | 1868 2M2 |
| 1861 10k ohms | 1865 220k ohms | All et |
| 1862 22k ohms | 1866 470k ohms | 99p each |
| 1863 47k ohms | 1867 1 Meg | |

SINGLE GANG SWITCHES (Lin Law)

These potentiometers are fitted with double pole on-off switches. The switch is incorporated within the rotary action of the pot. Specification of pot is as VC1. Switch rating 1.5 amps at 250V AC.

| | | |
|---------------|----------------|----------|
| 1870 4k7 ohms | 1874 100k ohms | 1878 2M2 |
| 1871 10k ohms | 1875 220k ohms | All et |
| 1872 22k ohms | 1876 470k ohms | 75p each |
| 1873 47k ohms | 1877 1 Meg | |

DUAL GANG LOG-ANTI-LOG POT

1888 Track specification as dual gang pots VC3, but tracks mounted to log-anti-log action 100k ohms £0.86.

SPECIAL VOLUME CONTROLS

A miniature 16mm type replacement volume control, incorporating single pole on-off switch. Resistance value 5k ohms. Tolerance 20% 1/2 watt rating.

| | | |
|------|-------|-----|
| 1889 | £0.31 | VC8 |
|------|-------|-----|

MINIATURE ROTARY VOLUME CONTROL

5k ohms log law with on-off switch, 20mm grooved spindle. Tag connections 17mm dia. Supplied with fixing nut. Used mainly for replacement.

| | | |
|------|-------|-----|
| 1890 | £0.62 | VC9 |
|------|-------|-----|

WIRE WOUND POTS

A range of wire wound single gang pots with linear tracks of 1 watt rating, fitted with 10mm bush and supplied with shakeproof washer and nut.

| | | |
|--------------|---------------|---------------|
| VC6 | | |
| 1891 10 ohms | 1895 220 ohms | 1899 4k7 ohms |
| 1892 22 ohms | 1896 470 ohms | All et |
| 1893 47 ohms | 1897 1k ohms | 92p each |
| 1894 20 ohms | 1898 2k2 ohms | |

SWITCHED POT (Log Track)

Specification as VC2 but track having (log) law.

| | | |
|---------------|----------------|----------|
| 1879 4k7 ohms | 1883 100k ohms | 1887 2M2 |
| 1880 10k ohms | 1884 220k ohms | All et |
| 1881 22k ohms | 1885 470k ohms | 75p each |
| 1882 47k ohms | 1886 1 Meg | |

PRE-SET POTS HORIZONTAL MOUNTING

Miniature type for transistor circuits. The wiper of the preset is provided with a slot for screwdriver adjustment. The tags of the preset will fit printed wiring boards with a pitch of 2.54mm. All tracks are linear law.

| | | |
|---------------|----------------|---------------|
| VC7 | | |
| 1801 100 ohms | 1807 10k ohms | 1813 1M ohms |
| 1802 220 ohms | 1808 22k ohms | 1814 2M2 ohms |
| 1803 470 ohms | 1809 47k ohms | 1815 4M7 ohms |
| 1804 1k ohms | 1810 100k ohms | All et |
| 1805 2k2 ohms | 1811 220k ohms | 10p each |
| 1806 4k7 ohms | 1812 470k ohms | |

PRE-SET POTS VERTICAL MOUNTING

Miniature type for transistor circuits. Wiper adjustment is made by a screwdriver slot.

ANTEX IRONS

| | | |
|------|--|-------|
| 1943 | 15 watt high quality soldering iron totally enclosed element in a ceramic shaft fitted with 3/32" bit | £4.83 |
| 1947 | Replacement element for 1943 iron | £2.19 |
| 1944 | Iron coated bit 3/32" for 1943 iron | £0.53 |
| 1945 | Iron coated bit 1/8" for 1943 iron | £0.53 |
| 1946 | Iron coated bit 3/16" for 1943 iron | £0.53 |
| 1948 | General purpose 18 watt iron fitted with iron coated bit. | £4.54 |
| 1952 | Replacement element for 1948 iron | £2.19 |
| 1949 | Iron coated bit 3/32" for 1948 iron | £0.53 |
| 1950 | Iron coated bit 1/8" for 1948 iron | £0.53 |
| 1951 | Iron coated bit 3/16" for 1948 iron | £0.53 |
| 1931 | Highly popular x25-25 watt quality soldering iron ceramic shafts to provide near perfect insulation breakdown voltage of 1500 volts AC and a leakage current of only 3-5uA and another shaft of stainless steel to ensure strength | £4.83 |
| 1935 | Replacement element for 1931 iron | £1.84 |
| 1932 | Iron coated bit 1/8" for 1931 iron | £0.58 |
| 1933 | Iron coated bit 3/16" for 1931 iron | £0.58 |
| 1934 | Iron coated bit 3/32" for 1931 iron | £0.58 |
| 1953 | SK1 soldering kit — This kit contains 15 watt soldering iron fitted with a 3/16" bit plus two spare bits, a reel of solder, heat-sink and a booklet 'How to solder' in presentation display box. | £6.38 |

1939 ST3 soldering iron stand. Stand made from high grade bakelite material chromium plated strong steel spring suitable for all models, includes accommodation for six spare bits and two sponges which serve to keep the soldering iron bits clean. **£1.73**

BIB HI-FI ACCESSORIES

| O/No | Ref | Price | |
|------|-----|---|-------|
| 806 | J | Compact tape head cleaning kit | £1.22 |
| 810 | 23 | Tape Editing kit | £2.85 |
| 811 | 24 | Cassette Tape editing and joining kit | £2.76 |
| 813 | 29A | Shaver cassette | £0.51 |
| 814 | 31 | Cassette Head cleaning tape | £0.71 |
| 817 | 36A | Record & Stylus cleaning kit | £0.46 |
| 818 | 41 | 8-track Cartridge tape-head cleaner | £1.24 |
| 819 | 42 | 'Groove Kleen' automatic, metal, record cleaner | £2.65 |
| 826 | 52A | Cassette storage tray (holds 10) | £0.92 |
| 827 | 53 | Hi-Fi stereo test cassette | £3.17 |
| 829 | 60 | Chrome finish 'Groove Kleen' (plastic) | £2.12 |
| 834 | 69 | Anti-static Hi-Fi cleaning liquid | £0.35 |
| 838 | 78 | Cassette fast hand tape winder | £1.50 |

VEROBOARD

| | | | | | |
|------------------|-----------|-------|------------------|-----------|-------|
| 2201 2.5"x5" | 1 Copper | £0.71 | 2211 2.5"x3.75" | 15 Copper | £0.53 |
| 2202 2.5"x3.75" | 1 Copper | £0.61 | 2212 3.75"x17" | 15 Copper | £2.39 |
| 2203 2.5"x17" | 1 Copper | £2.14 | 2213 3.75"x5" | 15 Copper | £0.90 |
| 2205 3.75"x3.75" | 1 Copper | £0.71 | 2217 3.75"x17.9" | 1 Plain | £1.79 |
| 2206 3.75"x17" | 1 Copper | £2.76 | 2218 3.75"x2.5" | 1 Plain | £0.44 |
| 2207 4.75"x17.9" | 1 Copper | £3.61 | 2219 5"x3.75" | 1 Plain | £0.68 |
| 2208 2.5"x11" | 5 in pack | £0.85 | 2223 2.5"x5" | 15 Plain | £0.37 |
| 2204 3.75"x5" | 1 Copper | £0.79 | 2225 5"x3.75" | 15 Plain | £0.56 |
| 2210 2.5"x5" | 15 Copper | £0.64 | | | |

CASES AND BOXES

INSTRUMENT CASES in two sections vinyl covered top and sides, aluminium bottom, front and back.

| No. | Length | Width | Height | Price |
|-----|--------|----------|----------|-------|
| 155 | 8in. | 5 1/2in. | 2in. | £1.72 |
| 156 | 11in. | 6in. | 3in. | £2.92 |
| 157 | 6in. | 4 1/4in. | 1 1/4in. | £1.79 |
| 158 | 9in. | 5 1/4in. | 2 1/2in. | £2.43 |

ALUMINIUM BOXES made from bright all, folded construction each box complete with half inch deep lid and screws.

| No. | Length | Width | Height | Price |
|-----|----------|----------|----------|-------|
| 159 | 5 1/2in. | 2 1/4in. | 1 1/2in. | £0.85 |
| 16 | | | | |

SUSTAIN FUZZ BOX

For that raunchy sound beloved of electric guitarists the world over, this simple little project is just the thing.

Fuzz-tone is to guitar what salt is to meat — it adds flavour and body. The ETI Fuzz Unit has an added bonus in an in-built sustain circuit, adding a bit of extra spice to the idea. The device offers three distinctive sounds, in addition to the 'straight through' option: sustain, fuzz with sustain or fuzz without sustain.

How We Did It

To explain how these sounds are realised, we have to consider the circuit diagram.

The input amplifier, IC1, gives the system some overall gain to boost the treble response and present the correct load impedance to the instrument. The mid-range gain is set to five, allowing 1 V peak-to-peak input signals before distortion and producing the largest possible dynamic range. The frequency response is flat from 20 Hz to about 2 kHz, after which an 8 dB step provides a gentle treble boost up to 20 kHz, where the response is rolled off.

Following the input stage is IC2a, one half of an NE571 compander IC configured as a conventional compressor with a fixed compression ratio of 2:1. This compression effectively halves the dynamic range of the incoming signal by attenuating high level signals and boosting low level ones; thus the signal hangs on — "sustains" — for much longer than it otherwise would. The compression also provides a constant level drive to the clipping stage, making the fuzz sound independent of the instrument output level.

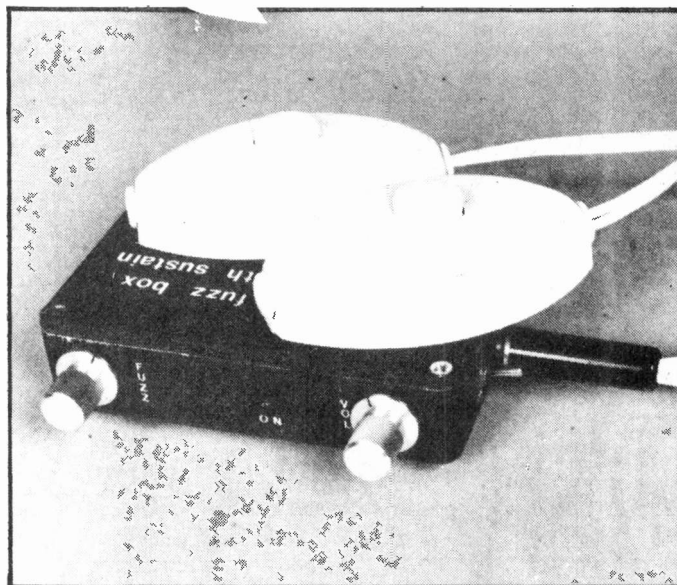
The fuzz stage, Q1, is a high gain amplifier stage. Because of the high, constant drive from the compressor it is always driven into hard clipping, resulting in an output which is substantially a squarewave. The output of the fuzz stage is fed through a tone control which varies the quality of the sound by rolling-off the high frequencies — one of the reasons for the treble boost at the input stage was to ensure that there would be some high frequencies to roll-off at this point!

Following Envelopes

The by now well-and-truly fuzzed signal is fed to the signal input of IC2b, the second half of the NE571 compander. This time the device is set-up as an envelope follower with a signal input and a control input; the output of IC2b is whatever frequencies are applied to the signal input but with the amplitude envelope of the signal fed to the control input. It is this envelope follower, plus some simple switching, which makes the Fuzz Unit so versatile — of which more shortly!

A deliberate modification to the envelope follower ensures that IC2b shuts-off completely when the signal on the control input falls below a certain level. This is a simple 'noise gate' function which prevents the amplification of low-level signals and noise, eliminating the hisses and buzzes of unwanted sounds and the squeals and howls of unexpected feedback! This function operates only when Fuzz function is selected.

The Fuzz Unit is capable of producing either sustain, fuzz with sustain, or fuzz without sustain. These variations are



achieved by selecting the appropriate output and the appropriate drive to the control input of the envelope follower.

The switching system is entirely electronic, so the guitar signal never leaves the box even if the footswitches themselves are a dozen yards away. The signal is not required to travel long lengths of cable and so is not attenuated or subject to interference. Also, single-pole non-audio type switches may be used, allowing a larger choice of switch types.

Two switch lines are used to control four electronic switches operating as two sets of change-over switches. One line controls A and B, (sustain on/off), the other controls C and D (fuzz on/off).

If neither fuzz nor sustain is selected, A and C are closed while B and D are open; the output of the unit is derived from the input pre-amplifier (so it will be a little louder and a little brighter than the guitar itself) via A and C.

If sustain is selected A and B change over and the output is from IC2a.

Selective Switching

Selecting fuzz closes D and opens C. Whether it is fuzz with sustain or fuzz without sustain now depends on the position of the sustain select switch. If sustain is selected the drive to the control input of the envelope follower is the compressed signal from IC2a; compression followed by expansion restores the amplitude envelope of the signal, so the output will have the dynamic characteristics of the original guitar sound, but will sustain for longer than usual. If sustain is not selected, the envelope follower control input is from the pre-amp. Therefore, the output of IC2b is the original signal expanded. Because of the value chosen for C7 and C16, the Fuzz Unit will produce a rather long 'delayed attack' effect when in

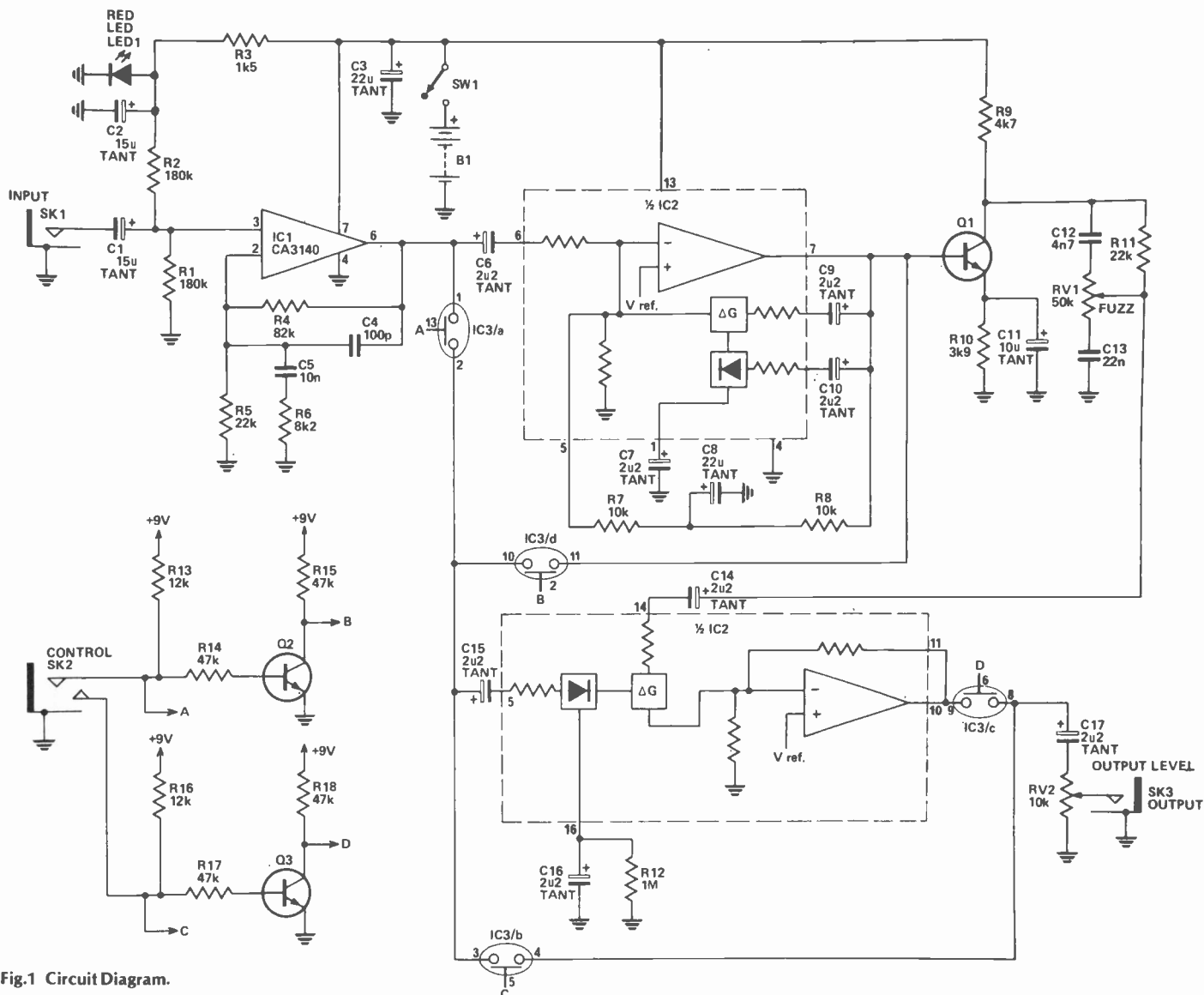


Fig.1 Circuit Diagram.

this mode. If a shorter attack is wanted, C7 and C16 should be reduced; this will give a faster attack in 'fuzz without sustain', and enhanced attack in 'fuzz with sustain'.

Once the box has been drilled, the PCB should be assembled according to the circuit and component overlay. Be sure that polarised components are correctly installed. The ICs should be put in last. Finally, make the control interconnections using the shortest possible lengths of wire.

Use insulated wire, and make sure that nothing is shorting to the box; the battery is best restrained by using a piece of double-sided tape.

After carefully checking that all connections are as they should be, apply power and you've got 'The Fuzz'.

Best results are obtained with the guitar output as high as it will go without causing distortion on loud notes when The Fuzz is switched to sustain only.

BUYLINES

Components for the ETI Fuzz/Sustain Box are readily obtainable from suppliers advertising in this issue.

HOW IT WORKS

The input amplifier (IC1) is a CA3140, chosen for its low noise. The input impedance of the device is quite high, so the effective value is determined by the parallel combination of R1, R2; the values used give an end impedance of 90k. R1 and R2 can be as low as 10k or as high as 1M, as long as they are the same and within this range.

The bias for the CA3140 is filtered and regulated by R3, C2 and LED1; the LED also acts as a 'power on' indicator! The LED must be red as other colours have a different forward voltage. The stage gain of five is set by the ratio of R4 and R5, while C4, C5 and R6 tailor the frequency response.

IC2 is a dual gain control IC, NE571, which may be set-up to implement a number of signal processing functions. Each half of the IC consists of a full wave rectifier acting on the control input, a variable gain cell (signal input), an operational amplifier and a bias system. The blocks may be set-up as, for example, a compressor, an expander, a limiter or an envelope follower. The compression/expansion ratio is internally set at 2:1 while the attack and release times are determined by an external timing capacitor and an internal resistor, the attack-to-decay time ratio is internally set at 1:5.

It is possible to vary both the compression ratio and the attack/decay ratio by the use of complex external circuitry. However, the internally set values are adequate for the purpose of this gadget.

PARTS LIST

Resistors all 1/2W,5%

| | |
|--------|------|
| R1,R2 | 180k |
| R3 | 1k5 |
| R4 | 82k |
| R5 | 22k |
| R6 | 8k2 |
| R7,R8 | 10k |
| R9 | 4k7 |
| R10 | 3k9 |
| R11 | 22k |
| R12 | 1M0 |
| R13 | 12k |
| R14,15 | 47k |
| R16 | 12k |
| R17,18 | 47k |

Potentiometers

| | |
|-----|-----------------|
| RV1 | 50k linear |
| RV2 | 10k logarithmic |

Capacitors

| | |
|--------|-------------------|
| C1,C2 | 15u tantalum |
| C3 | 22u tantalum |
| C4 | 100p disc ceramic |
| C5 | 10n ceramic |
| C6,C7 | 2u2 tantalum |
| C8 | 22u tantalum |
| C9,C10 | 2u2 tantalum |
| C11 | 10u tantalum |
| C12 | 4n7 ceramic |
| C13 | 22n ceramic |
| C14-17 | 2u2 tantalum |

Semiconductors

| | |
|------|-----------------------|
| Q1-3 | BC548 |
| LED1 | TIL220 red or similar |
| IC1 | CA3140 |
| IC2 | NE571 |
| IC3 | CD4016 |

Miscellaneous

Metal box, PCB, 9 V battery, DPST miniature switch, two jack sockets(mono), one jack socket (stereo).

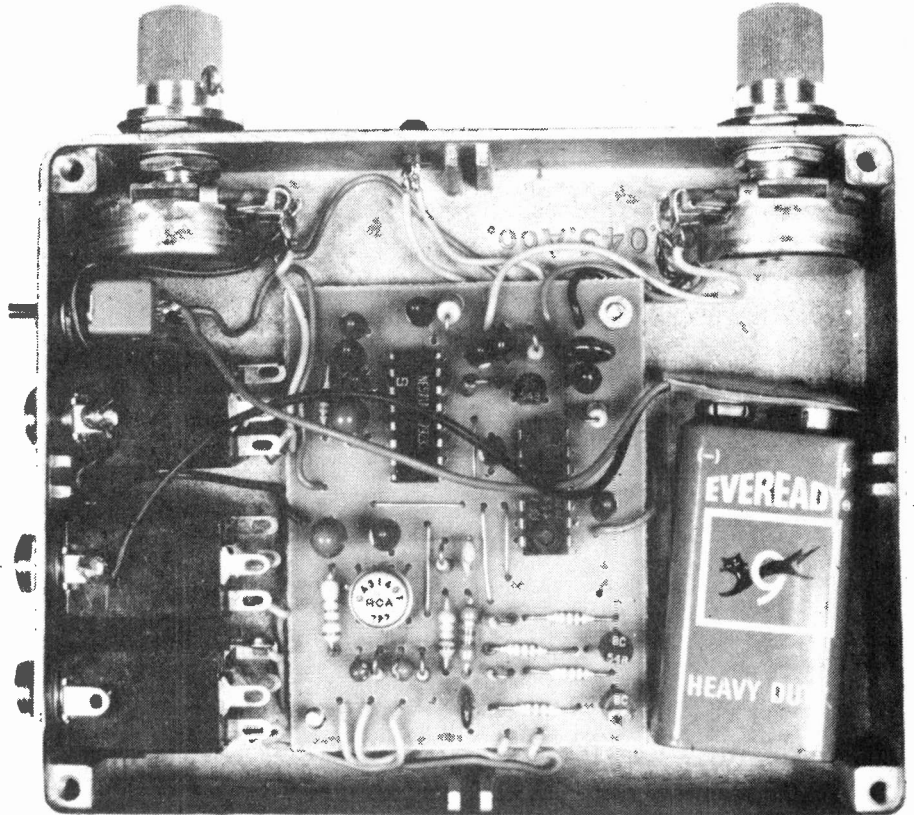
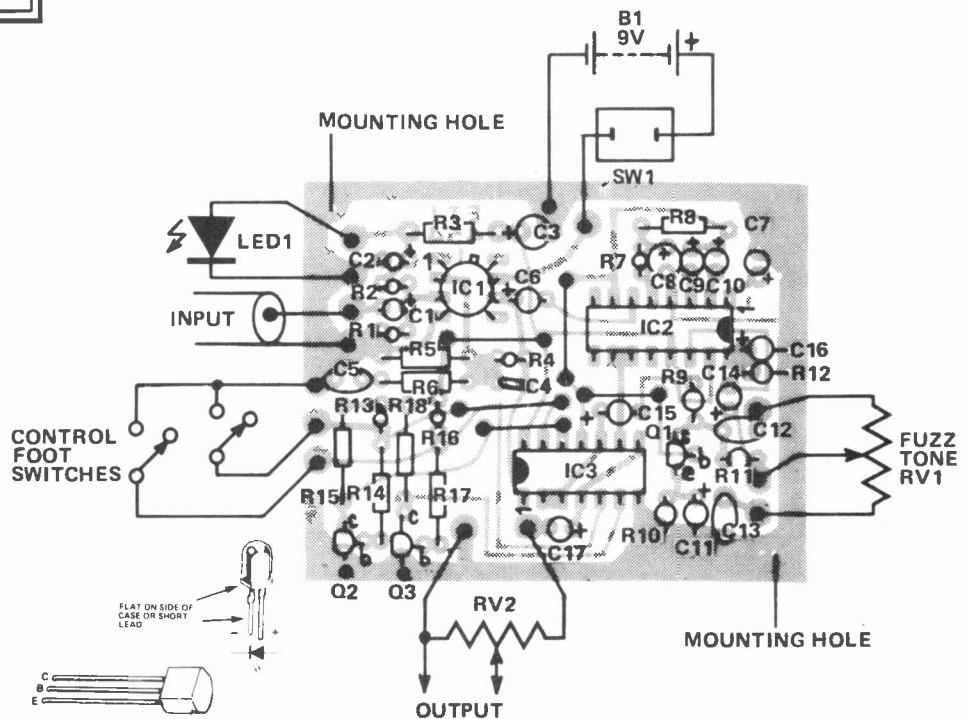


Fig.2 An internal view shows the relative positions of controls, PCB, sockets and battery. The battery can be held in place with a piece of double-sided tape. The unit can be installed in its own case as shown, or incorporated into an existing effects unit.

Fig.3 Component overlay. Note the orientation of IC1 and IC2; they are not mounted in the same direction. LED 1, in the bias network of IC1, is also used as a power on indicator. As the signal is switched electronically on the board, the control footswitches need not be expensive audio types.



BC547, BC548, BC549, BC557, BC558.

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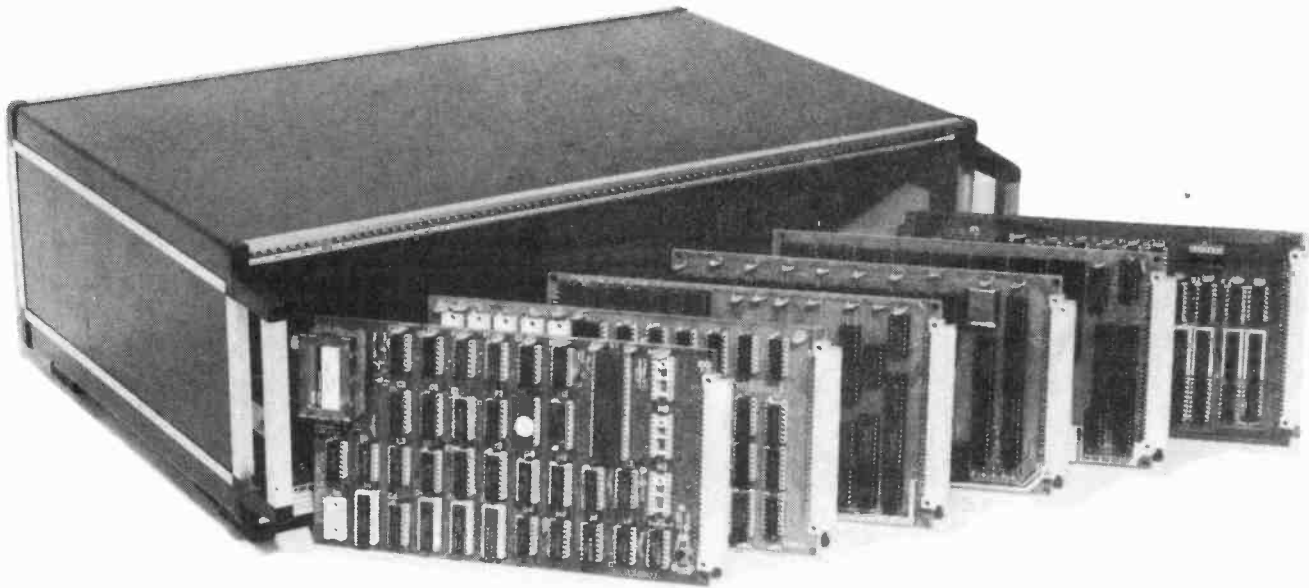
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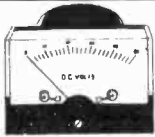
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| T28 | 0-100 MA | |
| T29 | 0-500 MA | |
| T30 | 0-1 AMP | |
| T31 | 0-2 AMP | |
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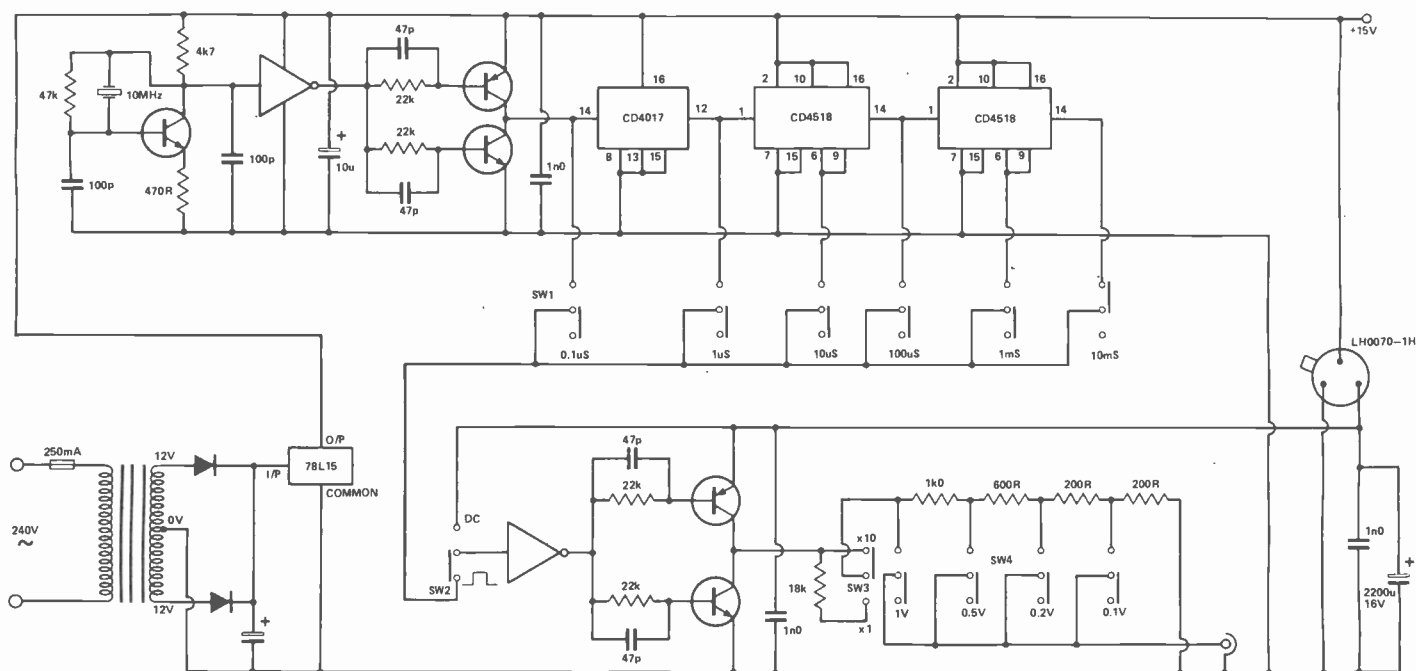
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| <p>RELAYS. 2 types both operate on 12V DC. sealed plastic cased types. 1-350 ohm with 2 make 5 amp contacts 75p. 2-1,000 ohm with 2 changeover 1 amp contacts 75p.</p> | <p>MICROPHONES. Min. tin pie. Om. uses dead air battery (supplied) £4.95. Low cost condenser ECM105 Omni. 600ohms. on/off switch standard jack plug £2.95. EM507 Condenser. omni. 600ohms. 30-18kHz. highly polished metal body. £7.95. DYNAMIC stick microphone dual imp. 600ohms or 20k. 70-15kHz. attractive black metal body. £7.75. EM506 Condenser. cardioid. omni. 600ohms or 50k. heavy chromed copper case. £12.95. DYNAMIC P.A. Mike. mobile radio etc. thumb switch 50k imp. £3.75. CASSETTE replacement microphone with 2.5/3.5 plugs £1.35. INSERT crystal replacement. 35x10mm 40p. GRUNDFOS Electret inserts. with built in FET preamp 3-6V DC. £1.00.</p> | <p>COPPER LAMINATED PRINTED CIRCUIT BOARD. Fibreglass GFR/FR4 type (Impreg. 2mm thick) 150x55mm 40p. 200x90mm 55p. Double-sided Fibreglass 1mm thick. 180x135mm 45p. PAXOLIM BASED TYPE: 180x135mm 40p. 280x200mm 50p.</p> | <p>PIEZO TWEETERS. require no crossover and can be used with system up to 100 watts. Frequency response 3.8 to 28KHz.</p> | <p>PROJECT BOXES. Sturdy ABS black plastic boxes with brass inserts and lid. 75x56x35mm 65p. 95x71x35mm 75p. 115x99x37mm 87p.</p> | <p>VERO HAND HELD BOX. White ABS. 24in x 3.7 in tapered. with screws 60p each.</p> |
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TECH TIPS



Scope Calibrator

M. Applebaum, London.

The oscilloscope calibrator shown has proved to be very useful for setting up the Y amps and TB ranges of most general purpose oscilloscopes. Needing no additional test equipment or adjustments the unit provides time markers from 0.1 μ S to 10 mS in decade increments to an accuracy better than 0.01% and amplitude levels from 0V1 to 10 V with an accuracy better than 2%.

The calibrator is built around the DH0070-1H voltage reference having an output voltage of $10V00 \pm 0.1\%$ max. By using this as the supply to a transistor switch, the switched output level is within 1% of the reference voltage using transistor types 2N3904 and 2N3906 as the complementary switches.

The crystal controlled oscillator runs at a frequency of 10 MHz and uses a standard circuit and 10 MHz crystal. This is divided down by a CD4017 decade counter followed by two further CD4518 ICs, each of which contains two BCD decade counters.

To maintain the voltage accuracy, the resistors in the potential divider chain should be 1% tolerance or better.

The output rise time is of the order of 50-70 nS, so that all leads should be kept as short as possible to avoid ringing appearing on the output voltage wave form. It is also advisable to fit 1n0 ceramic decoupling capacitors across the emitters of each pair of switching transistors.

In use, TB calibration would be effected by switching each decade of frequency and checking the

oscilloscope horizontal scale at different positions of the TB range switch.

Y amp calibration and attenuator compensation should be adjusted by setting the calibrator to the 1 mS range and then adjusting the oscilloscope internal gain on the 0V1 range and attenuator compensation capacitors at each oscilloscope gain range suitably switching the calibrator output level accordingly. It should be noted that the output stage will not drive a capacitive load of more than 20 pF without distortion. Consequently a $\div 10$ oscilloscope probe should be utilised if a long length of screened lead is necessary between the calibrator and oscilloscope. The probe compensation should then be initially set up on the highest sensitivity Y amp range of the oscilloscope.

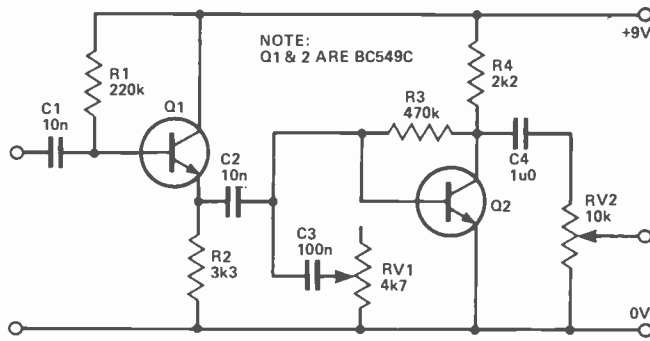
Tech-Tips is an ideas forum and is not aimed at the beginner. We regret we cannot answer queries on these items.

ETI is prepared to consider circuits or ideas submitted by readers for this page. All items used will be paid for. Drawings should be as clear as possible and the text should preferably be typed. Circuits must not be subject to copyright. Items for consideration should be sent to ETI TECH-TIPS, Electronics Today International, 145 Charing Cross Road, London WC2H 0EE.

Guitar Treble Boost

J.R. Spink, Cleveland

Q1 is connected as an emitter follower in order to present a high input impedance to the guitar. C2, being relatively low capacitance, cuts out most of the bass and C3 with RV1 acts as a simple tone control to cut the treble and hence the amount of treble boost can be altered. Q2 is a simple preamp to recover signal losses in C2, C3 and RV1.



Dimmer Decoder

I. Henry, Kirkcowan

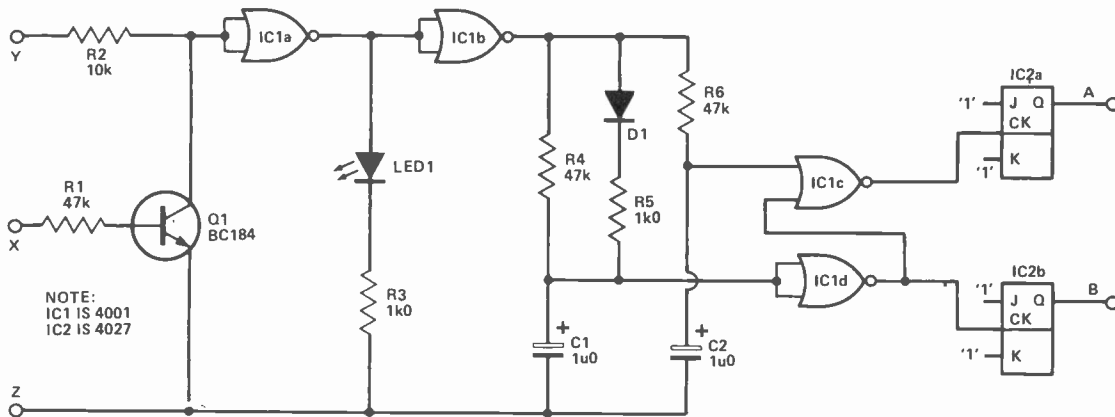
This circuit is an alternative decoder for the "ultrasonic remote control dimmer" project published in ETI June '79.

With this decoder, PB1,2 on the transmitter control two independent

channels. PB1 gives a pulsed input at X and a high output is generated at IC1c; PB2 gives a high input at X and a high output is generated at IC1d. IC2 is a dual JK flip-flop, but in this case the inputs have been connected to logic 1 and the outputs of IC1c,d connected to the clock inputs of the flip-flops. In this

configuration the outputs change state each time an input pulse is received, ie if A was at logic 0 and PB1 on the transmitter is pressed and released A will then be at logic 1.

The outputs A, B can be used via some buffering arrangement to switch relays for remote control of lights, etc.



Train Chuffer

C.S. Histed, Chislehurst

This circuit will produce a 'train chuffing' noise and might prove interesting to anybody with their own train layout.

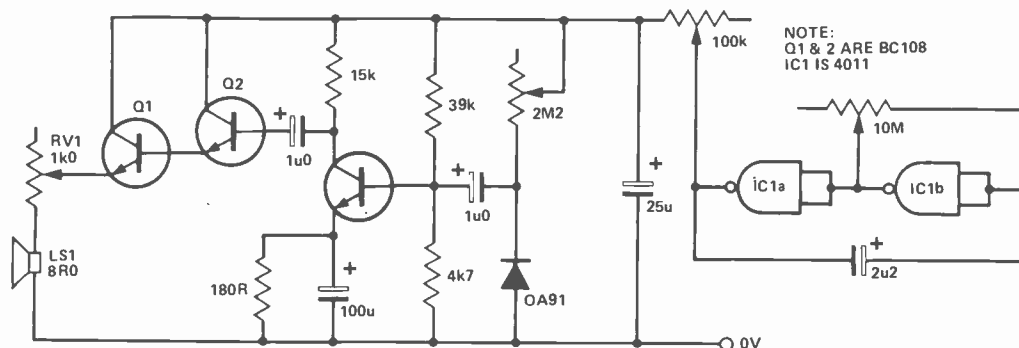
The circuit consists of a white noise generator, which only switches

on with the 'high' part of the square wave output from the clock circuit. The frequency of the clock is adjusted with the 10M pot and the output voltage of the clock is adjusted by the 100k pot (these pots control the rate of chuff and the volume of the chuff).

The 2M2 pot controls the amount

of noise produced and the 1k pot on the speaker controls the pitch of the average noise.

The circuit works by amplifying the amount of noise let through by the seemingly wrong way round diode and only letting the circuit be 'on' when the output of the clock is at logic 1.



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

DIGITAL COMPUTER LOGIC AND ELECTRONICS £7.00

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

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

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



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- Book 3** Compilers and interpreters; loops, FOR...NEXT, RESTORE; debugging; arrays; bubble sorting; TAB.
- Book 4** Advanced BASIC; subroutines; string variables; files; complex programming; examples; glossary.

THE BASIC HANDBOOK £11.50

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

A.N.S. COBOL £4.40

The indispensable guide to the world's No. 1 business language. After 25 hours with this course, one beginner took a consulting job, documenting oil company programs and did invaluable work from the first day. Need we say more?

DESIGN OF DIGITAL SYSTEMS £12.50

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



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

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

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

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

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

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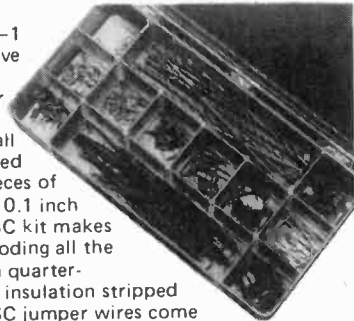
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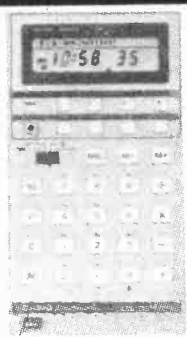
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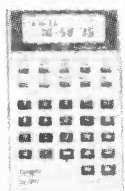
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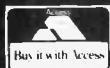
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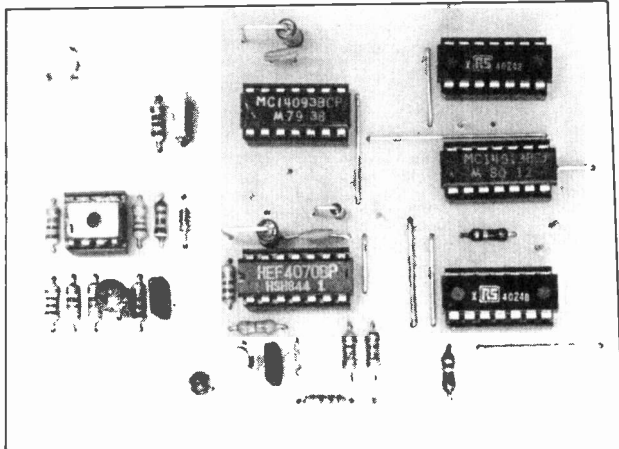
Moderate-speed cassette systems running at speeds up to 1200 baud have been with us for some time, but unfortunately the standard setters seem to prefer a slower 300-baud Kansas City standard. 300-baud can be too slow if you have a lot of data to manipulate and is suitable only for software distribution. That is, once the original chunk of a software package has been implemented in a system, the user or owner could then make a copy of that piece of software for his (or her) normal use. This working copy should be running at the highest data-transfer rate that the owner can afford. In case of a failure in the fast working copy, the user can always fall back on the original master copy running at the slow rate. This design enables you to store and retrieve digital data using an unmodified cassette recorder at 4800 bits per second. The prototype proved to be as reliable as any 300-1200 baud systems.

Dropout

One reason for cassette load/save failures is tape dropout — momentary loss of playback signal due to the absence of, or damage to, the ferromagnetic coating somewhere on an imperfect tape; or due to bad contact between the tape and the tape head. In audio cassettes, the tape runs at 1.875 inches a second. Thus, for a 300-baud KC (Kansas City) tape, a bit of data occupies approximately 0.00625 inches — how tiny! Any dropouts which are larger than that size will cause one or more bits of errors. The only practical solution is to use high quality cassettes which are certified or known to be originally free from dropouts. This applies to both 300-baud and the fast 4800-baud systems. From experience most tapes which are error-free at 300 baud can cope well at 4800 baud, but in the latter case, cassettes having good high-frequency specifications are preferred.

How Good?

This design aims to surpass all existing cassette interfaces in both speed and reliability, given that it should require no more hardware than other systems to build one. It should run



well with an average tape recorder and cassette tapes which can cope with the KC standard or CUTS 1200-baud standard. There will be no timing adjustments. The system can be implemented on any existing serial, asynchronous communication channel and thus can be readily added to most home computers. If it becomes impossible to run the system at 4800 baud due to any reasons including those in my list of observations then you might have to slow down the data rate to, say, 2400 baud.

To do so you only have to slow down your UART (Universal Asynchronous Receiver and Transmitter) clock frequency. There is nothing else to adjust, thanks to the all-digital timing.

Phase Encoding

There is nothing new or magic about the phase encoding format for data storage on magnetic tapes. Figure 1 illustrates how it works. A logic one is represented by the 5 V level and the zero by 0 V (Fig.1b). Most tape recorders cannot record and playback slowly varying signals or DC. Therefore, a long series of ones or zeros will just come out the same if we attempt to connect the data signal (also called NRZ or Non-Return to Zero) directly to the recorder. This is because the data signal in NRZ format contains important information which is extended down to the very low-frequencies, beyond the frequency range of tape recorders.

Figure 1a shows a carrier wave oscillating at, in this case, 4800 Hz. The carrier is modulated by the data signal of Fig.1b by the following rules:

- The data signal is assumed to be synchronised to the carrier. This means their transitions (edges) are perfectly in alignment.
- The carrier wave is inverted if data is a one and normal ie non-inverted if data is a zero. The resulting modulated carrier is shown in Fig.1c.

The phase encoded signal in Fig.1c is known to contain very little energy at low frequencies and can be recorded and played back with little distortion.

Demodulation

Figure 1d shows the typical replay signal from the tape recording. Notice the rounding of all sharp edges — this is due to the high-frequency cut-off of the tape recorder. Also the high-frequency components of the signal will suffer from more attenuation than the low frequency components. By using some form of equalisation circuit, we can easily improve the signal into that shown in Fig.1e, which is now good enough for a slicer circuit to decide whether it is high or low. The sliced signal in Fig.1f is very similar to that of Fig.1c but it may or may not be inverted by the playback amplifier inside your recorder;

Construction of the board (left) should not pose any problems. The LED is on if there is no input or during normal data transfer and off if data transfer is about to take place or has just concluded.



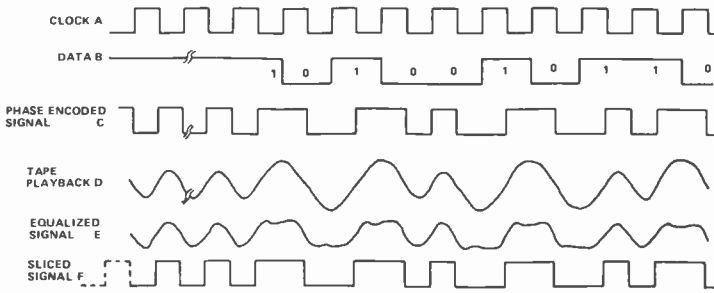


Fig.1 Timing diagram. The signal output is attenuated to about 100 mV (RMS), suitable for the mic input of most cassette recorders. A high pass filter is included to pre-compensate any loss in high frequency in the cassette. You may not need pre-emphasis capacitor C2 if you use a hi-fi deck.

pulse transitions may not be so precisely timed as in Fig.1c due to tape-speed fluctuations and it is more or less independent of the playback volume control setting. We then feed the signal of Fig.1f to a digital circuit (a demodulator), which recovers the data signal (Fig.1b) from the sliced signal (Fig.1f) and presents it to the UART receiver section.

Implementation

You will probably need a "double standard" approach at least in the beginning so that tapes can be converted from the original slow rate to 4800 baud. The interface circuitry can be connected to your computer system using five wires:

- two power lines (common earth and the 5V supply),
- two serial data lines (one for transmit (dump), one for receive (load)),
- one clock line running at 16x the baud-rate, i.e. 76,800 Hz at 4800 baud.

The only assumption made is that your computer software could handle the UART at 4800 baud. Some systems may not cope with a fast transfer rate. The serial I/O by program control instead of using a dedicated UART could be too slow, or maybe the VDU or TTY is not fast enough to dump some characters, eg filenames, in real-time. However, if you are using a memory-mapped VDU (PET, Superboard II, UK101, NASCOM, etc) or your system monitor buffers the load time messages in RAM, there is no problem, since no major hardware modifications are to be made and no software or data

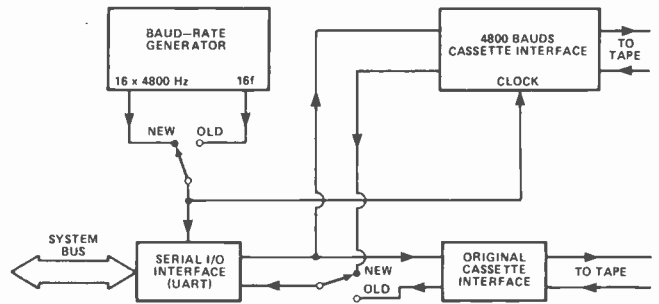


Fig.3 Adding the fast cassette interface to your system.

format to be changed. The fast system has been in use since March 1979, accumulating the bit error rate to better than 1 in 10. The tape conversion process is fairly straightforward; switch your system to the original interface, load the original tape to computer, switch to 4800 baud and record the same software onto a new cassette.

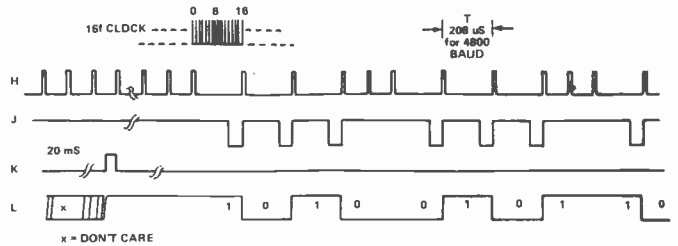


Fig.4 Timing diagram.

Postscript

After experimenting with various kinds of tape recorders it is sad to say that some cassette recorders just cannot cope with the 4800-baud system. These recorders don't work with 300-1200 baud systems anyway, (or work with persistent troubles) and they can't even play back a continuous tone steadily! That is, if you record a tone and playback, it sounds so wobbly that anyone can detect its poor speed regulation.

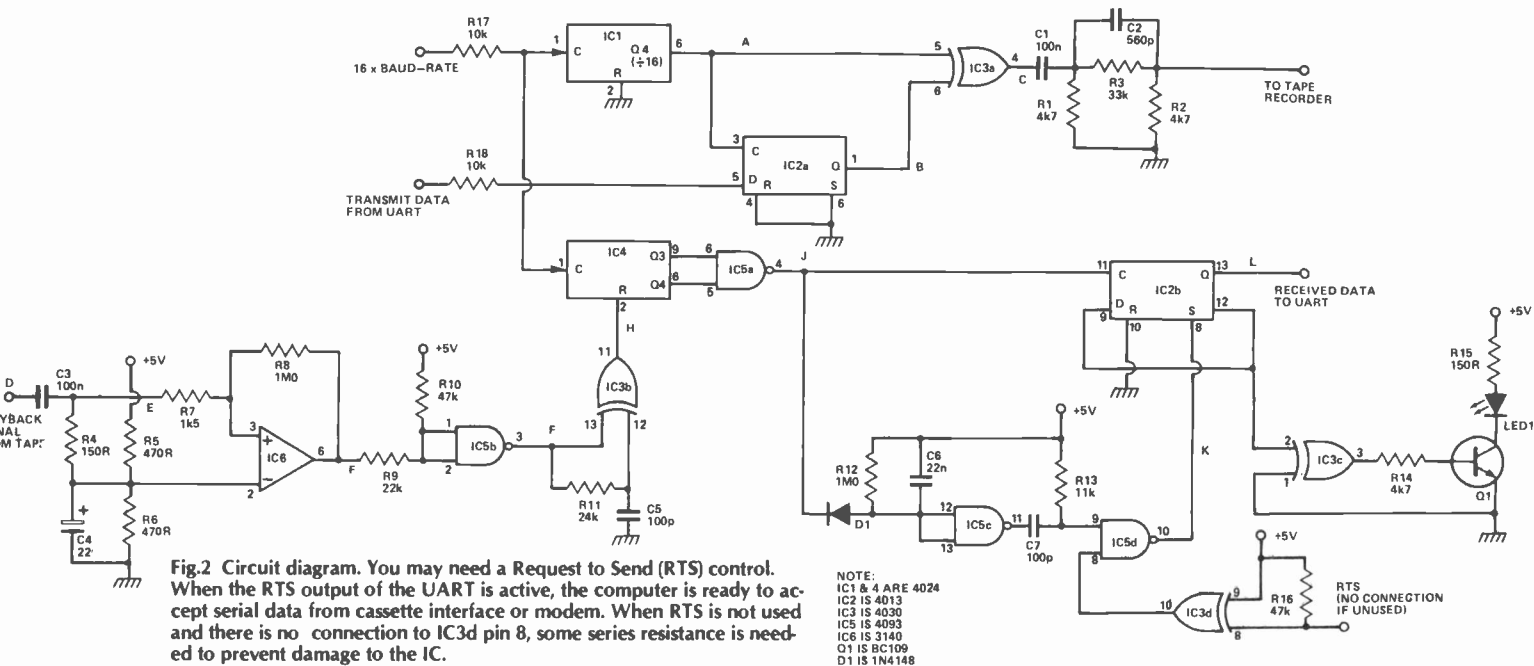


Fig.2 Circuit diagram. You may need a Request to Send (RTS) control. When the RTS output of the UART is active, the computer is ready to accept serial data from cassette interface or modem. When RTS is not used and there is no connection to IC3d pin 8, some series resistance is needed to prevent damage to the IC.

NOTE:
 IC1 & 4 ARE 4024
 IC2 IS 4013
 IC3 IS 4030
 IC5 IS 4093
 IC6 IS 3140
 Q1 IS BC109
 D1 IS 1N4148

ETI - Security found loading

HOW IT WORKS

The upper part of Fig.2 is the phase encoder. IC1 divides the UART clock signal by 16 to 1x baud-rate. The UART data signal is then brought to synchronism to our local clock (carrier) by means of a D-type flip-flop (IC2a). This synchronisation circuit makes sure that data transitions at IC2a always take place at the rising edge of the local clock (at A). However, if the computer data and the local clock happen to be in synchronism already, (a random choice of 1/16), this D-type flip-flop might be in trouble. In reality, this "perfect" chance of trouble never occurs, since the UART's internal + 16 clock divider circuit works much faster than IC1, even though both are triggered by the same falling edges of the 16x clock. Thus it is sure to achieve perfect synchronisation.

The lower part of Fig.2 shows the receiver/demodulator section of the system. First the signal from the recorder's ear-phone plug is fed to IC6 via C3. The values of C3 and R4 are such that any drop in level of the high frequency signal from an average cassette recorder is equalised. IC6 then slices through the average level of the equalised signal (Fig.1e). IC6 is wired as a Schmitt trigger circuit in order to suppress the background noise during playback. The output of IC6 is further buffered by IC5b. R9 and R10 make sure that the op-amp signal is well within the input range of the CMOS gate, IC5b.

The sliced tape signal is then passed through IC3b, which is configured as a one-shot triggered by both positive and negative-going transients. Its function is to generate a short pulse at point H whenever there is a level of transition at pin 10 of IC5b. The timing diagram is continued in Fig.4 for the sake of explanation of the demodulation process. Pulses at H should be made as narrow as possible: anything shorter than 10 uS will be suitable. The pulse duration at H is proportional to the product of R11 and C5. The narrow H pulses reset the binary counter IC4, which is again clocked at 16x baud-rate. The counter outputs Q3 and Q4 are NANDed so as to enable us to detect whether its count reaches 12 or more (1100 to 1111 in binary notation). In other words, as long as the H pulses are no more than 0.75T apart, where T is the duration of one bit, the output of IC5a at J will always be a one. This is because the counter is always reset to zero before it counts to 12. At 4800 baud, T is 208 uS. Theoretically the H pulses are either 0.5T or 1T apart, corresponding to 8 and 16 counts respectively. Thus, discriminating the spacing interval by the threshold of 12 counts seems to be most logical, allowing some ± 20% tape speed fluctuation. In the other case, if the H pulses are more than 0.75T apart, we will get a negative-going pulse at point J. If there are no pulses at H at all, as in the absence of the playback signal from the tape, the signal at J will be pulsed regularly at the baud-rate frequency with the mark-space ratio of 12:4.

From the timing diagrams (Figs.1 and 4), we may conclude that a "change" of the carrier phase corresponds to a change in the original data stream. This change in turn corresponds to the larger separation between successive H pulses, equal to 1T. Subsequently, long separation of H pulses is detected as a J pulse. We can, therefore, recover the original data signal from the J pulses by using IC2b, connected as a toggle flip-flop. It inverts its state upon receiving a J pulse. All seems to go well but we might still run into trouble if we happen to start IC2b wrongly and get all the data bits inverted, yet still obeying the change conditions discussed. Care must, therefore, be taken to ensure that the logic state of IC2b is always properly defined before data transfer can take place.

Fortunately, the asynchronous serial data transmission convention is such that on a UART getting ready to transmit, it always sends a series of marks (logic one). This means that we always have a steady tone recorded prior to the actual data signal. Therefore, we can preset IC2b to logic one before any transfer process commences. This function is carried out by means of IC5c and d. If the carrier is detected continuously for longer than 20 ms, the circuit will assume that this is a series of marks or logic one. It then resets IC2b accordingly. All subsequent data bits will then be demodulated with the correct polarity.

These properties are usually associated with cheap recorders. Users must avoid recorders with peak speed-fluctuations well over ± 20%, our required tolerance. Poor speed-regulation of a new recorder is associated with the lack of motor-regulator circuit, but it can also happen to a more costly recorder if the pinch-roller has been deformed, eg by leaving the machine off in the play position for a long time.

To sum up, the 4800-baud system may not work with all recorders due to the following reasons, in order of seriousness:

- (a) recorder transport mechanics — you need a recorder that can at least reproduce clean steady tone,
- (b) tape quality : use tapes which are better than just a "low-noise one, eg "Super Dynamic", "High Frequen-

- (c) cy", etc, recorder bandwidth — you tend to get more bandwidth from a radio-cassette than a hand-held recorder.

If your system has an RTS line and you are using it to control the cassette's motor, then you may also use it to control the received data line of this interface as well. When there is no input signal from the recorder, the idling sequence at point L (Fig.2) is 1010101, which is a series of the valid ASCII 'U' characters causing over-run error in the UART. This error is normally reset by the tape loader routine before the data transfer takes place. A normal way of tape loading is to type into the computer, specifying a tape load command, start playing the cassette recorder until you hear the header tone (continuous 4800 Hz) then type RETURN to start loading. The presence of the continuous tone is also indicated by the LED going off temporarily. However, if you happen to get a monitor which does not reset the UART (eg the UK101), then you need to get rid of the 1010101... pattern by means of the RTS line. With RTS line low (no request for data transfer) the LED is also off and the data output line is kept high and no longer causes overrun errors.

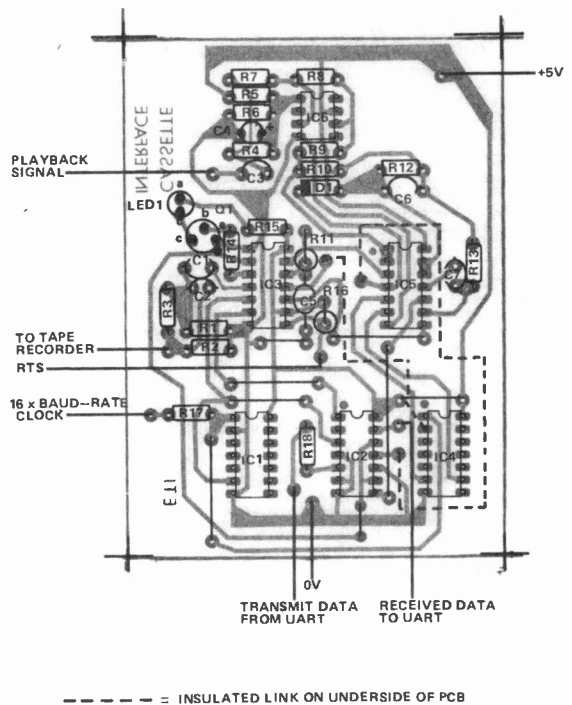


Fig.5 Component overlay.

PARTS LIST

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|---------------------|--------------|----------------|-------------------|
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| R1,2,14 | 4k7 | C4 | 22u 25V tantalum |
| R3 | 33k | C5,7 | 100p ceramic |
| R4,15 | 150R | C6 | 22n polycarbonate |
| R5,6 | 470R | | |
| R7 | 1k5 | Semiconductors | |
| R8,12 | 1M0 | IC1,4 | 4024B |
| R9 | 22k | IC2 | 4013B |
| R10,16 | 47k | IC3 | 4030B |
| R11 | 24k | IC5 | 4093B |
| R13 | 11k | IC6 | 3140 |
| R17,18 | 10k | Q1 | BC109 |
| | | D1 | 1N4148 |
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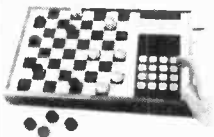
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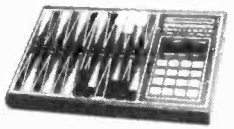
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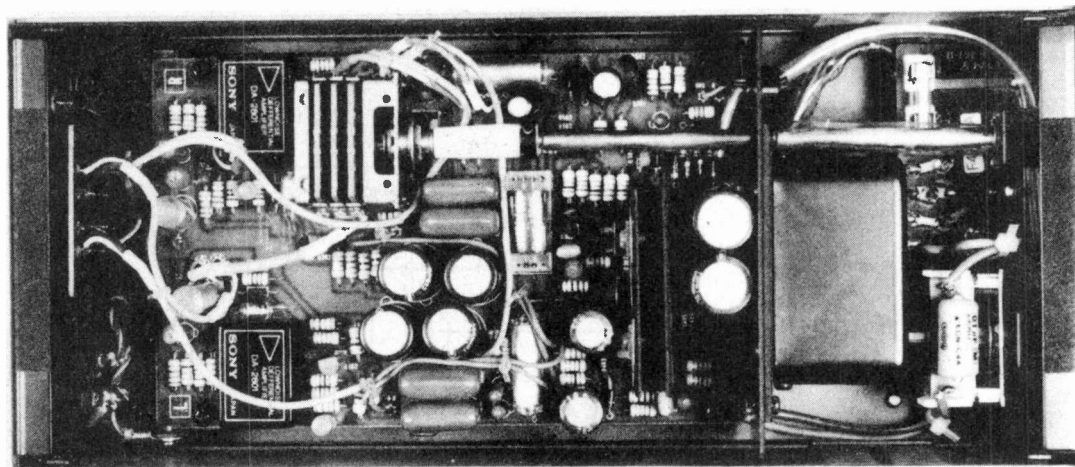


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HEAD AMP DESIGN

Videotone's Andy Sykes rounds off his head amp design guide with a few words on the dreaded mains hum.



The head amplifier design published in ETI in January is a good example of a differential input stage (Fig.1), which also makes use of a symmetrical output stage. A different approach is shown in Fig.2, that of the Videotone H300 amplifier. This is a refined version of the circuit in Fig 6 (last month) and is based on a simple parallel transistor pair.

Eight transistors are used for Q1 and two for Q2 and a bootstrap capacitor is employed to increase the open loop gain and so keep the distortion well below the noise level.

Trickle Charge

The design also features switchable gain and input capacitance to allow many different cartridges to be catered for. The commercial unit is powered by a rechargeable battery which is put on trickle charge when the head amp is switched off. This neatly removes both the need for a sophisticated mains power supply and the tedium of changing batteries.

De-Thumper

Any output spikes produced on power up or down, so prevalent in other designs, are also eliminated by the use of a darlington pair to slowly raise and lower the supply rail when the power switch is operated. The time constant of this rise and fall is far greater than any others in the circuit and so the unit switches on and off without damaging your precious speaker cones if you inadvertently leave the volume turned up.

Another advantage of this particular configuration is that the feedback resistor provides the bias for the first stage so

that potentially noisy input bias resistors are not required. The common emitter second stage gives a low output impedance, which enables relatively long signal leads to be used and renders variations in main amplifier input impedances unimportant. The frequency response extends well up into the MHz region to reduce susceptibility to RF pickup and note also the use of an inductor in the supply line. It also sounds good, though perhaps I am a little biased.

Mains Hum

The final point to be discussed is the bane of any audiophile's life, the dreaded mains hum. Oh for the DC supplies of yester-year. As with any other piece of sensitive electronics great care with screening and earthing arrangements must be taken to keep the hum gremlins at bay. The ideal case would be made of Mu metal, an alloy with particularly good screening properties, but this is not very cosmetic. If your head amp is to stand any chance of holding its own against the acres of brushed aluminium which enclose the average Hi-Fi, a smart but substantial aluminium or steel case is the next best thing.

Earth Loops

Connections to and from the head amp should be such that earth loops are avoided. Figure 3 illustrates one possible way of doing this, the turntable earth being separated from the signal earth to avoid hum pickup from the motor. It may also be necessary to tie the amplifier chassis down to a good earth

Fig.1. For full details of the ETI Moving Coil Preamplifier, see ETI January 1980.

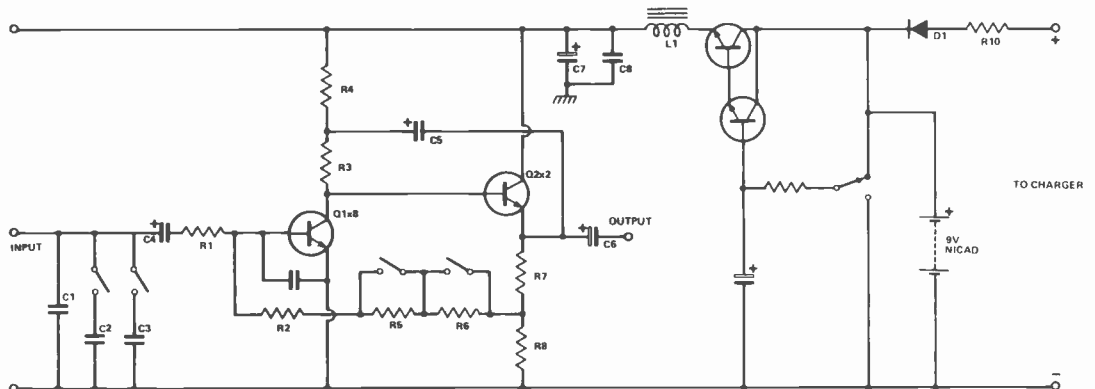
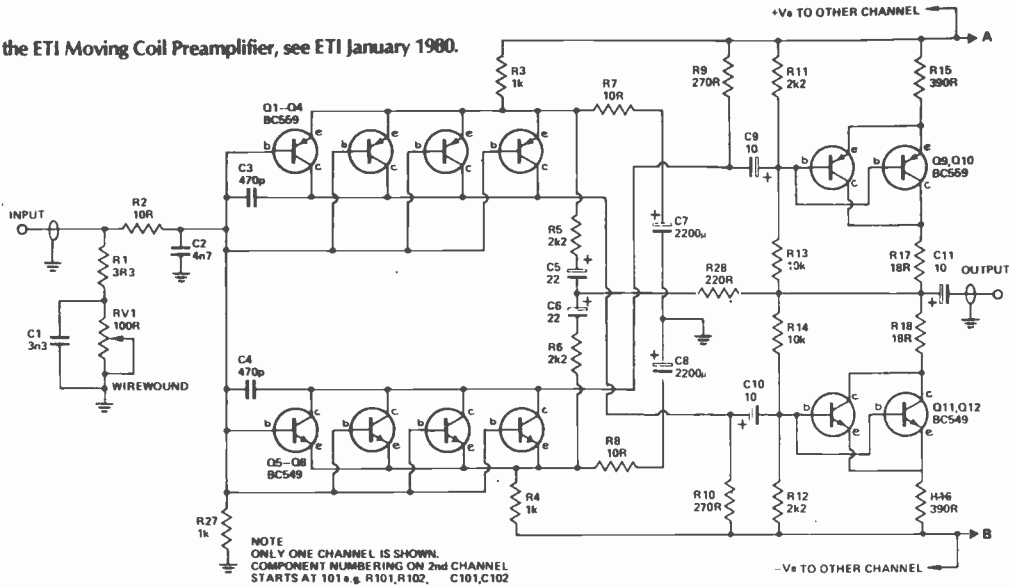


Fig.2. The Videotone H300 uses a different approach from the ETI design.

if it follows the modern trend of possessing a two-core mains cable. If your house wiring earth is not good enough, a passing water (not gas) pipe should be pressed into service, or even a length of copper pipe sunk into the back garden.

There is a case of a house with such bad earthing arrangements that the GPO telephone engineers not only resorted to sinking a rod in the garden, but instructed the occupants to water it before making a call in order to keep the telephone line from fading away.

Mains-Shy

A certain amount of experimentation may be necessary to obtain the best position to site the Head Amplifier. Keep it and all signal leads away from potential sources of electromagnetic radiation such as mains cables, amplifier transformers and electric motors. I know that all this is pretty boring stuff which all good Hi-Fi buffs have known since they were knee high to a volume control, but introducing a Head Amp to your Hi-Fi does increase the system gain by a further factor of 30 and so precautions against hum pickup must be correspondingly greater.

If you do plump for a mains powered design, a separate case away from the amplifier circuit will almost certainly be required. This supply should be as well regulated and decoupled as possible (the use of the various IC voltage regulators here is highly recommended). Long supply leads are a potential source of RF pickup so remember to decouple at high frequencies as well on the supply line as near to the amplifier circuit as possible. Again the use of an inductor in the supply lines is recommended.

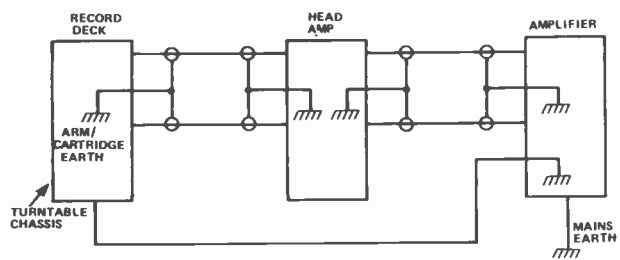


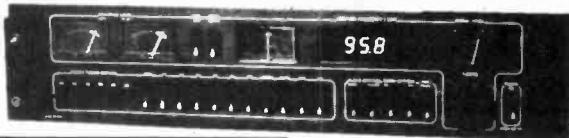
Fig.3. One possible way of avoiding earth loops.

Memories are Made of This

So there we have it, an albeit potted guide to Head Amplifier design, but it should point budding designers in the right direction, avoiding the more obvious pitfalls. It is well worth the time and effort expended on producing a head amp because, although the sound extracted from the record groove by a good moving coil cartridge is not startling when compared to a moving magnet of similar price, it is the subtleties of reproduction that are conspicuous by their absence; once heard, always hankered after. Even my wife can tell the difference and her normal assessment of any piece of Hi-Fi I bring home is based upon its ability to collect dust or support a plant pot. I am winning, though, slowly . . . very slowly.

ETI

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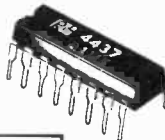
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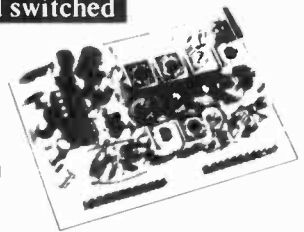
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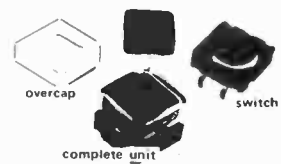
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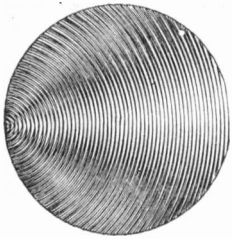
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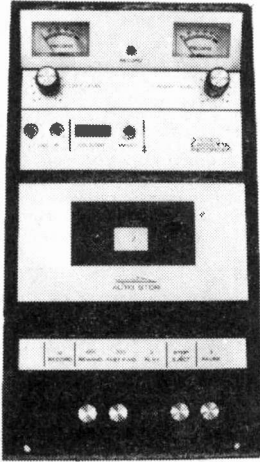
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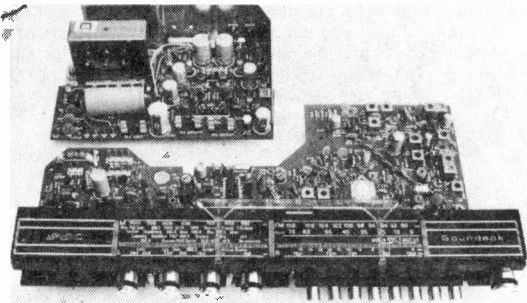
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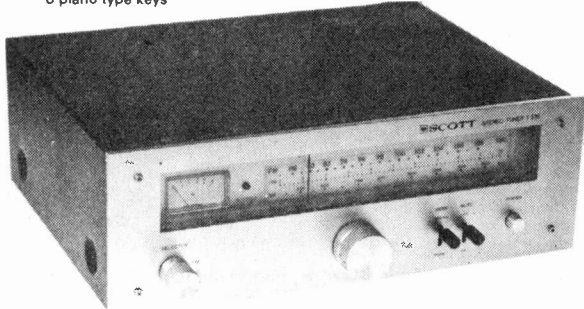
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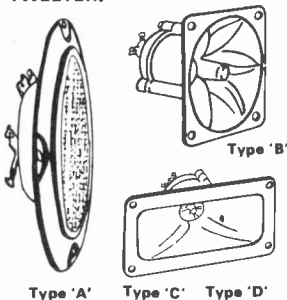
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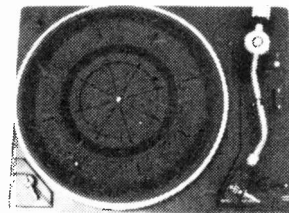
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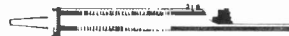
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DESIGNER'S NOTEBOOK

Ray Marston devotes this month's 'Notebook' to a discussion of practical temperature-sensing switches, alarms and metering circuits.

Temperature-sensitive circuits such as thermo-switches, alarms and electronic thermometers are amongst the most popular and common of all projects published in the technical Press. Such projects may use thermostats, thermistors or semiconductor devices as their basic temperature-sensing elements: each of these types of device has its own advantages and disadvantages and presents the electronics engineer with particular design problems. This month's 'Notebook' is devoted to a discussion of some of these problems.

Thermostats

The easiest way to implement a thermo-switch project is to use a commercially available thermostat of the type used in central heating systems, for instance, as the switching element. These devices usually take the form of a bimetal strip that closes a pair of contacts when the temperature falls below a preset 'trip' level, the level usually being variable over a limited range via a calibrated control.

The trip levels of these thermostats are usually accurate to within a degree or two and the devices give an adequate performance in most practical applications. They are simply wired in series with the switched load, as shown in Fig.1a, so that power is fed to the load when the temperature falls below the trip level.

You can reverse the action of a standard thermostat, so that power is fed to the load when the temperature rises above the trip level (contacts open) by using the simple circuit of Fig.1b. Here, when the contacts are closed the output of the inverting CMOS gate is driven low, so Q1 and the relay are off and zero power is fed to the load via the RLA/1 contacts. The circuit consumes a standby current (via R1) of only a microamp or so under this condition. When the thermostat contacts open, the input of the gate is pulled low via R1, so Q1 and RLA are driven on and power is connected to the load via the RLA/1 contacts.

Thermistor Circuits

Thermistors are simply resistive elements that are subject to fairly large changes in resistive value with small changes in temperature. They are ideally suited to use in sensitive or 'precision' thermal switching applications. The devices come in a variety of styles, but we'll concern ourselves here with inexpensive negative temperature coefficient (NTC) carbon-rod types only; a quick scan of component suppliers catalogues will show that these devices are readily available with a variety of resistance values at a variety of temperatures.

Figure 2 shows how you can use an NTC thermistor to make a precision under-temperature or 'frost' switch. Here, TH1 PR1 and R1-R2 are wired in the form of a bridge that is

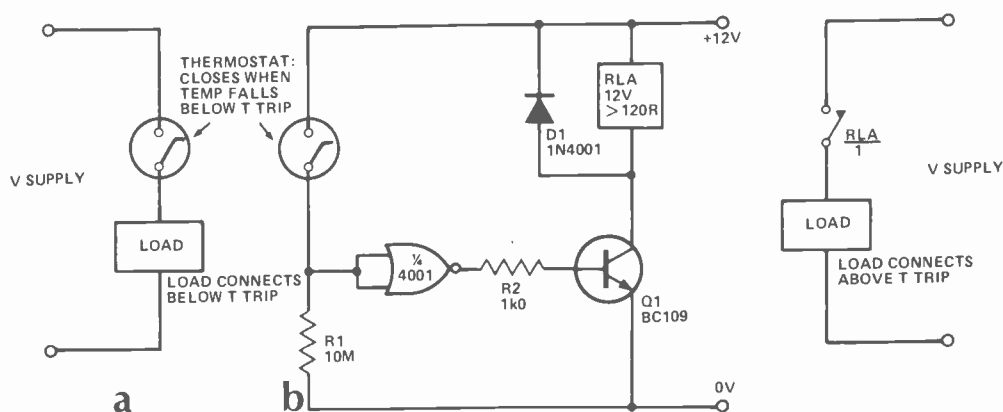


Fig.1 The effective switching action of a thermostat (a) can be reversed by using the circuit shown in (b).

almost balanced (via PR1) at the required trip temperature and the op-amp is wired as a voltage comparator with its output driving the relay via Q1. At temperatures below the trip level the pin 3 voltage of the op-amp output is driven to negative saturation and Q1 and the relay are driven on. At temperatures above the trip level the reverse action is obtained and the op-amp output is driven to positive saturation and Q1 and the relay are cut off.

The action of the Fig.2 circuit can be reversed, so that the circuit acts as an over-temperature switch, either by transposing the pin-2 and pin-3 connections of the op-amp or, as in the case shown in Fig.3, by transposing the TH1 and PR1 positions.

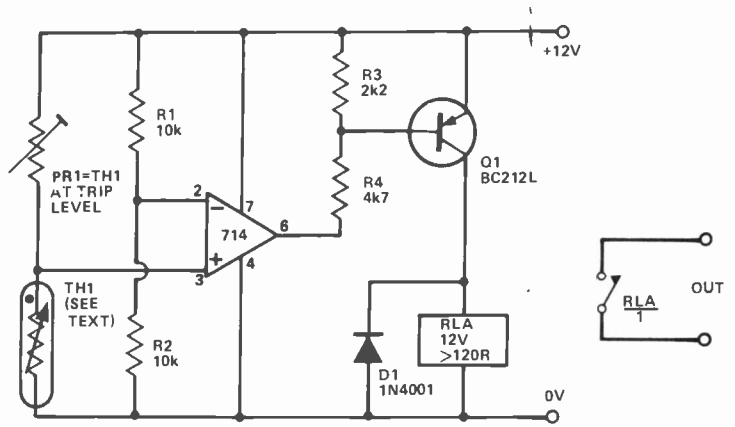


Fig.3 Precision over-temperature switch using thermistor sensor.

preset via PR1. The op-amp is wired as a conventional astable (with its output boosted by Q1-Q2), except that PR1-TH1 act as a potential divider between the output and pin-2 input of the op-amp and prevents the circuit from oscillating when the resistance of TH1 is below that of PR1. The action of the circuit can be reversed, so that it acts as an over-temperature alarm, by simply transposing TH1 and PR1. In either case, TH1 can be any NTC type that has a value in the range 2k Ω to 2M Ω at the required trigger temperature: the operating frequency of the astable can be changed by altering the C1 value.

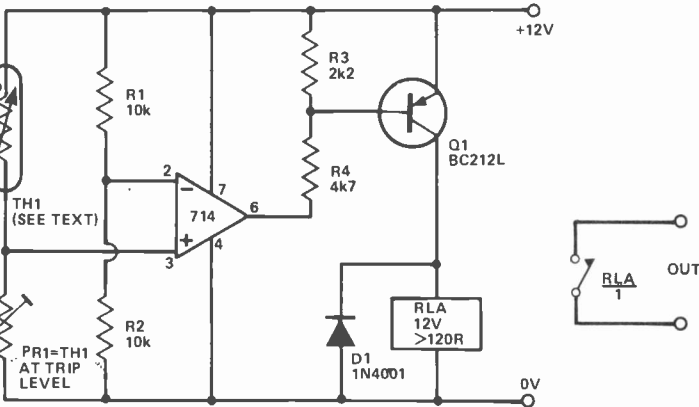


Fig.2 Precision under-temperature or 'frost' switch using thermistor sensor.

Two Into One

Figure 4 shows how the above two circuits can be used together to make a combined over/under-temperature switch in which the relay turns on if the temperature (of TH1) goes above a limit set by PR3 or below a limit set by PR2.

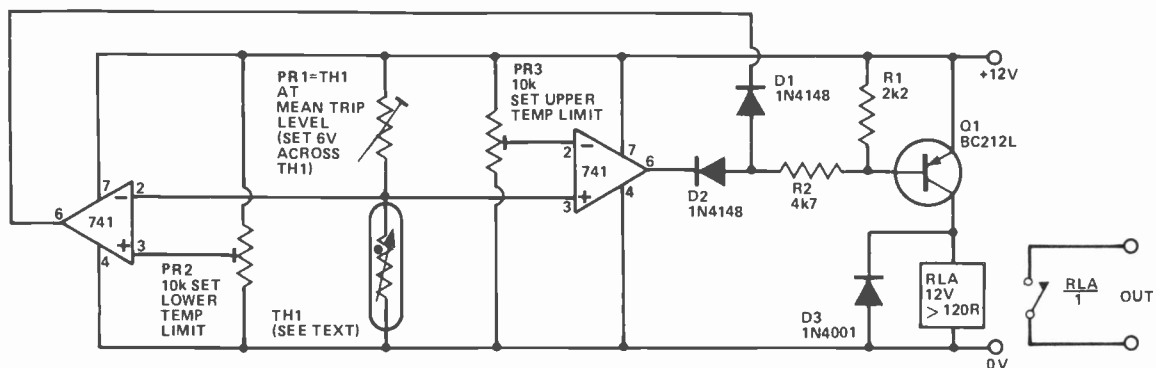
Note in the above three circuits that TH1 can be any NTC thermistor that exhibits a resistance in the approximate range 500 Ω to 9k Ω at the desired mean 'trip' temperature.

Finally, Fig.5 shows how an NTC thermistor can be used to make a direct-output alarm-call generator that produces a powerful fixed tone if the TH1 temperature falls below a level

Diode Sensors

Ordinary silicon diodes have junction temperature coefficients of about -2 mV/ $^{\circ}$ C when forward biased and can thus usefully be employed as temperature sensing devices. Major advantages of such diodes are that they give readily repeatable and consistent results and, because of their small masses, have fairly rapid thermal response times. A major

Fig.4 Method of combining the Fig.2 and 3 circuits to make a precision over/under temperature switch with independently adjustable upper and lower trip levels.



disadvantage is that their forward voltages are normally large compared to normal temperature-change values and are highly dependent on forward current: Typically, V_f values may be 630 mV at 1 mA and 660 mV at 2 mA, giving a nominal 3 mV V_f change (equal to a 1.5°C error) with a 10% change of forward current.

Figure 6 shows how a pair of 1N4148 (or similar) diodes can be used to make a differential temperature switch in which the relay turns on when the D1 temperature rises above that of D2. The circuit is responsive to the relative, rather than the absolute, temperatures of the two diodes. PR1 enables the differential trip levels to be varied over a limited range.

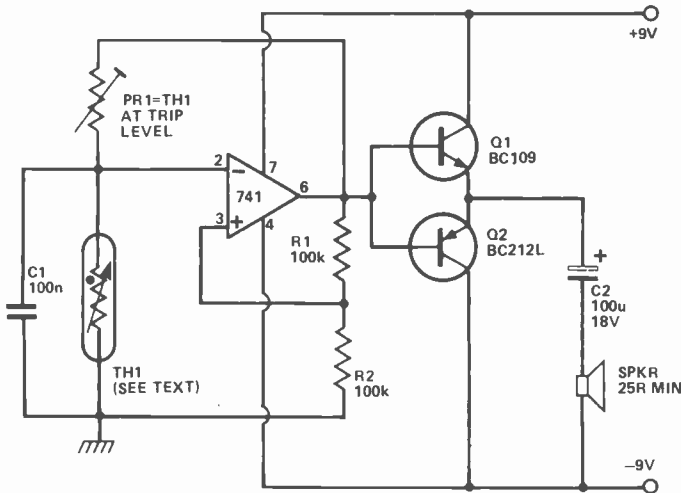


Fig.5 Direct output under-temperature alarm produces a powerful tone signal when temperature falls below a value preset by PR1. The circuit can be converted to an over-temperature alarm by transposing TH1 and PR1.

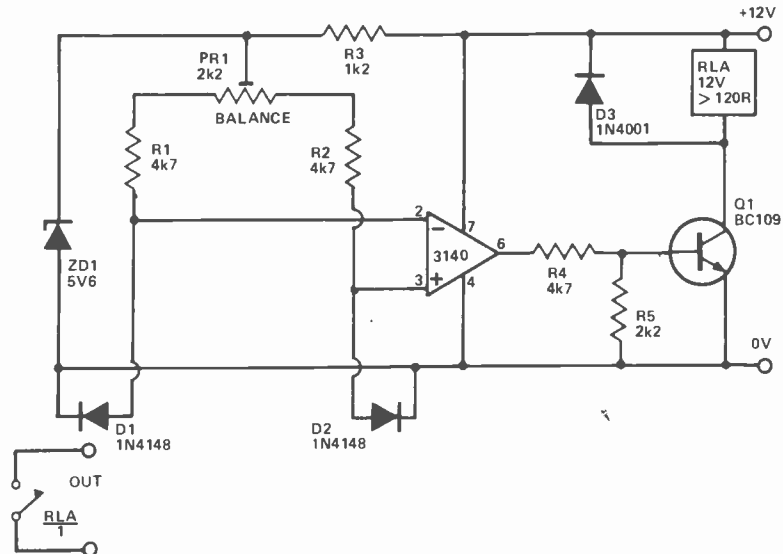


Fig.6 This differential temperature switch uses diode sensors and turns RLA on when the D1 temperature rises above that of D2.

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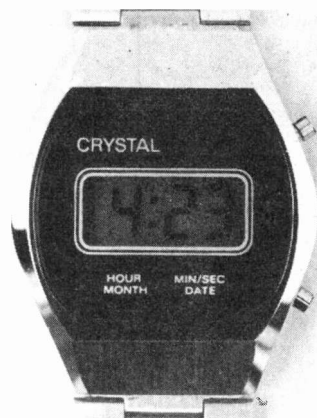
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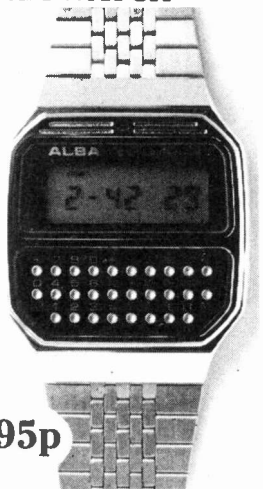
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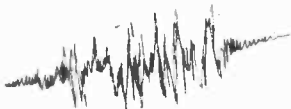
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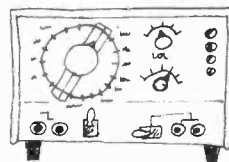
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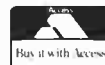
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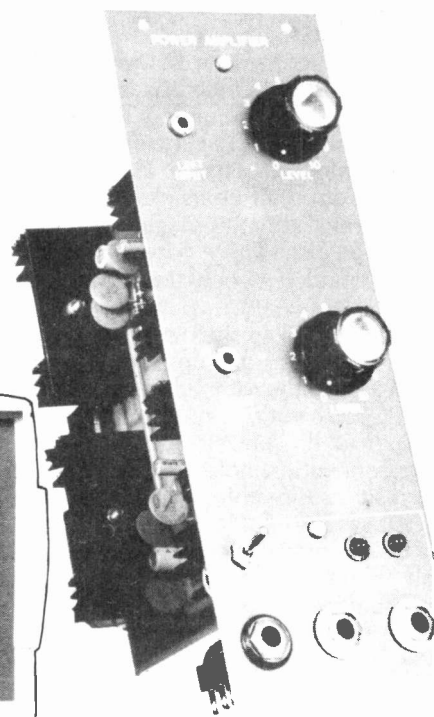


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MONITOR AMPLIFIER



Sound out your collection of Project 80 synthesiser modules with this 10 W per channel stereo power amplifier. Design by Charles Blakey

The 80-14 Stereo Power Amplifier is designed to be used in conjunction with the Project 80 synthesiser but with a few component changes it may also be used as a compact general purpose amplifier. The amplifier has an input impedance of 100k and an output of 10 W per channel into 8R with a maximum distortion of 0.5% (typically 0.1%). For use with the synthesiser the input sensitivity is 1V2 RMS for the rated output and for the general purpose version the sensitivity is 250 mV RMS. A switched headphone output is incorporated, suitable for use with low impedance headphones.

The design is based on the TDA2030 which is a Class B amplifier with low harmonic and cross-over distortion. It incorporates power limiting circuitry, giving short-circuit protection, in addition to a conventional thermal shut down system. The choice is based on experience with the TDA2030, the fact that 10 W per channel is adequate for domestic or monitoring use, the need to keep heat generation to an acceptable level and, not least, to provide a compact module.

Power Regulations

To obtain the 10 W per channel output it is necessary to use a 30 V supply; the maximum rating of the device is 36V. Furthermore, synthesiser applications in particular can generate peak current demands and these factors dictated the use of a regulated +15 V supply and DC coupling of the speakers. The components for rectifying, smoothing and regulating the power supply have been incorporated on the same PCB as the amplifier. When used with the synthesiser this allows the same mains switch to be used as for the +15 V module supply (Project 80-1) and for the fuse and

transformer for the amplifier to be housed in the keyboard case. A miniature three pole connector may then be used to couple the 15-0-15 V unregulated supply to the module housing allowing the module to be rapidly removed from the case when required. Also by having the capacitors on the PCB the ground returns from the speakers are kept short.

All Change

The component values shown in the circuit diagram are for the synthesiser version. For the general purpose amplifier the following component changes are required.

| | |
|------------|----------------------|
| R3,8 | wire links |
| R4,6,11,13 | 100k |
| R5,12 | 3k3 |
| C6,11 | 4u7 PCB electrolytic |

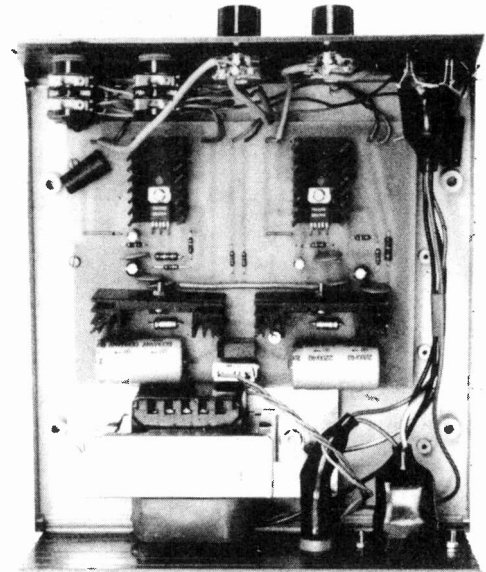
Construction

The module will fit onto the standard 9 x 3 inch panel and it can also be installed in a Tekal Alba A23G case but as with the panel version the transformer will have to be external to the case. For the self-contained amplifier a case with minimum internal dimensions of width 220 mm, length 250 mm and height 90 mm is required.

Construction should be carried out in the following sequence. Make the one wire link with insulated wire then solder in the resistors, capacitors and the bridge rectifier. Next install the TDA2030s. Slide the heatsink under the TDA2030 and, after checking that the pins are still in place, bolt the IC and the heatsink to the PCB. Do not move the

heatsink once the IC has been soldered since this will stress the pins. The voltage regulators are now bolted to their heatsinks (the pins should protrude from the side having the greatest distance from mounting hole to edge) and the combined heatsink and IC held firmly against the PCB while the regulator is soldered in place. There is no need to isolate any of the ICs from their heatsinks, but it should be noted that the heatsinks for the negative regulator and the TDA2030s will be at negative potential. A small amount of heatsink compound between the IC and their respective heatsinks is desirable.

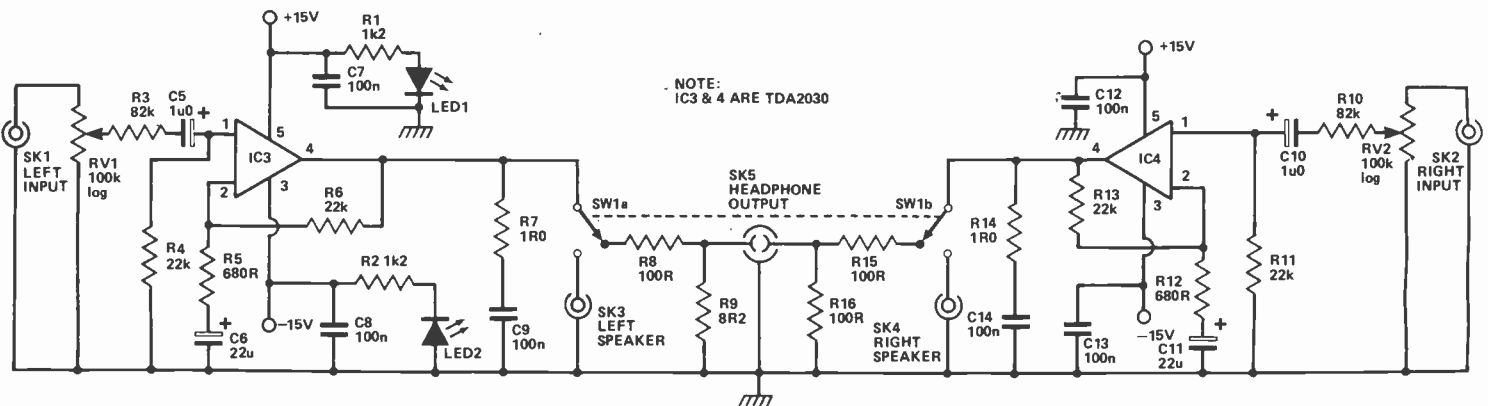
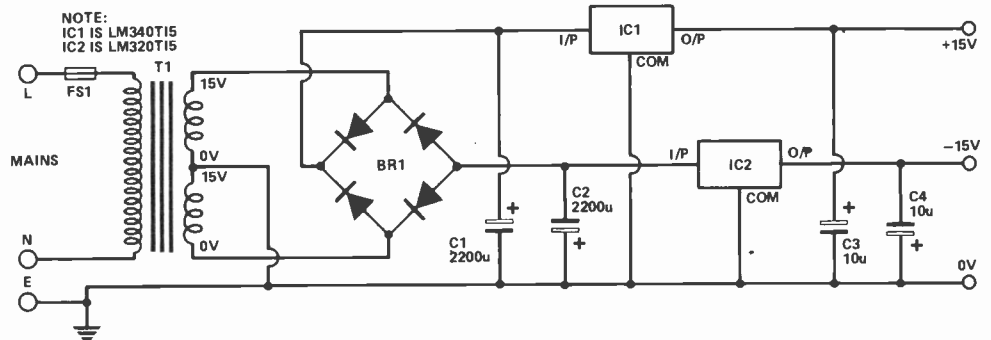
Next wire the PCB to the panel components. Screened wire should be used for the input leads which go from the input jack sockets to the rotary potentiometers and from the latter to the PCB. Do not common ground connections at the panel (except for the LEDs), but take them back to the appropriate connection hole on the PCB. Keep wiring as short and neat as possible. For the speaker leads it is preferable to use wire of at least equivalent to 16/0.2 mm. R8 and 15 can be soldered direct to the switch and a lead taken from the other end to the headphone socket while R9 and 16 should be soldered direct to the headphone socket. Remember to take a ground return from this socket to the PCB.



Inside the Project 80 Monitor Amplifier. Straightforward design and PCB layout makes for simple construction.

Fig.1 (right) Circuit diagram of the power supply. BR1 is a 2 A bridge rectifier.

Fig. 2 (below) Circuit diagram of the stereo Monitor Amplifier (synthesiser version). See text for alterations necessary to make a general purpose amplifier.



HOW IT WORKS

The TDA2030 power amplifiers (IC3 and IC4) require few external components and the function of the latter for the left input is described. C5 AC couples the amplifier while R3 and R4 form an attenuating network to reduce the sensitivity for use with the Project 80 synthesiser and, in the absence of RV1, determine the input impedance. RV1 provides manual adjustment of attenuation. R5 and R6 set the closed loop gain and for the general purpose version (R4 = 100k; R6 = 100k; R5 = 3k3) the voltage gain is approximately 30 dB. C6 is for DC decoupling of the inverting input and adjusts the low frequency cut-off. R7 and C9 increase frequency stability while C3, C4 (power supply) together with C7 and C8 are bypass capacitors which

also reduce the risk of oscillation.

SW1 allows selection of speaker or headphone outputs and for the latter R8 and R9 attenuate the output to a level suitable for low impedance headphones.

The power supply is a conventional regulated supply with a nominal +15 V and 1A5 per rail which is sufficient for 8R speakers at peak output of the amplifiers (about 13 W with 10% distortion). The regulators will also cope with 4R speakers in combination with a suitable transformer. R1, R2 together with LED 1,2 give a visual indication of supply voltage to the amplifiers.

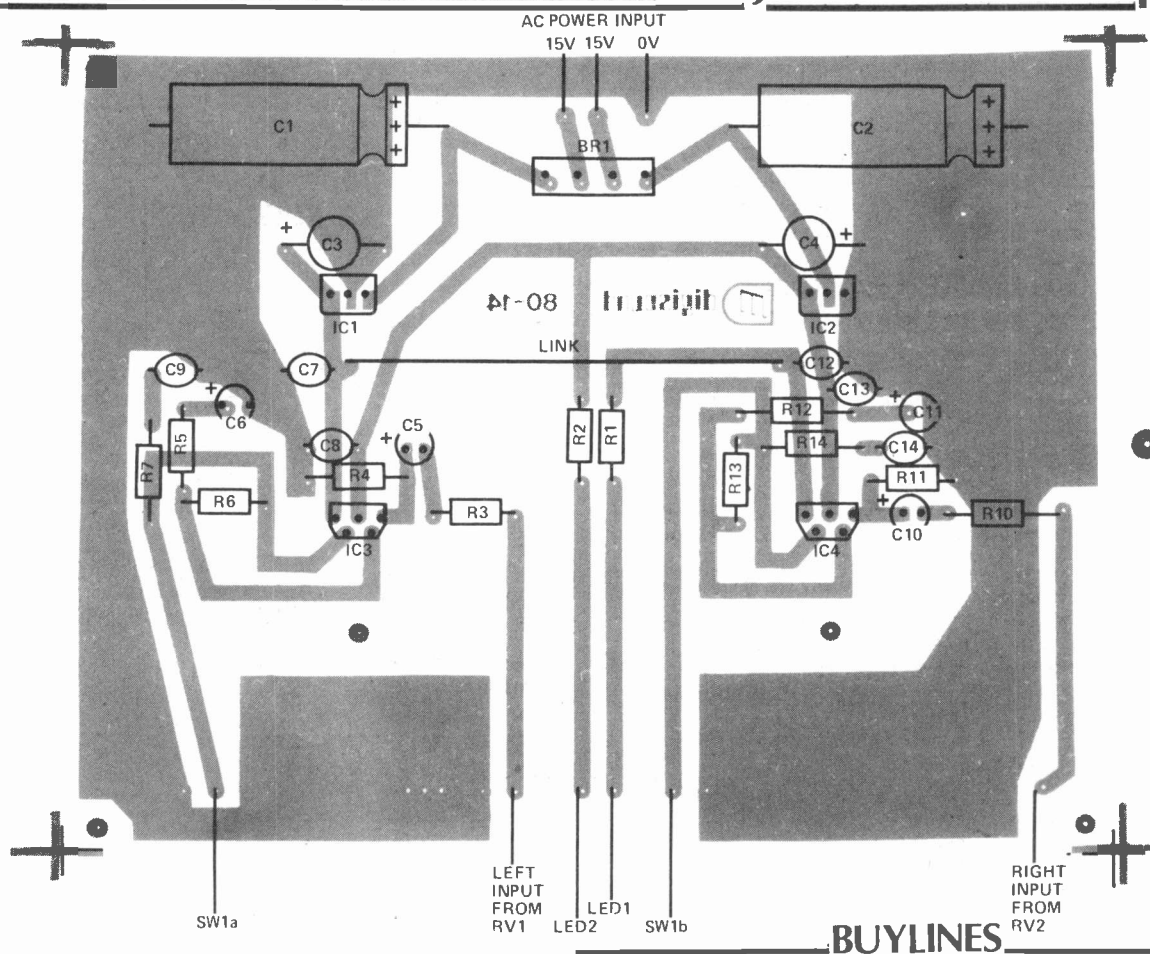


Fig.3 Component overlay.

BUYLINES

A kit for the stereo amplifier is available from Digisound Limited, 13 The Brooklands, Wrea Green, Preston, Lancs PR4 2NQ for £22.20 inclusive of postage and VAT. The kit includes the PCB and all listed components except transformer and case/panel. Please specify synthesiser or general purpose version.

PARTS LIST

(Synthesiser version, 8R speakers)

Resistors ¼ W carbon except where stated

| | |
|------------|--------------------|
| R1,2 | 1k2 |
| R3,10 | 82k |
| R4,6,11,13 | 22k |
| R5,12 | 68R |
| R7,14 | 1R0, ½ W |
| R8,15 | 100R, ½ W |
| R9,16 | 8R2, 2W5 wirewound |

Potentiometers

| | |
|-------|------------------|
| RV1,2 | 100k logarithmic |
|-------|------------------|

Capacitors

| | |
|-----------------|----------------------------|
| C1,2 | 2200u 40 V electrolytic |
| C3,4 | 10u 25 V electrolytic |
| C5,10 | 1u0 100 V PCB electrolytic |
| C6,11 | 22u 25 V PCB electrolytic |
| C7,8,9,12,13,14 | 100n disc ceramic |

Semiconductors

| | |
|--------|----------------------|
| IC1 | LM340T-15 |
| IC2 | LM320T-15 |
| IC3,4 | TDA2030H |
| LED1,2 | Red LED |
| B1 | 2 A bridge rectifier |

Miscellaneous

| | |
|-------|---|
| SW1 | DPDT subminiature switch |
| SK1,2 | 3.5 mm jack sockets (phono sockets for GP version) |
| SK3,4 | 0.25 inch mono jack sockets |
| SK5 | 0.25 inch stereo jack socket |
| T1 | 50 VA transformer, dual 15 V secondaries in series or 15-0-15 V type. |

FS1

Chassis fuse holder with 1 A fuse.

Heatsinks for IC1,2,3, and 4

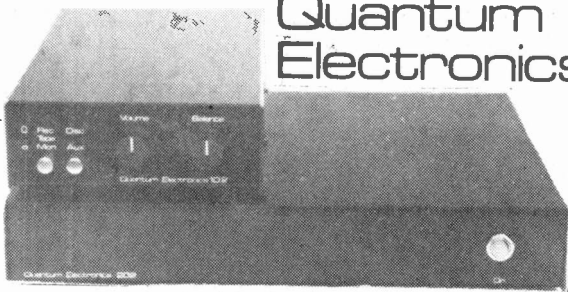
Ironing

A final point to note is that comparatively heavy currents will flow through many of the connections and it is essential that they are properly soldered. The connections requiring most care are those to ground where the large foil area acts as a heatsink. This is eased by using a tinned PCB but even then it is necessary to place the soldering iron adjacent (not touching) to the lead to be soldered and allow the area to heat up sufficiently prior to heating the lead and applying solder to it.

After construction connect the transformer and switch on. Gently touch each IC in turn. These should remain cool, since the TDA2030 quiescent current to each is only of the order of 50 mA. The LEDs will indicate whether the power supply is functioning. If any of the ICs run hot at this stage check the component placement and condition of soldered joints. Next connect the speakers and if any hum is evident check the wiring from PCB to panel components. Finally connect the amplifier to an audio source to determine that the module is functioning correctly.

Conventional Hi-Fi speakers should not be used in conjunction with a synthesiser since single frequency tones of more than a few watts can damage treble speakers. For most purposes full range speakers with a nominal impedance of 8R and a rating of 15 W will prove adequate.

Quantum Electronics



PRE-AMP: KIT £85.50, BUILT £92.50

The most cost-effective pre-amplifier available. It provides a perfect match for any cartridge, moving coil or magnetic and also accepts auxiliary and 2- or 3-head tape machine with outstanding technical performance from an elegant circuit configuration. The kit requires no soldering and takes only about 15 minutes. The module is available separately at £51.75. We also have separate mains supplies for the pre-amplifier in kit form and ready-built, and modules/hardware for moving coil head amps.

POWER AMPS: KITS FROM £100.50 BUILT £151.00

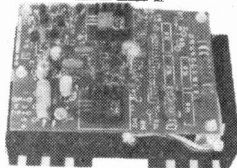
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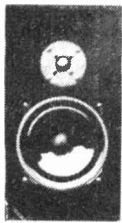
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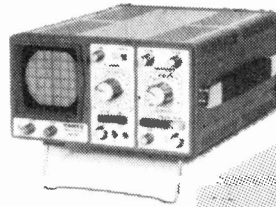
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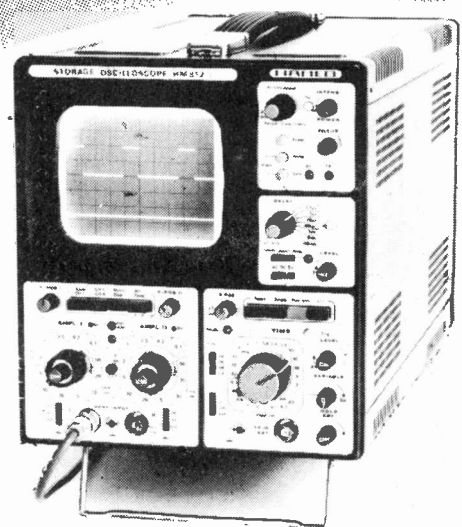
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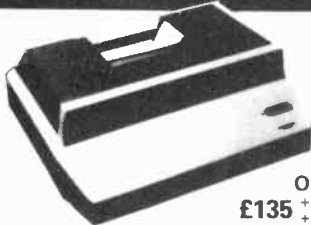
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ASTROLOGUE

Over the years ETI has covered almost every aspect of spaceflight. Now in the new regular series Ian Graham keeps you up to date with what's happening in the world of aerospace.

One aspect of the European space programme suffered a serious setback in May this year, when the Ariane launch vehicle ended up in the Atlantic Ocean two minutes after embarking on its second test flight.

Ariane is the key to Europe's future independence from America and Russia in placing satellites in Earth orbit. It will vie with the American Space Shuttle for business. Although the European Space Agency (ESA) is supporting the development and testing programme, once the hardware is proven Ariane will have to pay its own way by charging customers to carry their payloads into orbit.

The 200 tonne, three stage rocket first took to the air in December 1979 at the fourth attempt. The first hold-up was caused by excessive pressure readings in one of the four first stage Viking 2 engines. In fact the engines were OK. The fault was in the pressure sensor.

During the second attempted launch a fault appeared in the on-board batteries. Again, a sensor was found to be responsible. Unfortunately, this malfunction caused further delay by damaging one of the third stage subsystems (helium pressurisation). When Ariane finally got off the ground, its performance exceeded the designers' predictions, to the relief of all concerned. Ariane was a success.

Test Launch

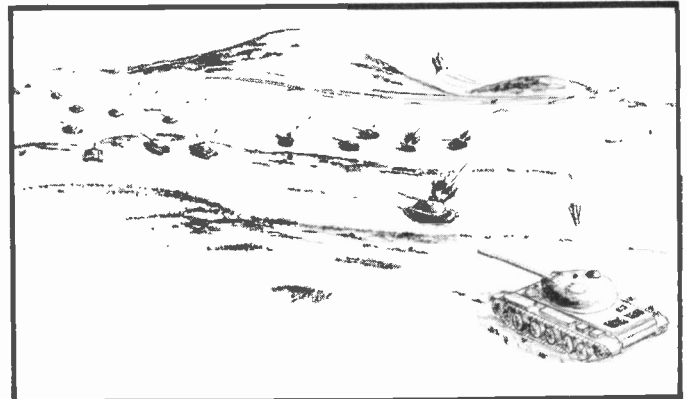
The second test rocket blasted off from the Guiana Space Centre in French Guiana on May 23rd. Within a few seconds of lift-off, pressure in one of the four first stage engines began to fluctuate. Two of the remaining engines suffered the same rapid pressure variations, which set up vibration in the structure itself. Eventually, the rocket broke up and blew itself to pieces.

The wreckage has now been recovered from the Atlantic mud and investigators have found a small metal identification tag in a fuel injector in one of the engines, although it isn't known if the tag was lodged in the injector at launch or during the break-up. The investigators are also looking at several other possible causes. The next test flight, originally scheduled for November, has been postponed until the beginning of next year.

Hughes' News

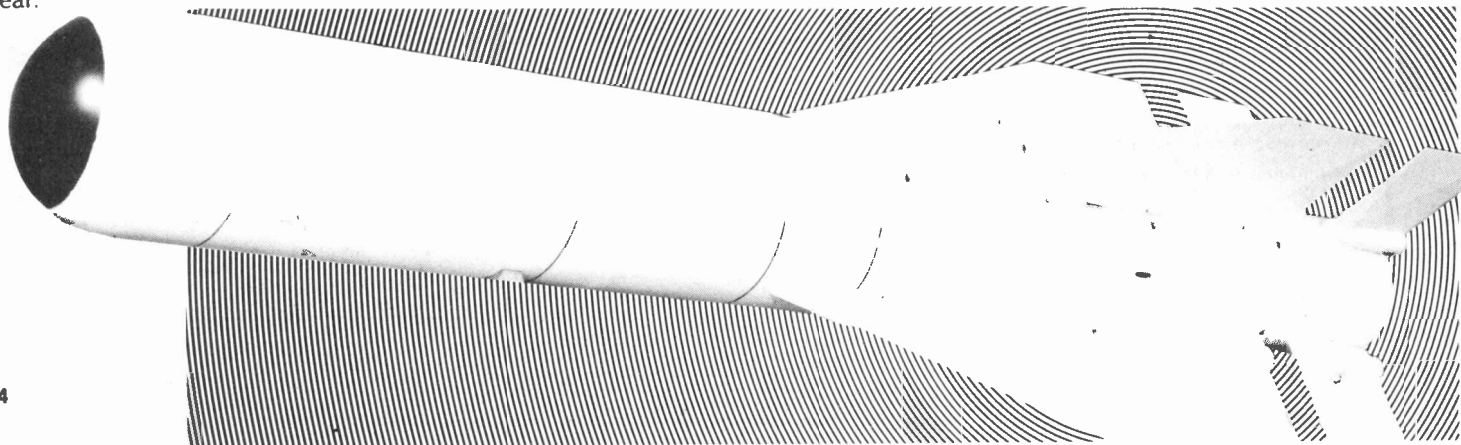
This is the first chance we've had to look at the new Hughes Aircraft Company Wasp anti-armour missile. It is one of a new generation of 'fire and forget' missiles; that is, once fired from an aircraft, the missile can carry on to its target without any guidance from the mother aircraft.

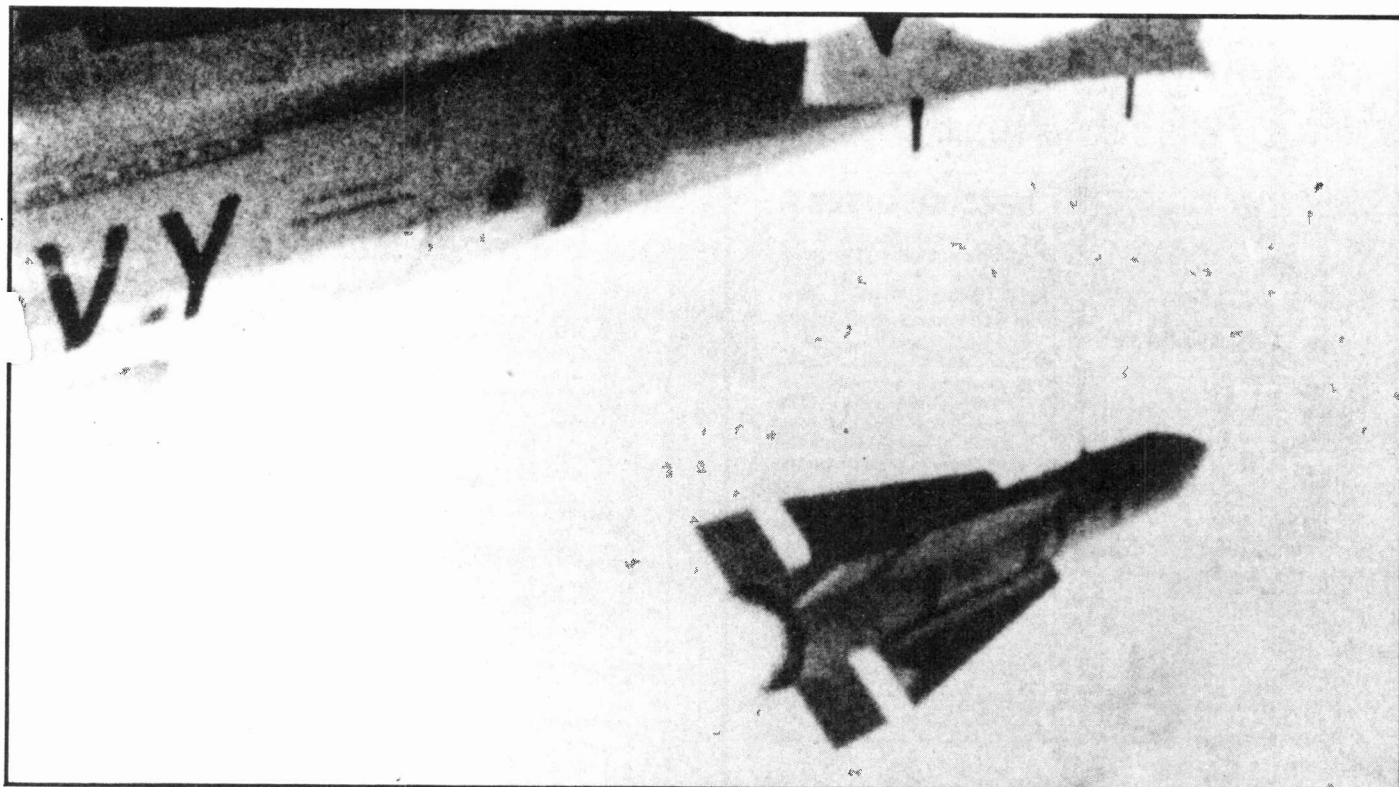
Of its predecessors, Maverick had to be targeted by the aircraft and could only be fired singly. Wasp can be fired either singly or in swarms of ten or more, but its over-riding advantage is that the aircrew do not have to identify a target before launch. The missile looks after all that itself. So, the aircrew can send a dozen Wasps on their way against a formation of enemy tanks and make for home without contacting the air defences. For that reason I'd guess Wasp will be a popular missile with the aircrew who will operate it.



In this artist's impression, a swarm of Wasps has been launched in the general direction of a formation of enemy tanks. The aircrew are already making for home. Each missile then seeks out a target and attacks.

The Hughes Aircraft Company's Wasp air-to-surface anti-armour missile. When the five feet long missile is launched, the wings flip out into the flying position.





An F-14 wing-tip camera catches a glimpse of the first airborne launch of the new upgraded version of the Phoenix air-to-air missile.

On Target

How does Wasp find its targets? Two sensors are under evaluation — infra-red and millimetre radar. Millimetre radar has three main advantages over infra-red. Its high resolution enables tanks to be distinguished from trees and buildings, it uses very small antennae and it is relatively unaffected by adverse weather conditions.

If a group of the missiles are fired at a number of targets, they will each attack a different target. If they can find only one target, it suffers a severe case of overkill. Wasp has a range of six miles when fired from an aircraft with a ground speed of 500 MPH. Two rival versions are under development by Boeing and Hughes.

AIM To Kill

Earlier this year the US Navy's new AIM-54C Phoenix air-to-air missile was successfully launched from an airborne F-14. It intercepted a drone aircraft target, passing well within the 'kill' range, if the missile had been armed. The Hughes AIM-54C, an improved version of the AIM-54A, carries a new digital electronics unit which is more flexible and reliable than the analogue unit it replaces. It also has a more effective target detector.

This first successful interception was achieved over a greater range than was possible with its predecessors. The F-14 launching aircraft travelled subsonically head-on towards the supersonic QF-4 fighter drone. In this launch, the Phoenix was guided on to the target by radar returns from the F-14's weapon control system. Closer to the target, it can switch to its own active radar system.

The upgraded Phoenix will become the US Navy's primary long-range air defence weapon in the 1990s.

SHORTS

A spacesuit was destroyed by fire at the Johnson Space Centre in April. Fortunately there was no-one in the suit at the time, although a technician was badly burned. To avoid a recurrence, a review board has recommended several modifications to the high pressure oxygen system and seals.

GEOS-D, the latest in a series of Geostationary Operational Environmental Satellites, is due to join its two companions in Earth orbit as we go to press. The 12 feet high by seven feet in diameter spacecraft will be launched from Cape Canaveral on September 9th by a three stage Delta 3914 booster. Next month I hope to bring you an in-depth report on this latest weather satellite and the GEOS system.

In July's Digest we brought you the sad news that the Viking Lander 2's batteries had run out of juice. The latest news on the Viking population of Mars is that Viking Orbiter 1 has now reached the end of its supply of attitude control gas. Viking Lander 1 is the only member of the foursome that is still functional.

We now know that the first Space Shuttle launch has been postponed from November this year until at least March next year. Next month Astrologue will look into the political, financial and technical problems that have beset the Space Shuttle from the start.

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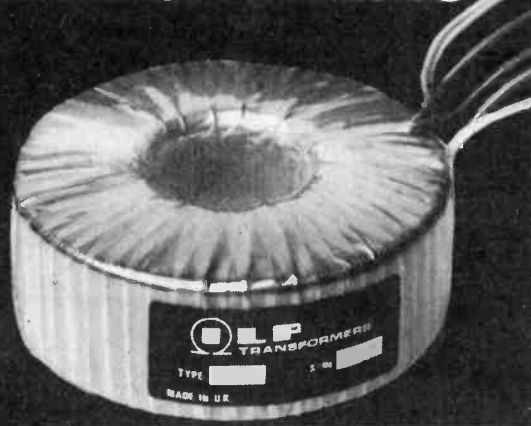


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MICROBASICS

In the second part of our new series, Henry Budgett takes the mystique out of the inner workings of modern man's best friend and contemplates the bits and pieces necessary to make it all work.

Having introduced the various component parts of a computer system in last month's episode I shall now move onto the actual microprocessor itself. Just as we divided the computer up into a number of parts so we may dissect the microprocessor. It is important to understand at this early stage that the much-vaunted micro is merely a very complex piece of electronic logic and is totally useless on its own without the ranks of qualified engineers, programmers and other allied trades, the supposedly mighty micro is an incomprehensible lump of high technology!

Architectural Heritage

The average, general purpose computer can be divided into a number of discrete elements as we saw last month. One of these components is the Central Processing Unit or CPU and this can be sub-divided still further. The microprocessor is really a totally integrated central processing unit; it still needs all the other bits and pieces to make it perform as a computer. Some of the later designs do incorporate internal memory

areas and one or two even have self-contained programs, the new SC/MP chip from National Semi with the NIBL BASIC built in being a prime example.

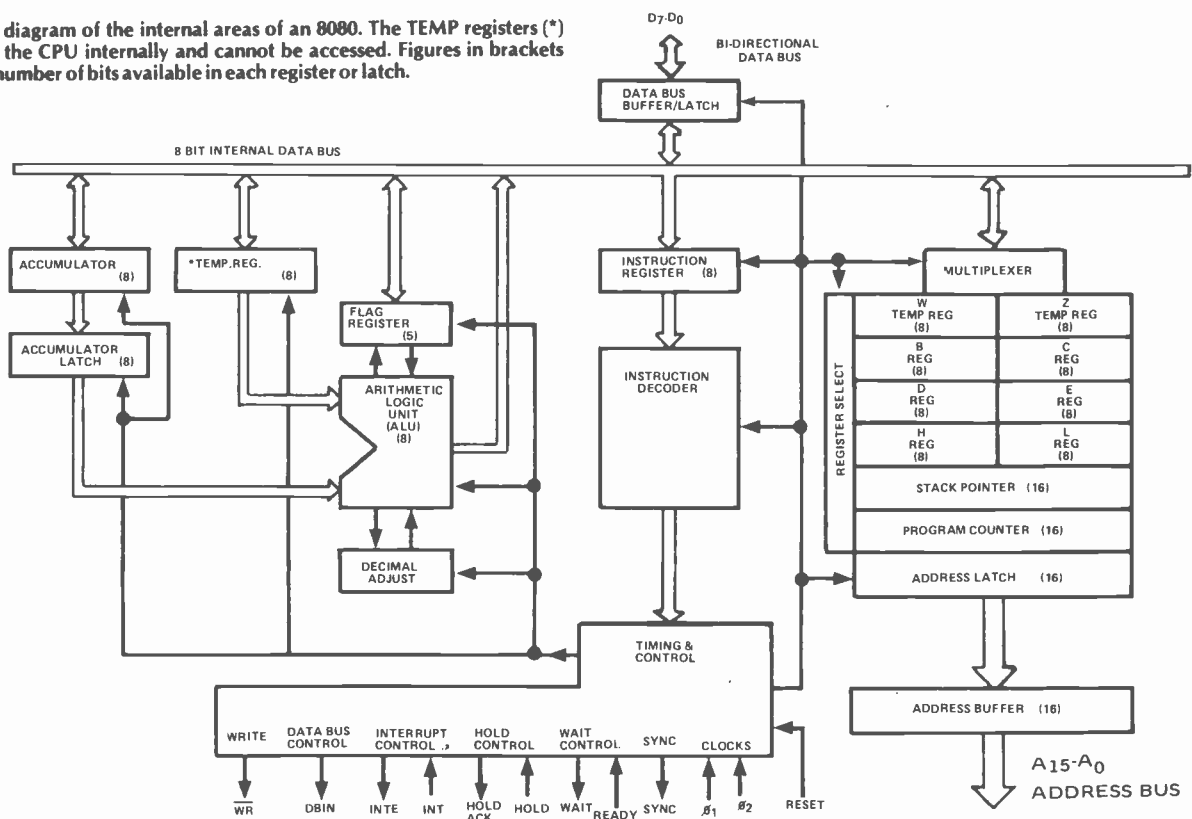
The three main sections of the CPU are the registers, the ALU and the control circuitry.

Taking them in order we find that the registers are a group of storage units within the CPU. Some of these are available to the programmer, others are used solely by the processor as counters or storage locations. The most important of these is the Accumulator. This register is used to store the data to be processed by the ALU, a typical instruction being to add the contents of some memory location to the Accumulator and to hold the result in the Accumulator for further processing. Many of the current families have other general purpose registers for data storage — the 8080 has six for example.

Flagging Already?

Closely associated with the Accumulator are a number of special registers called the flags. These are used to indicate the

Fig.1 Block diagram of the internal areas of an 8080. The TEMP registers (*) are used by the CPU internally and cannot be accessed. Figures in brackets refer to the number of bits available in each register or latch.



status of the ALU after an operation. Typical flags are 'carry' showing that an arithmetical carry has occurred, 'overflow' which simply shows that the number has exceeded the word length of the Accumulator and a number of bits which indicate the sign of the result in the Accumulator. There is also one other register connected with the Accumulator and ALU and that is the index register. This holds any offsets used in addressing or indexing and its inclusion is machine dependent.

The processor also requires a number of special registers, the instruction register and the program counter being two typical examples. These both have a 'double word' capacity, that is they can hold a full sixteen bit address. The contents of the program counter are always one in front of the address currently being used. This is in order to allow subroutines to re-join the program at the right place. When multiple subroutines are used, these addresses are held in a LIFO memory area called the stack. Some processors have a built-in stack which allows only a certain number of subroutines, whereas others use a dedicated area of memory, which can be, in theory, as large as you like.

All the stored information in memory is, until decoded, garbage. The instruction register performs two tasks in that it not only holds the currently selected address contents but also decodes them to see if they are valid instructions or data. This is usually done by a mask programmed ROM (Read Only Memory) which has all the valid instructions stored in it. The reason for coding the instruction set into a 'microprogram' are twofold. Firstly, it makes the control circuitry much simpler and, secondly, one can, in theory at least, change the instruction set of one's processor. As an example of this there are some 20 extra codes built into the Z80 CPU that are not mentioned in the manuals. Apparently they are not all guaranteed to work on all Z80s. Anyone know what they are and what they do?

Cycling Around

All the processes of control are under the charge of a central clock which synchronises the various happenings within the CPU. Some processors require a two phase clock, others a single phase, but in almost all cases the clock must be crystal

controlled. The reason for the accuracy needed is that, if one is to expand the system further than the basic CPU and its associated support circuitry, the clock must remain stable under variations of temperature and varying loads. Computer buses are fairly capacitive and can, over reasonable transmission distances, turn a nice square wave into a very unpleasant object indeed. The fundamental speed of the CPU is governed by the clock frequency. The original 8080 ran at 1 MHz and the 8080A, because of improved internal circuitry, runs at 2 MHz and will, therefore, process at twice the speed. However, and this is a common misconception, the actual CPU doesn't process at these speeds because of a number of reasons.

The most obvious reason is that the ALU is a serial device, that is it takes one bit at a time rather than processing the entire word. The second reason, which I will elaborate on in a minute, is that one has to perform a number of discrete operations within the chip just to get the information in a place where it can be processed and this takes time. All these operations are performed in cycles, the fundamental unit of time taken to fetch and execute a single instruction. On inspection of a data sheet on your chosen micro you will find this time quoted in terms of the number of clock cycles taken. All other instructions are then specified in the number of cycles that they take.

State Visit

To further explain this concept of instruction cycles let's take a look at the various types. The basic-FETCH cycle, also known as the M1 cycle, is made up of four states. During the first three, the processor fetches the instruction from the memory location indicated by the program counter. The counter is at this point showing the current location and has not been incremented. The fourth cycle is taken up by decoding the instruction. An example of this is the instruction to add the contents of a register to the Accumulator. If we wish to access a memory location rather than a register, we will have to perform a memory read, which requires an extra machine cycle. Say we wish to add the contents of a given memory location to the contents of the Accumulator. The sequence of operations is as follows: the processor extracts the

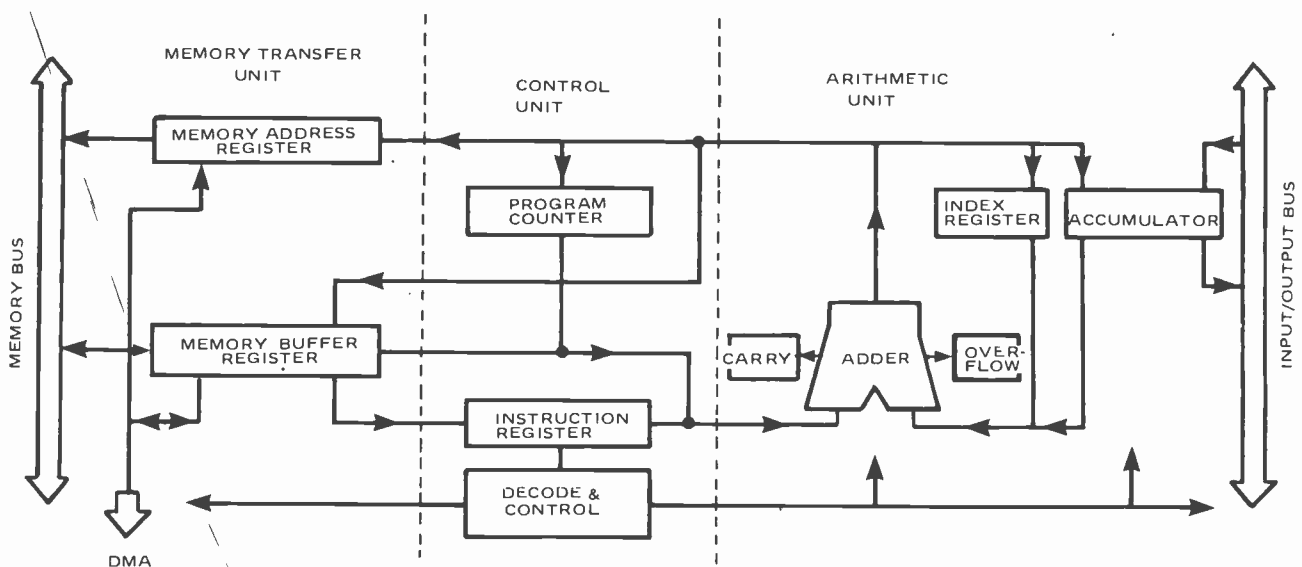


Fig.2 Functional block diagram of a CPU. This represents the minimal configuration you would expect to find. You could implement this (for fun) in discrete logic elements and see how it worked. It makes a good demonstration piece for schools and colleges.

single byte instruction from the memory location given in the program counter; this takes three states. This is decoded and the processor sends, as an address, the contents of its H and L registers. The data word returned during this cycle is held in a temporary register inside the CPU and we have now used six states. The final act of adding the temporary register contents to the Accumulator takes a further state making seven in all, or two cycles. The longest operation of all, in 8080 code, takes 16 states or five machine cycles.

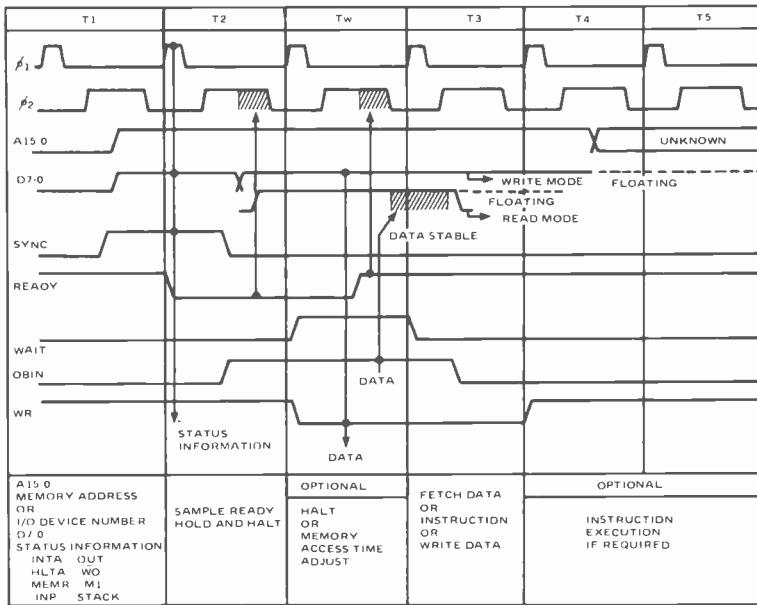


Fig.3 Timing diagram showing the various states that can make up a machine cycle: The vertical arrowed lines indicate information access states.

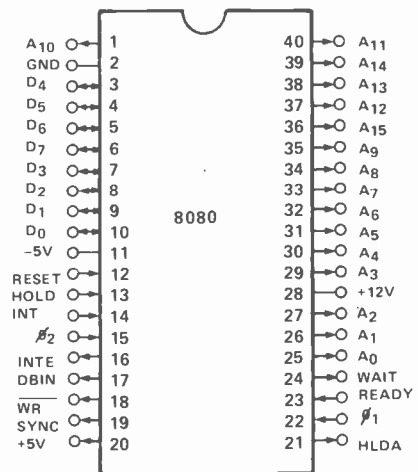
The Ins And Outs

The final section of our look at the internals of a CPU is the connections you can make with the outside world. Generally, the CPU is housed inside a DIL package with some 40 legs. Under normal circumstances, assuming the standard eight bit CPU, we will have 16 pins for the address bus, eight pins for the data bus and 16 pins left to play with. Just what you do with them depends on the kind of CPU you have, but let's take a close look at the pins on an 8080.

Having already mentioned the address and data bus, we only need to say that the data bus is a bi-directional system and is capable of tri-state operation. It can assume a high impedance state, which is neither a logic zero nor one and this is used under some special circumstances, which will be mentioned next month. Four further legs can be allocated to power; the device needs $\pm 5V$, $+12V$ and ground. Yet two more legs can be allocated to the required two phase clock, leaving us ten possible control signals to communicate the state of the device to the outside world. These are SYNC, DBIN, WAIT, HLDA, INTE, READY, HOLD, INT and RESET. Taking these in order, the SYNC indicates the first state of each machine cycle, thus acting as a synchronisation signal, hence the name. The DBIN signal tells the outside world that the CPU can accept data. It should be used to externally enable the

transfer. WAIT is an indication that the CPU has entered a WAIT state, triggered by pulling the READY line low before the second state time. This causes extra states to be added to the cycle time for as long as the READY line is held low. The process is often used in situations where the memory or device currently being accessed is slower than the processor.

Our next signal, WR, is provided for the synchronisation of external transfers. These include memory and I/O operations and it is the converse of DBIN. There now follows a group of controls, which are concerned with things called interrupts. An interrupt is the computer equivalent of a tap on the shoulder and is used by peripheral devices to tell the processor that they are ready to be looked at. The INT line must be set high to tap the computer on its shoulder, but this will only work if the INTE line has been enabled previously. Inside the CPU, the interrupt is signalled by a status bit being set and the external device must put its instruction onto the bus in order for any action to be taken. The HOLD line is concerned with direct memory access and as such we shall not dwell on this until next month. The HLDA is merely an indication that the CPU is in a HOLD state. Finally we have the RESET line which, as its name implies, does. The signal will restore the CPU to the first state of a machine cycle and it also clears the program counter. It is essential to start all the power up sequences with this signal otherwise you never know what you may find yourself doing! It is also worth noting for all those sceptics among you that pressing RESET does *not* destroy all your registers, it merely sets you back to the beginning without destroying your program *unless* the person who programmed the monitor on your system clears the memory as the first operation. Whoever said that programmers were logical anyway.



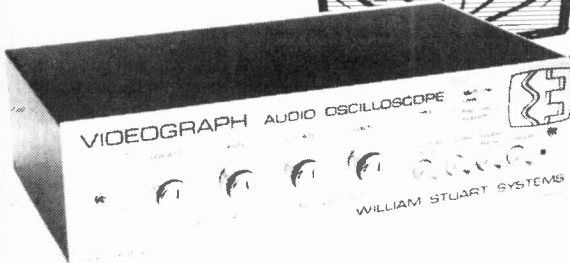
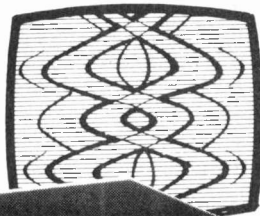
Pin designations of the 8080. Developed by Intel, fathers of the micro, it is still regarded as the workhorse of eight bit processing. It also spawned the Z80, probably the most powerful eight bit chip using current technology.

Coming Soon

Next month's slice of bits will investigate the thorny topic of memory devices and show you the way in the ROM-RAM jungle as well as telling you how to ignore your CPU altogether and really make things work fast.

ETI

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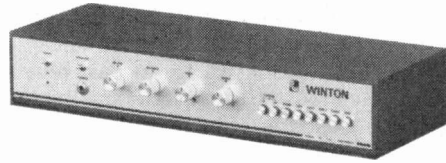
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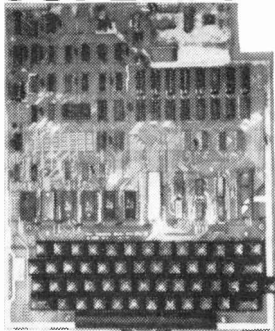
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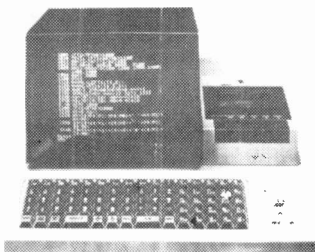


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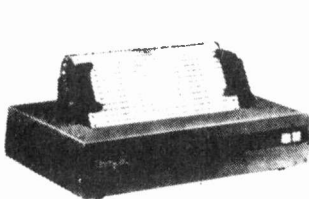
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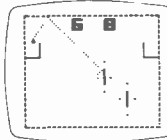
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ELECTRONICS TOMORROW

A spanner's not much help when your computerised fuel injection system dies. Dave Raven of Metac Electronics reports on the quality control that keeps your chips up to scratch, with a footnote on hand-held games.

While we must welcome the arrival of new electronic circuitry in everyday products (cars, sewing machines, food mixers, etc), electronic failures always seem much worse and more difficult to put right. The difficulty now in making temporary repairs to an item, which has been transformed into a solid block of plastic containing a thick-film circuit, is underlined to the stranded motorist when he is out in the pouring rain.

My own recent experience of this occurred miles out in the countryside. I was directed with my faulty alternator to a small holding, miles from anywhere. The gentleman who attended to me was clearly an expert, despite outward appearances and disused cars littering his yard. A small workshop/caravan was crammed with used starter motors and dynamos. With the precision of a brain surgeon, he diagnosed my faulty alternator (a diode in yer alternator) and immediately commenced stripping it down and replacing the faulty component. With an elaborate piece of home made test equipment, which put Heath Robinson to shame, he tested the alternator on the bench under full load. While watching this rustic genius I felt assured that, even with the advent of microprocessors this man will survive. But what of all the other indispensable backyard mechanics who are willing to be called out on breakdowns at 9am on a Sunday morning? If you happen to be equipped with an elaborate computer-controlled fuel injection system, then just try and sort that out mate.

Quality Control

The whole elaborate procedure for the quality control of precision electronic equipment is now becoming of vital importance. If electronic products are to achieve the same reputation as earlier mechanical products, which appear to go on forever, it is necessary that they are produced to the same high standards. Electronic products properly tested can achieve very high levels of quality and reliability as any airline pilot or astronaut will testify. The term quality is used to express our level of satisfaction with either goods or a particular service which we use. The notion of quality becomes more ambiguous when we must express our satisfaction with a particular instrument after we have used it through several months. Even if the qualities noticed during the first few months have deteriorated, the product must remain within the specification during its useful life. The measurement of the deterioration of quality of a batch of instruments is when we start to examine the probability of failure or its reliability. A

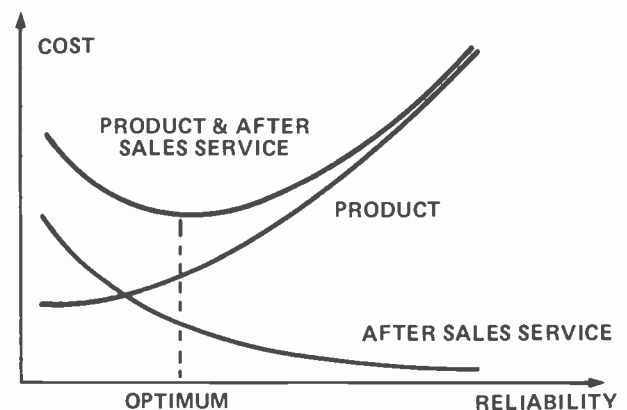


Fig.1. The optimum reliability, considering the cost of the product and the cost of repair during the after-sales service period.

reliable instrument is one which maintains its performance throughout its useful life. A product's reliability can be defined within exact limits by the manufacturer and, naturally, the higher the product's reliability, the higher the price is. The reliability of an instrument is in the mathematical sense of the term — the probability of good functioning within clearly defined performances, in a given time period, under conditions of normal use. This reliability, in the form of probability, is expressed by the quotient of the number of instruments still working at the time of the test divided by the number of instruments initially put into service, when this latter tends towards infinity. The following formula can be used to calculate reliability:-

Reliability = No. of instruments working correctly at time of test/No. of instruments initially put into service.

Failure Rate

The other factor which is linked closely with reliability is the rate of failure. This parameter represents the speed with which the products cease to work correctly. The rate of failure in terms of time can be expressed graphically as a (bathtub) curve, which can be divided into three parts. The first part involves early failures which arise during the first few months. The second part involves random failures, with a constant rate of failure. No physical or chemical procedure can eliminate them and this is of prime importance to electronic products. The last part involves failures due to wear, signifying the end of a product's lifetime.

Image Projection

The failures which occur during the first few months are particularly unwelcome, since they do much to tarnish a supplier's image. They are also very expensive to deal with. The reliability tests which a watch would need to undergo if we are to meet the requirements of the Swiss Industry Standards are divided into two categories:-

1. Performance and quality tests.
2. Accelerated life tests simulating wear.

Testing Time

The example below is the type of performance that electronic watches must undergo if they are to reach an acceptable level of quality for the Swiss (and, indeed, Metac): Control for good functioning of all external controls accessible to the wearer, such as time setting, second stop, rapid corrector, etc; measurement of trimmer adjustment range in positive and negative areas; measurement of supply voltage at which the watch ceases to function correctly; measurement of current consumption and calculations of performance in terms of type of battery used; measurement of the performance deviation of the watch, expressed in seconds per day as a function of the supply voltage variation; determine the effects of temperature variation on the quartz crystal and the integrated circuit; measurement of the watch's resistance to thermal shocks and determination of the watch's resistance to magnetic fields.

Note: a watch can be termed anti-magnetic if it withstands without damage three passages in a magnetic field of 60 Oersted. A watch can be termed anti-shock if it withstands without damage two shocks corresponding to a fall from a height of one metre on a hard wood floor; the intensity of such a shock is around 5,000 g (1 g = unit of gravity acceleration).

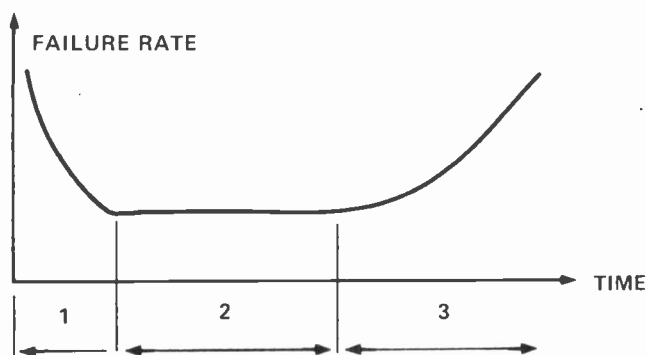


Fig.2. The bathtub curve shows the rate of failure of a product in terms of time.
1. Early rate of failure; 2. Random failures, with a constant rate of failure;
3. Failures due to wear.

Hand-held Games

Electronic games have been with us now for the last three years and are continually growing in their sophistication. The early TV game chip with its four simple games proved to quickly become a bore and probably ended up in the bottom of the toy cupboard the day after boxing day. Space Invaders and the other microprocessor based games, which until now were only to be seen at fun-fairs and in the local pub, are soon to emerge as portable hand-held games, which will easily fit into the Christmas stocking. The only viable way to produce really high technology microprocessor chips is in large volume. Once all the production problems are solved, the manufacturer starts to crank the handle and out spew millions of chips. Since rockets, machine tools, etc cannot consume very many chips in peace-time, the industry requires a volume product, which will soak up all this excess production.

Software In Hand

Now that chip shortages (which probably held back this product last year) have been overcome, the relatively simple task of assembling hand-held games will ensure their success this Christmas in a big way. Over 500 different hand-held games are being produced. However, reports from the Far East indicate that only a small number are up to standard and will be acceptable to the UK market. Finding a suitable game, which does not quickly become a bore, is a major headache for designers. The chip manufacturers are Texas Instruments, AMI and General Instruments in the main and these companies expend a considerable effort in writing software for hand-held game microprocessors. It still remains a very high risk business, however, and manufacturers and importers will try hard to ensure that they do not have large stocks remaining after Christmas.

Moving Pictures

Trends in hand-held games are in the direction of more LCD games than the LED type. These will last 20 to 30 hours compared to only three to five for LED ones. The use of fluorescent tube and larger memories are also expected developments. The drawback with LCD hand-held games is that they must have a combination of driver and LCD display. Companies in Hong Kong are working on this to produce the combination of chip and driver which makes players move on the display. The final touch will be a single chip direct drive microprocessor for LCD games. The standard type of LCD display has between 128 and 256 dots and the players and balls are mere blips on the screen. It is, however, hoped soon to produce a program of more than 600 dots and the LCD microprocessor will have drive capability with good resolution. Hand-held game trends are also moving towards devices that produce sounds. An example of this is sound producing microprocessors, which produce musical sounds in toys, or screeching wheels and engine sounds for toy cars.

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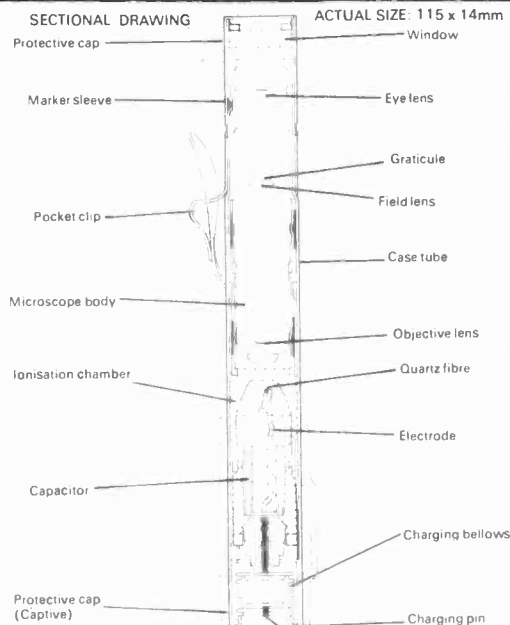
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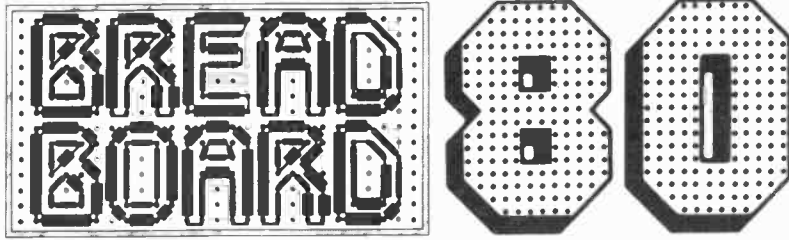
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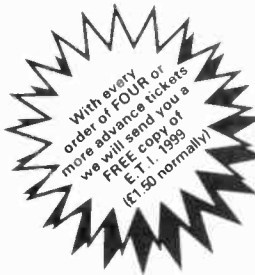
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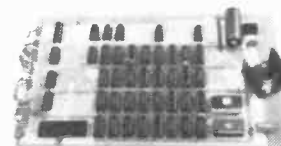
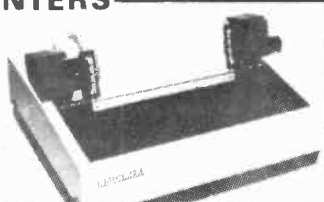
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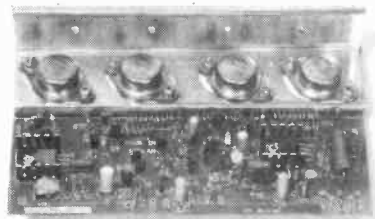
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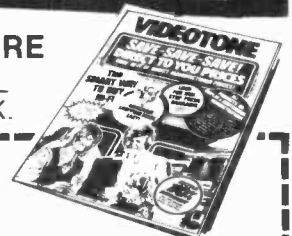
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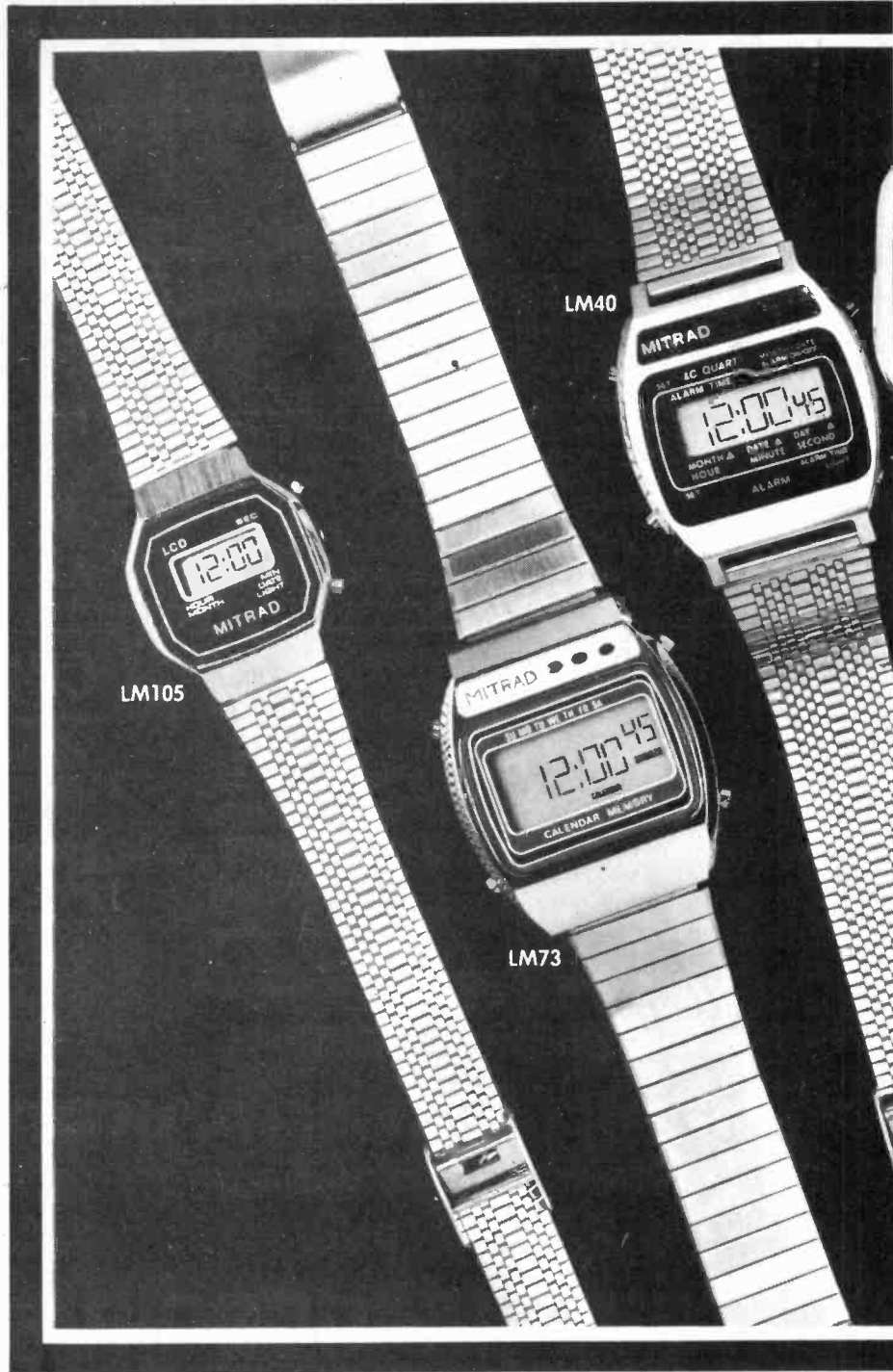
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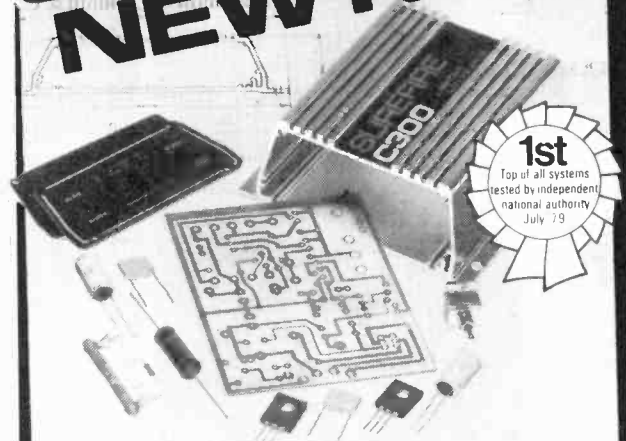
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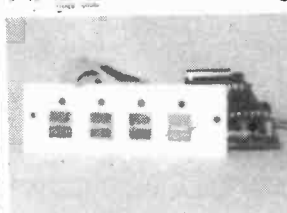
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K008 Extended range, as above, also including 220, 470 and 1000µF. Total of 100 for £8.05.
K021 Miniature carbon film 5% resistors CR25 or similar, 10 of each value from 10R to 1M, E12 series. Total 610 resistors £8.15.
K022 Extended range. Total 850 resistors from 1R to 10M £8.50.
K041 Zener diodes 400mW 5% BZY88, etc. 10 of each value from 2.7V to 36V, E24 series. Total 280 for £18.37.

TM4030 RAM

4096 bit dynamic RAM with 300ns access time, 470ns cycle time, single low capacitance high level clock i/p. Fully TTL compatible, low power dissipation. Supplied with data £2.75.

COMPONENT PANELS

Z525 Contains 11 800mA 60V 2N5061 SCRs, 11 6V8 zeners, 11 1N4004 diodes plus Rs, Cs, etc. Only £1.
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Z527 2 x 6V reed relays, 6 x 2S030 or 2S230 6 x 400V reeds, plus Rs, Only 50p.
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TTL, LINEAR, OPTO

All new full spec — Fairchild/SGS
TTL: 5400, 5401, 5402, 5403, 5404, 5405, 5410, 5421, 5430, 5450, 5451, 5453, 5460, — All 12p ea. 5470, 5472, 5474, 5475, 5476, 5480, 5486, 5490, 54107, 54121, 54122 — all 20p ea. 5482, 54126 — 40p ea. Others (74S, H) on B/L 12 (SAE please)
LINEAR: 9665 or 9666, 7 x 50V Darlington's in 16 OIL 80p; 75452 or 4 dual periph driver 70p; KX1444 7 CMOS P-channel buffers, 15V 16 OIL 24p.
OPTO: Isolators, FC0831 80p; TIL115/118 60p; FPE100/106 infra red LED £2.50; FN0847 7 seg 0.8" CA £2.00; FN0850 CC £2.00. (Data on request for linear & opto devices)

VEROBLOC BREADBOARD

New from Vero, this versatile aid for building and testing circuits can accommodate any size of IC. Blocks can be joined together. Bus strips on X & Y axis — total 360 connexion points for just £4.15.

POLYESTER CAPS

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|-----|------|----------|------|
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| 015 | 250V | C280 | .025 |
| 022 | 400V | C280 | .025 |
| 068 | 250V | Advance | .025 |
| 22 | 250V | C280 | .036 |
| 22 | 250V | Advance | .035 |
| 22 | 100V | Minibox | .035 |
| 47 | 250V | C280 | .05 |
| 47 | 160V | C296 | .04 |
| 10 | 250V | C280 | .065 |
| 15 | 63V | Filmcap | .065 |
| 2 | 160V | Filmcap | .098 |
| 3.3 | 100V | Wima MKS | .15 |
| 4.7 | 100V | C281 | .195 |
| 4.7 | 100V | Wima MKS | .235 |
| 6.8 | 100V | Wima MKS | .285 |

POLYSTYRENE CAPS TANT BEADS

22pF 125V 5% £8/1000 1/5/35 .06
27pF 125V 5% £8/1000 3/3/25 .08
1500pF 125V 10% £14/1000 10/25 .15
8200pF 125V 10% £14/1000

MINIATURE CERAMIC CAPS

Thompson/CSF miniature type in the following values
3 9pF, 4 7pF, 22pF, 33pF, 47pF, 47pF, 68pF, 82pF, 100pF, 560pF, 2700pF† All 5% except †10%, †20%
Prices up to 82pF £7/1000
100pF £9/1000
560pF £5/1000
2700pF £9/1000
Samples on request (see please)
Mullard min. ceramics
33pF 5% 100V £7/1000
330pF 2% 100V £8/1000
3300pF 10% 100V £13/1000
Stettner min. ceramics
330pF 5% 63V £7/1000
022µF 63V £14/1000
Lemco .047µF 63V £16/1000

SEMICONDUCTORS

741 .12 555 .19 7401 .08 7405 .09 74174 .21 4001 .17 4011 .17 S1 signal diodes like IN4148 by TI on bandolered reels of 10k £80 (1k £10). IN4002 £25/k, IN4006 £34/k, IN4007 £38/k, Ge signal diode DK14 £20/k, SCRs 2P4M (C106D) 4A 400V .26, 2N5060 8A 30V .15, CR2011A 200V .18.
See July 5 advt for transistors, send sae for latest bulk buyers list

MICRO-PRINT LTD

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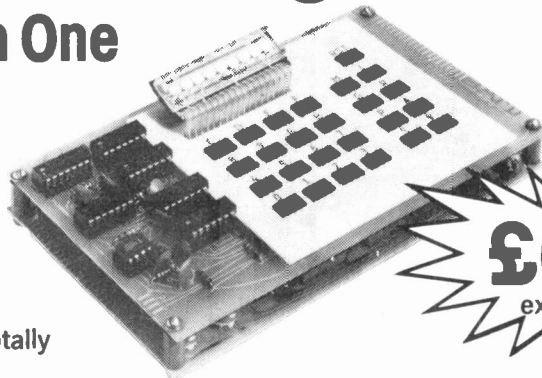
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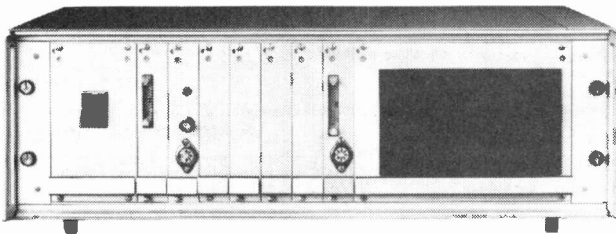
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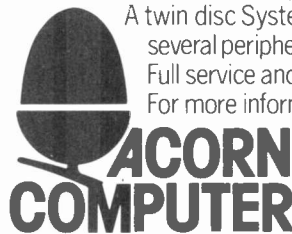
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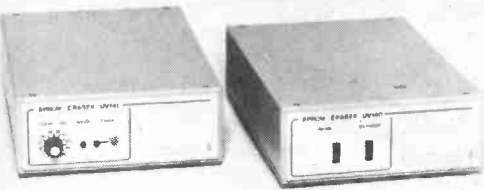


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UV EPROM ERASERS

UV 140, UV 141



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

Features

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

Supplied complete with mains plug and flex

Model UV141: Price £77.70

Also available without timer as

Model UV140: Price £61.20

Tex Microsystems "EPROMPT" UV ERASER



A low cost alternative to the above erasers (UV 140/141) claimed by the manufacturer to erase up to 32 chips in 15-30 mins. This is the cheapest eraser we have seen. The unit has no timer, power switch or safety interlock switch. The user places up to 32 chips into loose conducting foam in the erasure tray (16 along the base, 8 on each side). The chips are held in place by the UV tube which sits in the tray. (Unlike the UV 140/141, no special precautions have been taken to prevent the seepage of UV light, but the manufacturers state that "Incident light from this device is quite safe at distances above 12 inches".)

(Dimensions — 325 x 64 x 38mm)

EPROMPT ERASER: Price £33.56

5204/2708 PROGRAMMING SERVICE: £7.50 each prom. (Price does not include prom, we accept handwritten/typed source code — must be hexadecimal).

PROM WASHING SERVICE: 50p each prom

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The following computer boards have been added to the range for use with the Z80 (114 x 203mm fibreglass with gold plated edge connector).

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- OP2 8 line relay output board **£9.40**
- SIO RS232 serial interface board **£9.40**
- MXD2 16K dynamic ram board **£9.40**

SPECIAL OFFER (Subject to stocks)

No monthly accounts for these prices:

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|--------------------------------------|---------------|---------------|
| | each | per 8 |
| 2114 (450nS) — 1K x 4 | £2.99 | £22.40 |
| 2708 (450nS) — 1K x 8 | £5.25 | £39.60 |
| 2516/2716 (450nS) — 2K x 8 single 5v | £12.00 | £88.00 |
| 4116 (250nS) — 16K x 1 Dynamic | £3.99 | £30.40 |

CMOS

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

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| 4002 25p | 4044 90p | 4097 £5.98 | 4412P £14.93 | 4534 £5.60 |
| 4006 95p | 4045 £2.63 | 4098 £1.92 | 4415V £5.24 | 4536 £3.69 |
| 4007 18p | 4046 £1.10 | 4099 £2.00 | 4422 £5.66 | 4537 £26.10 |
| 4008 80p | 4047 £1.71 | 4010 £1.92 | 4433 £12.30 | 4539 97p |
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| 4010 50p | 4049 45p | 4012 £3.67 | 4451 £3.81 | 4543 £1.80 |
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74C

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| 74C44 28p | 74C127 £2.55 | 74C256 £2.55 | 74C925 57p | 80C20 85p |
| 74C46 28p | 74C128 £2.55 | 74C257 £2.55 | 74C926 57p | 80C21 85p |
| 74C48 28p | 74C129 £2.55 | 74C258 £2.55 | 74C927 57p | 80C22 85p |
| 74C50 28p | 74C130 £2.55 | 74C259 £2.55 | 74C928 57p | 80C23 85p |
| 74C52 28p | 74C131 £2.55 | 74C260 £2.55 | 74C929 57p | 80C24 85p |
| 74C54 28p | 74C132 £2.55 | 74C261 £2.55 | 74C930 57p | 80C25 85p |
| 74C56 28p | 74C133 £2.55 | 74C262 £2.55 | 74C931 57p | 80C26 85p |
| 74C58 28p | 74C134 £2.55 | 74C263 £2.55 | 74C932 57p | 80C27 85p |
| 74C60 28p | 74C135 £2.55 | 74C264 £2.55 | 74C933 57p | 80C28 85p |
| 74C62 28p | 74C136 £2.55 | 74C265 £2.55 | 74C934 57p | 80C29 85p |
| 74C64 28p | 74C137 £2.55 | 74C266 £2.55 | 74C935 57p | 80C30 85p |
| 74C66 28p | 74C138 £2.55 | 74C267 £2.55 | 74C936 57p | 80C31 85p |
| 74C68 28p | 74C139 £2.55 | 74C268 £2.55 | 74C937 57p | 80C32 85p |
| 74C70 28p | 74C140 £2.55 | 74C269 £2.55 | 74C938 57p | 80C33 85p |
| 74C72 28p | 74C141 £2.55 | 74C270 £2.55 | 74C939 57p | 80C34 85p |
| 74C74 28p | 74C142 £2.55 | 74C271 £2.55 | 74C940 57p | 80C35 85p |

MODULATORS

| | |
|--|-------|
| UM1111 E36 UHF Ch.36 Vison Modulator | £2.50 |
| UM1231 UHF Ch.36 Vison Modulator with handswitch (for computers etc) | £4.70 |
| UM1263 FM Sound Sub-carrier Modulator | £2.50 |

SWITCH MODE PSUs

| | |
|------------------------------------|---------|
| AC 22215 5V/10A | £69.90 |
| AC 92215 5V/5A, 12V/1A, — 5V/0.1A | £86.80 |
| AC 54215 5V/20A | £92.20 |
| AC 92215 5V/10A, 12V/2A, — 5V/0.1A | £125.50 |



MICROPROCESSORS

| | | | | |
|--|--------------------|-------|------------------------|--------|
| COMPUTER BOARDS | 5000 MPU | £6.95 | INTERFACE | £1.40 |
| 114 x 203 mm fibreglass, gold plated edge connector. | 5802 MPU | £8.95 | 81LS95/517A | £1.14 |
| Buffered SC/MP CPU £9.40 | 6810 (128 x 8 RAM) | £3.25 | 75491 LED driver | 50p |
| SC/MP Protoboard £9.40 | 6812 (128 x 8 RAM) | £3.75 | 75492 | 92p |
| Z80 CPU card £9.40 | 6820, 6821 PIA | £3.96 | 2N425 | £3.95 |
| YOU 'A' £1.40 | 6850 ADCA | £4.85 | 8T26/8T28 | £2.64 |
| YOU 'B' £1.40 | MK8880 | £2.84 | 174 | 48p |
| YOU 'C' three £9.40 | | | | |
| EPROM Programmer (Z708A) | 6502 | £7.95 | CRT Controller: Uarts | |
| 4K PROM board (Z204) | 6502 PIA | £6.22 | Thompson CSF SF196364E | £11.50 |
| 8K PROM board (Z708A) | 6522 | £7.95 | AY-5-1013 UART TR 1602 | £4.00 |
| 2K RAM board (| | | | |

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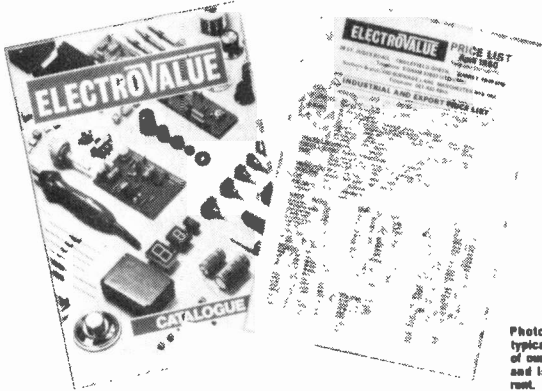


Photo shows a typical example of our price list, and is not current.

It's Electrovalue's quarterly price list published to keep you up-to-date on price and item variations in our 128 page catalogue (FREE ON REQUEST). If you are not yet a customer on our regular mailing list, we will send you our current price list FREE on request and a catalogue (No. 10) with it as well if you wish.

OUR MINI-SELECTION POINTS THE WAY!

EXAMPLE ONE - SOLDERING IRONS

| | | | |
|---------|------------|--------------------|-----------|
| Oryz 50 | £12.08 net | Antex X25 | £4.83 net |
| Isotip | £25.90 net | Desolder tool SR3A | £7.48 net |
| Antex C | £4.83 net | 500 gm reel solder | £7.59 net |

EXAMPLE TWO - PRINTED CIRCUIT MATERIALS

| | | | |
|----------------------|-----------|-----------------|-----------|
| PCB's 300 x 150 mm | | Etch Resist Pen | £1.21 |
| 5SHBP S/S £1.38 | D/S £1.73 | Breadboards | |
| F/Glass S/S £2.19 | D/S £2.48 | Bimboard 12 | £9.23 |
| Positive resist 75cc | £1.67 | Eurobreadboard | £6.56 net |
| Ferric Chloride 500g | £3.45 | T-Dec | £5.18 |

EXAMPLE THREE - SWITCHES

| | | | |
|---------------|----------|---------------------------------|------------|
| Chrome toggle | | 13A time switch adaptors | |
| Std. SPST 65p | DPDT 89p | Smiths TS 100 | £14.43 net |
| Min. SPDT 66p | DPDT 92p | Wavechange, Lorlin, 1P12W, 2P6W | |
| | | 3P4W, 4P3W | 46p each |

EXAMPLE FOUR - CAPACITORS BY SIEMENS

Polyester 7.5mm PCM
1, 1.5, 2.2, 3.3, 4.7nF, 10, 15, 22, 33, 47nF 8p each. 0.1µ 12p, 0.15µ 15p, 0.22µ 18p, 0.33µ 21p, 0.47µ 27p, 0.68µ 34p, 10mm PCM 1µ 37p.

Electrolytic axial (µF/V)
1/40 15p, 1/100 12p, 2/25 15p, 2/25 12p, 4/7/16 15p, 4/7/40 12p, 10/25 12p, 10/40 13p, 22/25 13p, 22/40 16p, 22/63 19p, 47/10 13p, 47/25 16p, 47/40 19p, 47/63 20p, up to 1000/16V 32p, Then 1000/25V 44p, etc.

Also full supporting ranges of other ceramic, plastic and electrolytic caps.

EXAMPLE FIVE - POTENTIOMETERS BY RADIOHM

| | | | |
|------------------------|------|------------------------------|----------|
| Single gang lin or log | 34p | | |
| Twin gang lin or log | 93p | (Twin types stereo matched) | |
| Mono slider lin or log | 83p | Slider knobs | 10p each |
| Twin slider lin or log | 136p | Presets lin, horiz, or vert. | 12p |

EXAMPLE SIX - RESISTORS

½, ¼, ⅓W 2.3p 1W 6p. Wirewound from 23p

AND AS FOR SEMI CONDUCTORS . . . THIS LIST IS BUT A FRACTION OF WHAT WE CARRY

| | | | | | | | |
|-----------|-------|--------|-------|---------|-------|----------|-------|
| 1N914 | 6p | 40673 | 99p | E1110 | 92p | TIP31A | 52p |
| 1N4007 | 9p | 555 | 34p | E1210 | 92p | TIP32A | 52p |
| 1N4148 | 5p | 556 | 88p | LM301AN | 35p | TIP41A | 69p |
| 1N5402 | 19p | AC129 | 39p | LM374N | 87p | TIP41C | 74p |
| 2N1599 | £1.01 | AC176 | 67p | LM380N | £1.14 | TIP42A | 89p |
| 2N2369A | 24p | AD136 | £4.25 | LM3900N | 78p | TIP42C | 74p |
| 2N3055 | 81p | AD149 | £1.01 | MJE2955 | £1.13 | TIP2955 | 69p |
| 2N3702 11 | 11p | AD161 | 40p | MJE3055 | £1.00 | TIP3055 | 69p |
| 2N4443 | £1.78 | AD162 | 52p | MPSA12 | 42p | TIS43 | 40p |
| 2N4444 | £2.28 | AF127 | 43p | MPSA63 | 44p | W02 | 35p |
| 2N4991 | 72p | AL102 | £1.84 | OA47 | 14p | ZN425E | £4.49 |
| 2N5457 9 | 45p | BA379 | 29p | OA90 | 8p | ZTX107 9 | 14p |
| 40HF40 | £2.25 | BB103 | 43p | OA91 | 8p | ZTX300 | 14p |
| 40361 | 49p | BB104 | 70p | OA202 | 16p | ZTX500 | 16p |
| 40362 | 49p | BB105 | 37p | OC29 | £1.23 | | |
| 40636 | £1.69 | C106D1 | 52p | OC36 | £1.18 | | |
| | | CA140F | 46p | T2800D | | | |

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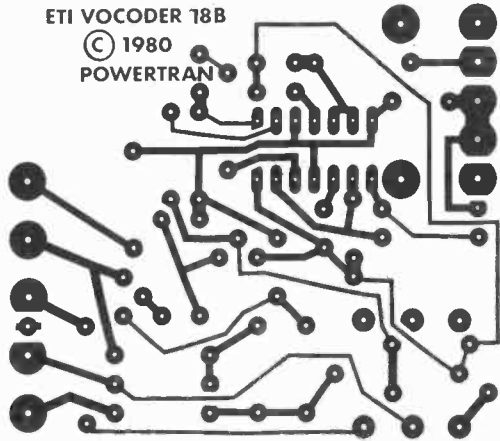
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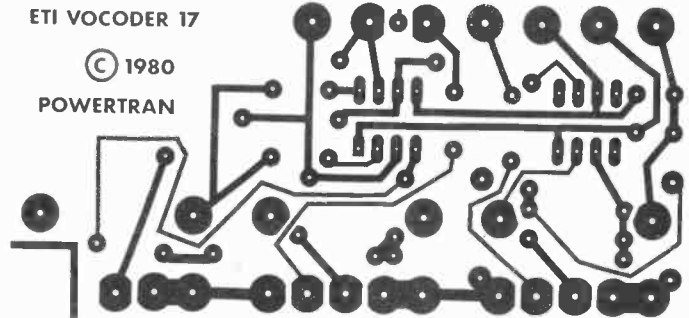
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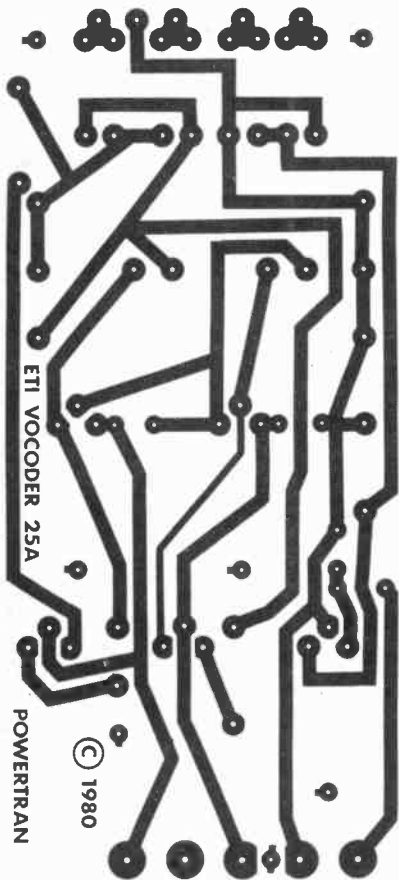
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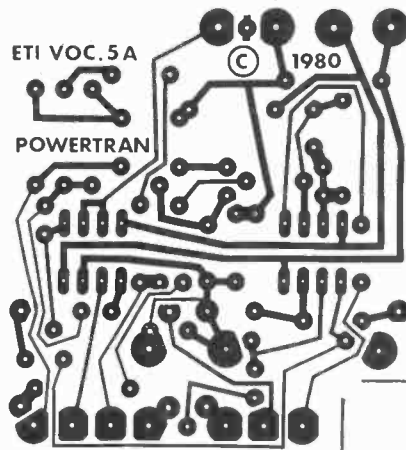
Vocoder Slew Rate Control Board



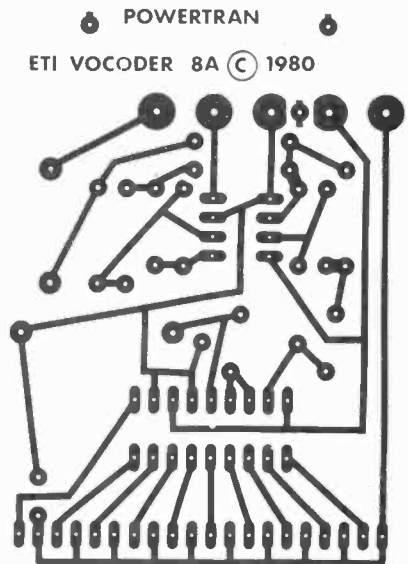
Vocoder Ouput Amplifer Board



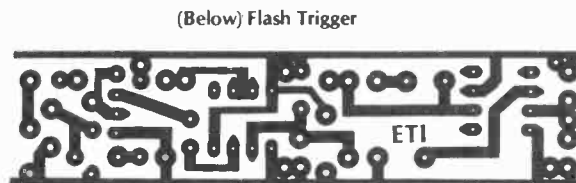
Vocoder Power Supply Board



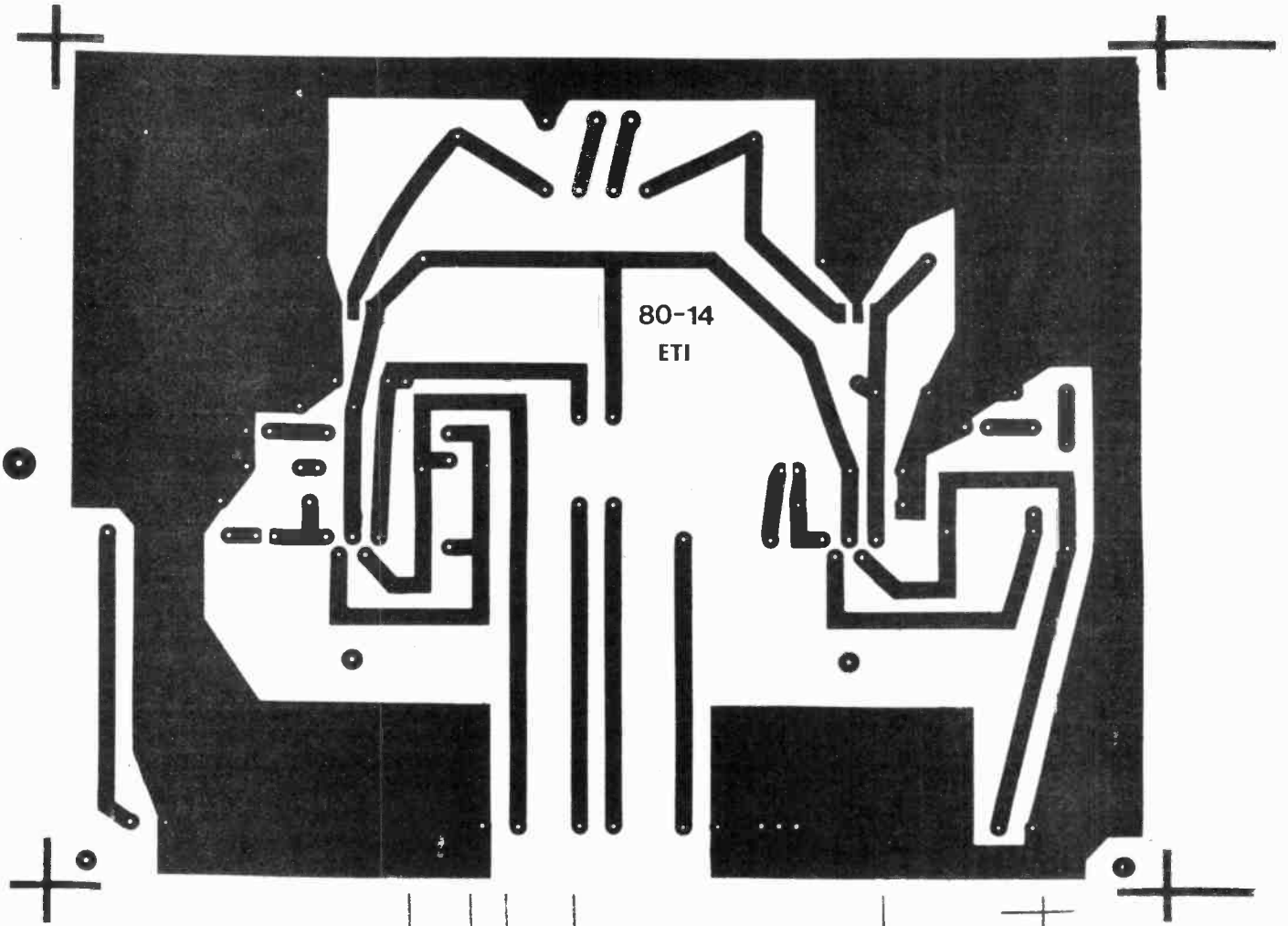
Vocoder Input Amplifier Board



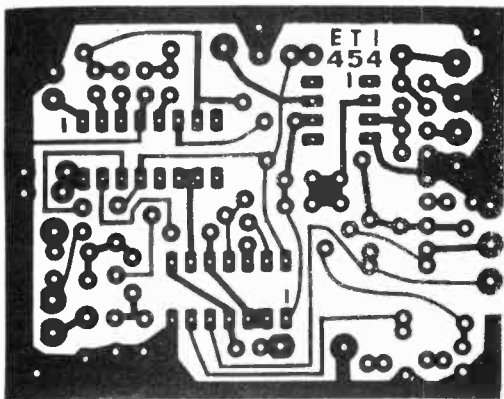
Vocoder LED PPM Display Board



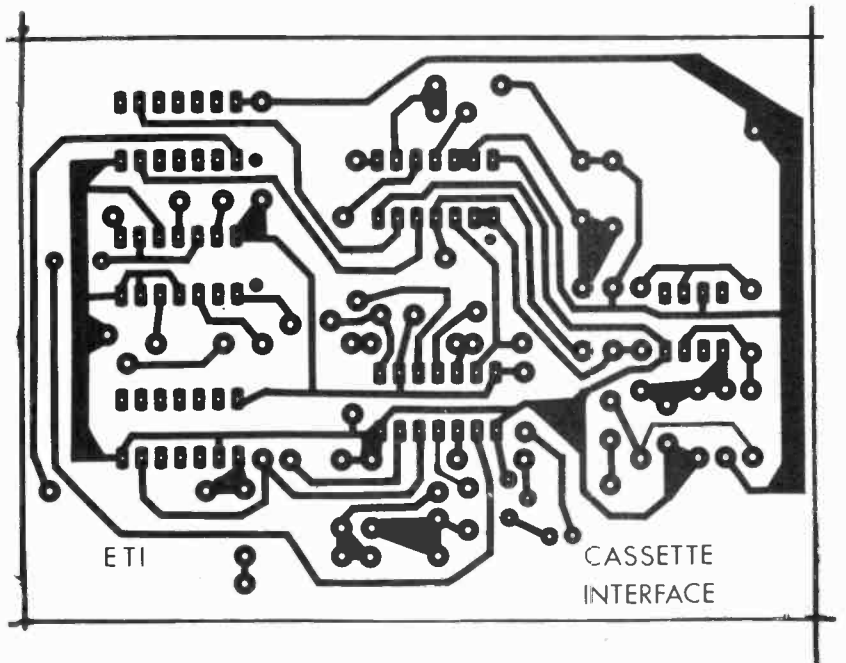
(Below) Flash Trigger

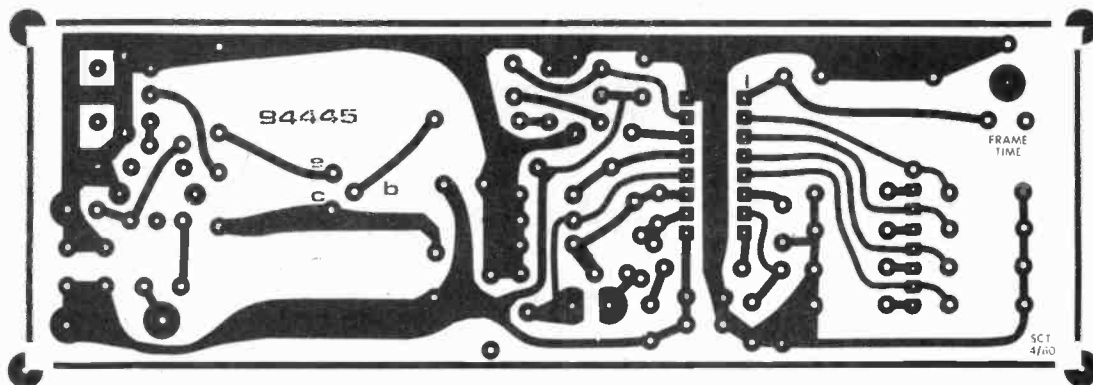


(Above) Monitor amplifier

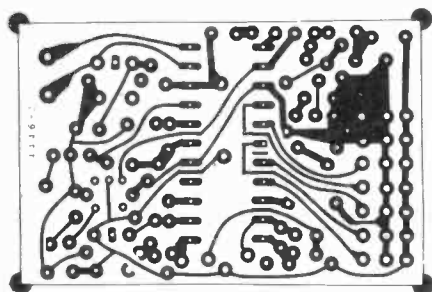


(Above) Sustain/Fuzz board

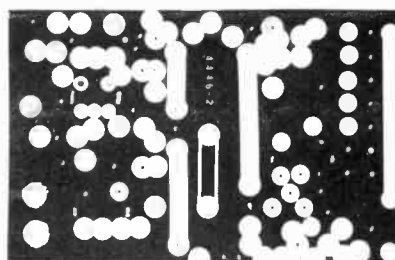




FM Radio Control transmitter board



FM Radio Control receiver board (topside)



FM Radio Control receiver board (bottom side)

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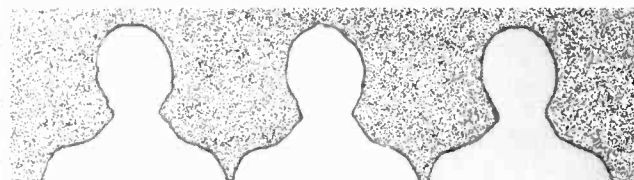
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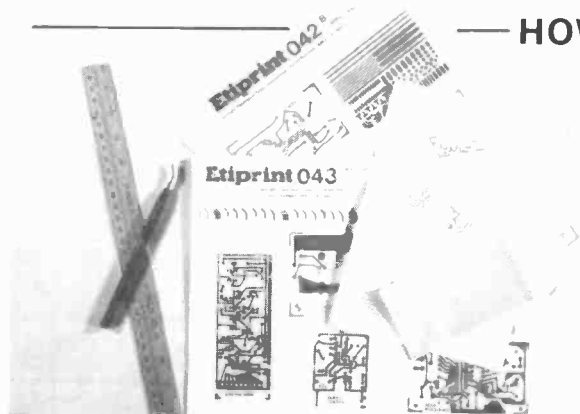
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| 039A | Hum Filter Logic Probe | Dec 79 | 041A | ETI Audiophile ETI VCA Signal Trace ETI HC Electromyogram | Mar 80 | 043 | IR60 preamp, Receiver, PSU, Servo Tester, VU—PPM | May 80 |
| 039B | Long Period Timer Rain Alarm Touch Switch Flash Trigger Pseudo Random Noise Gen | Dec 79 | 041B | VCM Heater Controller | Mar 80 | 044A | IR60 Function Board (Top & underside) Control Circuit, Line Transmitter, Tape Response Meter Ohmmeter | June 80 |
| 039C | Function Generator | Dec 79 | 042A | 300W Amp Module | Apr 80 | 044B | FM receiver PSU & Monitor Amp Drum Synth (function board) | June 80 |
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- X5 MULTIPLIER TO 250ms/div
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- ★ SENSITIVITY: 0.5div int, 100mv Ext
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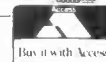


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LB31000SLC

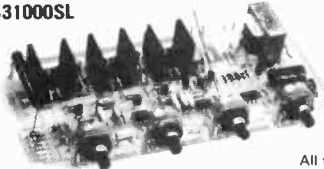


£29.90

A high performance sound to light system which automatically switches to a chase when the music ceases. Super sensitive with an anti interference circuit, the unit will operate from practically any amp and control up to 1,000W/channel, 5Hz to 70K. Controls: bass/mid/treble/master-sensitivity/chase speed.

3 CHANNEL SOUND/LIGHT

LB31000SL

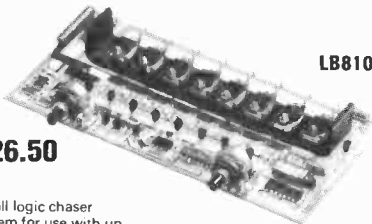


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All the advantages of the SLC without chase. Controls: bass/mid/treble/master sensitivity. Excellent performance

2/4/8 CHANNEL CHASER

LB81000LC

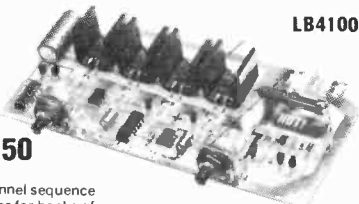


£26.50

An all logic chaser system for use with up to 8 channels at 1,000 watts each. Facilities include footswitch trigger and module cascading (16, 24, 32 channel, etc.), chase speed and re-cycle delay.

4 CHANNEL SEQUENCER

LB41000LS

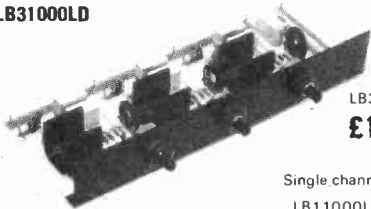


£17.50

A 4 channel sequence generator for banks of lamps up to 1,000W per channel. Two speed controls, cross effect to provide settings between seconds and rapid burst.

1 AND 3 CHANNEL DIMMERS

LB31000LD

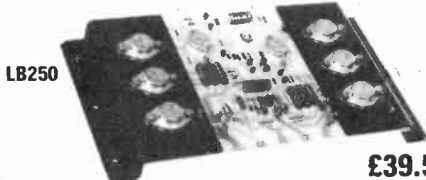


LB31000LD
£14.70

Single channel version
LB11000LD £6.70

Power dimmer units for theatre/stage applications up to 1,000W per channel, with on board suppressing. The unit is also available without rotary pots, for use with sliders —

LB31000LD (no pots) £13.50 Sliders 75p each.



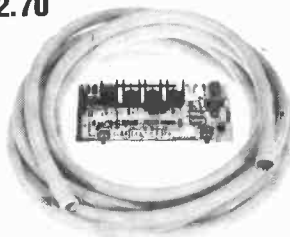
LB250

£39.50

ROPE LIGHTS/DRIVER

LB41000LC-S

£22.70



24 feet ropes
Red/Yellow
Blue/Green

ROPE LIGHTS
20% off R.R.P.

£41.40

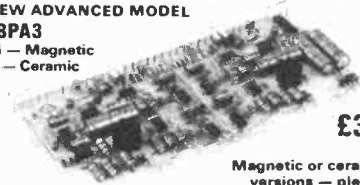
A four channel chaser up to 1,000W per channel, with a sound trigger facility. The music input signal modulates the speed of the chase giving an excellent sound/light effect. The unit will control up to 10 ropes with chase speed and trigger level control.

STEREO DISCO MIXER/PREAMP

NEW ADVANCED MODEL

LBPA3

M — Magnetic
C — Ceramic



Still an amazing
£30.70

Magnetic or ceramic deck versions — please state

All the requirements of a stereo disco preamp on one board, left and right deck mixers/ tone controls/ mic. mixer/ tones/ mic. auto fade over decks/ and P.F.L. The unit can be used with either LB100/150/250 and respective supplies.

Full set of pots — £8.63 Sliders — £11.21 (Six stereo, three mono).

LBPA2

£17.20

A four channel mixer and tone stage for mics, guitars, etc. Can be used with any LB amps. Set of pots £2.74, sliders £5.23.

LBPA1

£19.50

A stereo hi-fi preamp and tone stage for mag. p.u./tape/tuner, etc. Outstanding quality. Set of pots £3.27, sliders £4.49.

3-WAY ACTIVE CROSSOVER

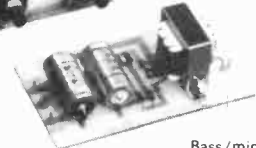
LBACO1

£17.90



LBPSU1

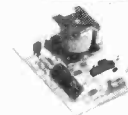
£6.20



Bass/mid/treble active crossover with stage booster! Available with crossover points of 200Hz or 300Hz, and 2K or 3KHz (please specify) LBPSU1 supply for LBACO1 (1 or 2).

LBRLD1

£5.70



A de-thump unit for use with any LB power amps. Simply connects between amp and speaker.

PIEZO HORNS

£5.75

P/P 50p



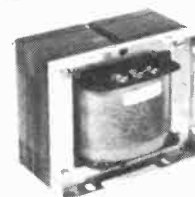
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(8ohms)

| | | |
|---------------------------|---------------------------|---------------------------|
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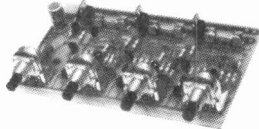
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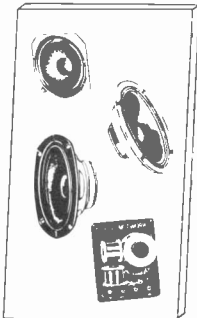
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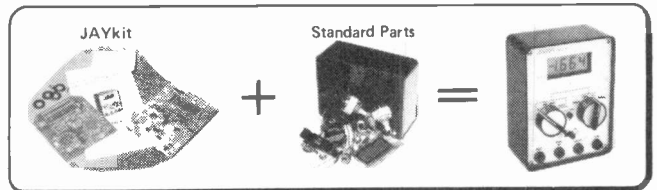
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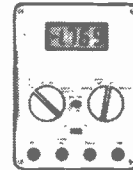
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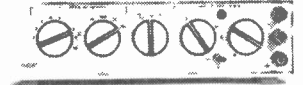
DM-2



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- ★ Resistance 1Ω to 20MΩ
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FG-1a



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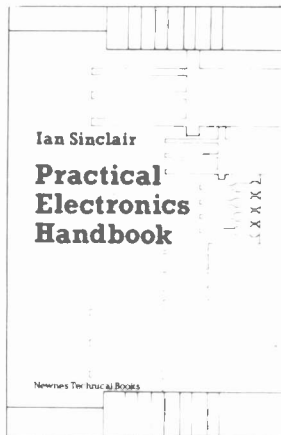
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| 78L12 | 33p | |
| 78L15 | 33p | |
| 7905 | 85p | 7805 |
| 7912 | 85p | 7812 |
| 7915 | 85p | 7815 |
| TIC246 16A 400V Triac | 115p | |
| C106D 4A 400V 50SCR | 45p | |

| SPEAKERS | | |
|--------------------------------|------|--|
| 64mm 8Ω | 110p | |
| 64mm 64Ω | 110p | |
| 70mm 8Ω | 140p | |
| 70mm 80Ω | 170p | |
| 56mm 8Ω | 100p | |
| Pair of ultrasonic transducers | 380p | |
| Magnetic earphone + 3.5mm plug | 17p | |
| Crystal earphone + 3.5mm plug | 48p | |

| POTENTIOMETERS | | |
|--|------|--|
| Preset var. or hor. | 8p | |
| Rotary 5K-1M Log or Lin | 33p | |
| Rotary 5K-1M stereo | 110p | |
| Slide 60mm travel 5K-500K log or Lin, single | 65p | |
| Suitable knobs for above with coloured caps in red, blue, green, grey, yellow and black. Rotary 16p. Slide 12p each. | | |

| CONNECTORS | | | |
|------------|------|----------------|-------------|
| DIN | Plug | Chassis Socket | Line Socket |
| 2 pin | 9p | 8p | 12p |
| 3 pin | 12p | 10p | 12p |
| 5 pin 180 | 13p | 11p | 16p |
| JACK | Plug | Scr. plug | Socket |
| 2.5mm | 10p | 16p | 9p |
| 3.5mm | 11p | 18p | 9p |
| std. | 17p | 30p | 22p |
| Stereo | 25p | 39p | 25p |

| MISC | | |
|--------------------------------|------|--|
| 8mm stranded conn. cable | 30p | |
| Min. mains cable per metre | 25p | |
| PP3 battery clips | 6p | |
| Crocodile clips | 6p | |
| AA rechargeable cells | 145p | |
| PP3 rechargeable cells | 495p | |
| Red or black terminals | 30p | |
| 3 lead TO18 socket | 15p | |
| Red or amber neon indicator | 42p | |
| Subminiature SPST toggle | 65p | |
| Standard SPST toggle | 40p | |
| Miniature slide switches | 16p | |
| IP12W rotary switches | 52p | |
| Push to make switches | 16p | |
| TO5 heatsinks | 12p | |
| 20mm panel fuseholders | 22p | |
| ORP12 LDR | 70p | |
| 3.75 x 5 0.1 veroboard | 99p | |
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| 3 x 2 x 1 aluminium box | 82p | |
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| TIL111 optoisolator | 80p | |
| 4 self adhesive feet | 20p | |
| SRB Soldering iron | 430p | |
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|--------|-----|-----------------------|-----|---------|-----|
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| AC128 | 25p | BCY71 | 18p | TIP2955 | 65p |
| AD161 | 40p | BD131 | 35p | TIP3055 | 60p |
| BC107 | 10p | BD132 | 35p | ZTX107 | 12p |
| BC108 | 10p | BD140 | 35p | ZTX108 | 12p |
| BC109 | 10p | BFX29 | 25p | ZTX109 | 12p |
| BC147 | 9p | BFX64 | 26p | ZTX300 | 14p |
| BC182 | 10p | BFY50 | 23p | ZTX500 | 15p |
| BC182L | 10p | BFY51 | 23p | 2N3053 | 25p |
| BC184 | 10p | MJ2955 | 98p | 2N3055 | 55p |
| BC184L | 10p | TIP29C | 60p | 2N3702 | 9p |
| BC212 | 10p | DIODES | | | |
| BC212L | 10p | IN914 | 4p | 1N4148 | 3p |
| BC214 | 10p | 1N4001 | 4p | 1N4002 | 5p |
| BC214L | 10p | 1N4006 | 7p | 1N5401 | 14p |
| | | BZY88 series 8p each. | | | |

LINEAR

| | | | |
|--------|------|---------|------|
| LM324 | 52p | MM57160 | 650p |
| LM339 | 55p | NE531 | 140p |
| LM348 | 100p | NE555 | 23p |
| LM377 | 170p | NE556 | 60p |
| LM378 | 230p | NE567 | 120p |
| LM380 | 80p | RC4136 | 100p |
| LM381 | 140p | SN76477 | 230p |
| LM382 | 120p | TBA800 | 80p |
| LM385 | 90p | TBA810 | 110p |
| LM387 | 120p | TA1022 | 630p |
| LM1458 | 40p | TL081 | 45p |
| LM1830 | 180p | TL082 | 85p |
| LM3900 | 60p | TL084 | 125p |
| LM3909 | 72p | XR2206 | 390p |
| LM3911 | 120p | ZN414 | 80p |
| LM3914 | 320p | ZN425E | 475p |
| LM3915 | 320p | | |

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|------|------|------|------|
| 4001 | 25p | 4072 | 25p |
| 4002 | 25p | 4081 | 30p |
| 4006 | 95p | 4082 | 30p |
| 4007 | 25p | 4085 | 85p |
| 4011 | 30p | 4093 | 80p |
| 4013 | 45p | 4095 | 110p |
| 4015 | 85p | 4098 | 80p |
| 4016 | 48p | 4099 | 110p |
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|-------------------|-----|-------|-----|
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OPTO

| | | | |
|--------|----------|--------|------|
| Red | 0.125in. | 0.2in. | |
| Green | TIL209 | TIL220 | 10p |
| Yellow | TIL211 | TIL221 | 16p |
| Clips | TL213 | TIL223 | 16p |
| | | | 3p |
| DL704 | 0.3in CC | | 130p |
| DL707 | 0.3in CA | | 130p |
| FND500 | 0.5in CC | | 100p |

CAPACITORS

| TANTALUM BEAD | | | |
|--|-----|-----|-----|
| 0.1, 0.15, 0.22, 0.33, 0.47, 0.68, 1 and 2.2uF @ 35V | | | 12p |
| 4.7, 6.8, 10uF @ 25V | | | 20p |
| 22 @ 16V, 47 @ 6V, 100 @ 3V | | | 26p |
| POLYESTER (Mullard C280 series) | | | |
| 0.01, 0.015, 0.022, 0.033, 0.047, 0.1 | | | 6p |
| 0.15, 0.22 | | | 8p |
| 0.33, 0.47 | | | 12p |
| RADIAL LEAD ELECTROLYTICS | | | |
| 63V 0.47 1.0 2.2 4.7 10 10 7p | | | |
| | 22 | 33 | 47 |
| | | | 9p |
| 25V 10 22 33 47 7p | | | |
| | 100 | | 9p |
| | | 470 | 20p |
| | | | 32p |

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AND NOW A DIMMER THAT MAKES TOUCH DIMMERS OBSOLETE

Two years ago TK Electronics launched a touchdimmer kit, the TD300K, which made knob controlled dimmers obsolete. This was such a great success that many magazines and music retailers soon produced similar designs. SO THAT OTHERS MAY FOLLOW, TK have designed a touch dimmer kit with an Infra Red Remote Control enabling you to switch and control the brightness of your lights from the comfort of your armchair etc. (as well as manually by touching the frontplate or by using the TDE/K extension kit). As with all our kits, these units come complete with all components including RFI suppression, frontplate, a neon to help you find the switch in the dark and a neat box for the transmitter. The plastic frontplate has no metal pads to touch ensuring complete safety and enabling the plate to be covered with a decorative finish to blend with your room decor.

We have designed the light (dimmer unit) to fit a standard wall box, the transmitter to fit your hand and the price to fit your pocket.

In two years time everyone will be selling remote control dimmers but you can have your TD300K kit NOW for only £14.30 for the dimmer unit and £4.20 for the transmitter for the more athletic of you, the TD300K is still available at £8.90 and the TDE/K at £2.00.

DON'T FORGET to add 40p P&P and 15% VAT to your total purchase

| TRIACS | | | |
|---------------------------|-----|-----|------|
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| 8A | 58p | | |
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| 8A isolated tab | 65p | | |
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| Red, Green, Yellow | £2.90 |

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.

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Uses LM3911 IC to sense temperature (80°C max) and triac to switch heater. 1KW £4.00

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Each unit has 4 channels (rated at 1KW at 240V per channel) which switch lamps to provide sequencing effects, controlled manually or by an optional opto-isolated audio input.

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DL2100L
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Optional Opto Input, DLA1 60p

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|-----------------------------------|-----|
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| 100mA secondaries | |
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| 9.0 9V | 85p |
| 12.0 12V | 90p |

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|--------|-----|--------|-----|
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| 14 pin | 12p | 28 pin | 24p |
| 16 pin | 14p | 40 pin | 38p |

INTEGRATED CIRCUITS

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|---|-------|
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| 741 Op. Amp. | 19p |
| AY-5-1224 Clock | £2.60 |
| AY-5-1230 / 2 Clock / Timer | £4.50 |
| AY-3-1270 Thermometer | £5.20 |
| ICL7106 DVM (LCD drive) | £7.00 |
| LM377 Dual 2W Amp | £1.45 |
| LM3795 Dual 6W Amp | £3.50 |
| LM380 2W Audio Amp | 80p |
| LM382 Dual / low noise Preamp | £1.00 |
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| LM2917 f.v Converter (14 pin) | £1.60 |
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| LM3911 Thermometer | £1.20 |
| LM3914 Dot / Bar Driver | £2.10 |
| MM74C911 4 digit display controller | £6.50 |
| MM74C915 7 segment BCD converter | 96p |
| MM74C926 4 digit counter with 7 seg o/p | £4.50 |
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| S9263 Touchswitch 16-way | £4.85 |
| SN76477 Complex Sound Generator | £2.52 |
| TBA800 5W Audio Amp | 88p |
| TBA810AS 7W Audio Amp | £1.00 |
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| TDA2020 20W Audio Amp. | £2.85 |
| ZN1034E Timer | £1.80 |

All ICs supplied with data sheets
Data Sheets only 10p each device

| REMOTE CONTROL COMPONENTS | | RC500K KIT | |
|--|-------|------------|--|
| LD271 IR Emitting Diode | 36p | | |
| SFH205 Photodiode Detector | 95p | | |
| SL480 IC Pulse Amp | £1.70 | | |
| SL490 32 command encoder / transmitter | £2.40 | | |
| ML922 10 channel receiver + 3 analogue outputs | £4.20 | | |
| ML926 16 channel receiver 4 momentary binary o/p | £1.40 | | |
| ML928 16 channel receiver 4 latched binary o/p | £1.40 | | |
| ML929 16 channel receiver 4 latched binary o/p | £1.40 | | |
| Data Sheets per device | 10p | | |
| These ICs can be used with infra red, ultrasonic or radio links, depending on range, cost and speed of operation | | | |

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ALL COMPONENTS ARE BRAND NEW AND TO SPECIFICATION. ADD VAT AT CURRENT RATE TO ABOVE PRICES. 40p P&P MAIL ORDER - CALLERS WELCOME BY APPOINTMENT

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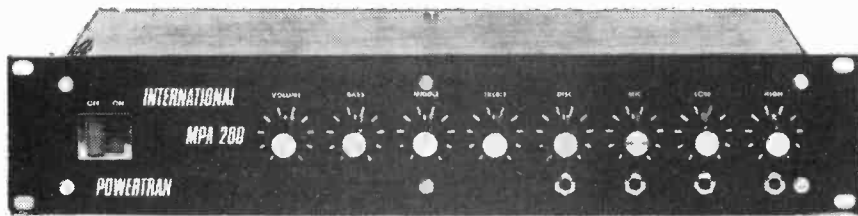
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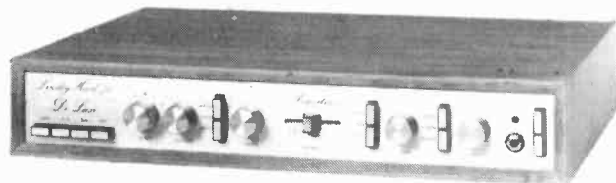
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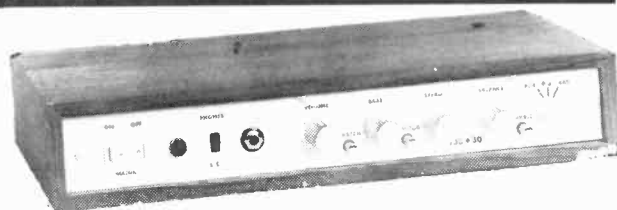
SYNTHESIZER KITS ON PAGE 8. MORE KITS AND ORDERING INFORMATION ON INSIDE FRONT COVER.

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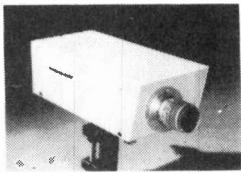
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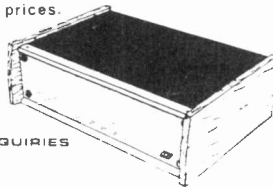
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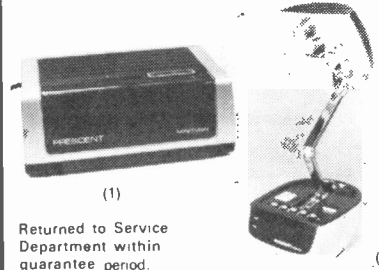
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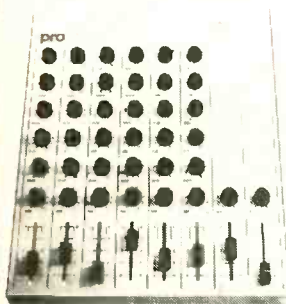
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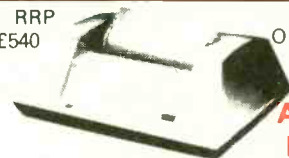


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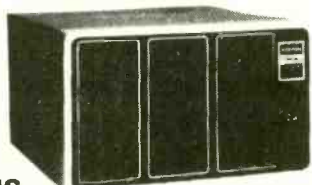
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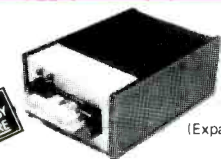


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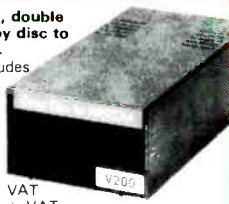
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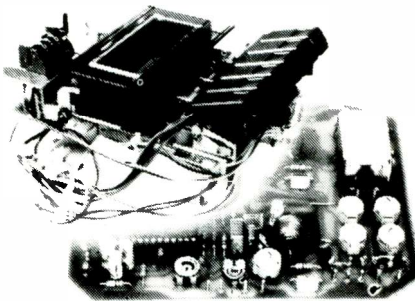
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