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Realistic Direct Entry Programmable Scanning Receiver. Hear real-life drama on six exciting bands. With direct access to all frequencies, you can punch in actual frequencies for monitoring, storing in the computer's memory or just exploring. Big fluorescent display. Phase-locked loop security. 72-9111

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<tr>
<td>LK1</td>
<td>3 channel sound-to-light 300 w/channel 1V — 100w input £9.90</td>
</tr>
<tr>
<td>LK2</td>
<td>3 channel 3kW zero voltage firing 200mV — 100w input £17.90</td>
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<tr>
<td>LK3</td>
<td>2kW slider dimmer suitable for clubs/pubs. A professional unit c/w face plate £5.50</td>
</tr>
<tr>
<td>LK4</td>
<td>4 channel 4kW audio — forward/reverse auto — two speed ranges £16.50</td>
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COMPLETE KIT...ONLY £50.00 includes 60 page data manual.
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If you liked "Invaders" you’ll love ASTEROIDS IN SPACE by Bruce Wallace! Your spaceship is travelling in the middle of a shower of asteroids. With lasers, but with the addition of ASTEROIDS FRAGMENTS INTO SMALL ASTEROIDS! The Apple game paddles allow you to rotate your spaceship, fire its laser gun, and give the other player a thruster to escape. In this endless space-time to time, too, you’ll encounter an alien spaceship whose mission is to DESTROY YOU, so you’d better destroy it first! High resolution and sound effects add to the arcade-like atmosphere of this game generator. RUNS ON ANY APPLE II WITH AT LEAST 32K AND ONE DISK DRIVE!

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The Internal ICL7660 is a monolithic MAXICOMOS power supply circuit which offers unique performance advantages over previous voltage-to-digital converters. The IC L 7660, a complete single supply voltage conversion from positive to negative for an input range of +1.5V to +10.0V, resulting in complementary output voltages of –1.5 to –10.0V.

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Wide operating voltage range 1.5V to 10.0V
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NEW!! AT-8911 S-100 Bang

The amazing AV-8911 is a fantastically designed sound source and music generator, perfect for use with any S-100 micro computer. Contains 16 channels of audio frequency. The AV-8911 provides up to 2048 memory locations for program storage and there is a dot matrix and Multifunction Oscillator for even more variation. The AV-8911 also features a prototyping area to allow for the addition of various parts to build a variety of programmable effects.

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Britain's first 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, and you can use it to do quite literally anything from playing chess to managing a business.
The ZX80 is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done, connects 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.

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Remember: all prices shown include VAT, postage and packing. No hidden extras.
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<tr>
<th>Quantity</th>
<th>Item</th>
<th>Item price £</th>
<th>Total £</th>
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<tbody>
<tr>
<td></td>
<td>Sinclair ZX80 Personal Computer kit(s). Price includes ZX80 BASIC manual, excludes mains adaptor</td>
<td>£79.95</td>
<td></td>
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<tr>
<td></td>
<td>Ready-assembled Sinclair ZX80 Personal Computer(s) Price includes ZX80 BASIC manual and mains adaptor</td>
<td>£99.95</td>
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<td></td>
<td>Mains Adaptor(s) (600 mA at 9V DC nominal unregulated)</td>
<td>8.95</td>
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<td></td>
<td>Memory Expansion Board(s) (each one takes up to 3K bytes)</td>
<td>12.00</td>
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<td></td>
<td>RAM Memory chip(s) - standard 1K bytes capacity</td>
<td>16.00</td>
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<tr>
<td></td>
<td>Sinclair ZX80 Manual(s) (manual free with every ZX80 kit or ready-made computer)</td>
<td>5.00</td>
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NB: Your Sinclair ZX80 may qualify as a business expense.

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The P.E. power amp kit is a module for high power applications—disc units, guitar amplifiers, public address systems and even high power domestic systems. The unit is protected against short-circuiting of the load and is safe in an open circuit condition. A large safety margin exists by use of generously rated components, the input stage uses four 115 watt transistors normally only two would be used, result, a high powered output unit. The PC board is breadboarded, etched and ready to drill for ease of construction, and the aluminum chassis is prefomed and ready to use, supplied with all parts and circuit diagram.

Price: £9.50 plus £1.00 p&p

ACCESSORIES
- Suitable L.S. coupling electrolylic
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MULLARD PREAMP MODULES AND TWO 12 WATT POWER AMP KITS.

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BUILD A 12 WATTS PER CHANNEL STEREO AMPLIFIER

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Price: £30.60 plus £3.30 p&p
BREADBOARD

Providing there are no last minute production or distribution hiccups with this issue (after our industrial problems earlier in the year we only managed to get back on schedule last month) you could be reading this in time to make plans to visit Breadboard '80. Odd though the name is we are sure nearly every enthusiast will by now be aware that the Breadboard exhibition caters for all those interested in electronics as a hobby.

Once again PE will be exhibiting, in our own rather unpretentious manner. We will be very pleased to meet any readers that care to come along, and of course, we will have a number of projects on show—many of them operational. We will also be selling past (back to August '80) and present copies and our own book PE Popular Projects.

Some of the items we expect to have working are: PE Teletext, PE Master Rhythm, PE Starsspinner (see page 31), a speech synthesiser (see page 44), PE Congress Hi-Fi Amp, Compukit Sound Generator, etc. We will also be showing many items of test gear including the PE Microntune (see page 28) and the range of in-car entertainment equipment from our special offer on page 24 (this equipment will not be available to purchase from the stand). So if you want to see any of these items or if you just want to chat, come and find us on stands E3 and E4.

If last year is anything to go by, a weekday is best and make sure you bring earplugs and a loud voice! Might we suggest that you also bring plenty of money as there have been many exhibition offers on retailers stands in past years and you could find some bargains.

AVAILABILITY

Many readers have informed us that they have problems buying recent issues—some have been told that we have not published certain issues, one man even rang recently to ask if PE had ceased publication! Let us make it quite clear that we have published every issue this year—although some were more than a month late.

One of the problems is that these days the newsagents are watching their finances and are not prepared to stock more issues than they are sure they can sell. This means that they often sell out early and few spare copies of any issue are available. In order to make sure of your issue, may we suggest you place an order with your newsagent and ask for your copy if it fails to arrive.

SPECIAL ISSUES

The availability problem becomes more acute when we have a special issue, gift or extra supplement etc. This issue carries the Electrovalue catalogue free with all UK copies and next month the issue will carry a free 132 page Tandy catalogue, banded to it. These free catalogues do increase demand for issues so please don’t miss out! You have been warned! We are also planning special issues for March, April, May and June and we expect our February issue to be in demand because we hope to cover the electronics incorporated in an entirely new and quite revolutionary luxury British car, which should be launched after Christmas.

For some time PE contributors have been involved in the development of instruments and a locking system for this £65,000 plus vehicle. We will be describing the development of these instruments and showing how to make similar items to fit rather more mundane vehicles. We can’t reveal what the car is or what it looks like yet, but “stay tuned” for full details.

Mike Kenward

Technical Queries

We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in Practical Electronics. All letters requiring a reply should be accompanied by a stamped, self addressed envelope and each letter should relate to one published project only.

Components are usually available from advertisers; where we anticipate supply difficulties a source will be suggested.

Back Numbers

Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 95p each including inland/overseas p&p.

Binders

Binders for PE are available from the same address as back numbers at £4.30 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions

Copies of PE are available by post, inland or overseas, for £11.80 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.
ECONOMIC SCOPE

The new Model SB 3M oscilloscope from Albol Electronic will serve most purposes required by industrial, service and hobby engineers, and yet manages to keep on the right side of the significant £100 price barrier. With a bandwidth of 0 to 3MHz at -3 dB (extending to 6MHz at -6 dB), the SB 3M breaks new ground, in its class, by offering time-base automatic triggering by i.c. comparator control of the type usually fitted only to luxury 'scopes. A 10 mV signal is all that is needed for a firmly locked and triggered time-base.

The measuring field on the c.r.t. is 50 by 60mm, and the deflection sensitivities are selectable (by push-button) from 0-05 to 20 V/cm. Calibration accuracy is ± 5 per cent. Albol say that the input characteristics are 1 megohm ± 5 per cent, and 30 pF ± 10 per cent. The time-base can be either automatically triggered or synchronised, and it has four switch-selectable calibration speeds, from 1 µs/cm to 5 ms/cm. A six-stage attenuator, from x 1 to x 10, can be applied to each.

Triggering, which can be either internal or external, can be polarised positive or negative, in the range 10Hz to 500kHz. If internal synchronisation is used the range extends from 10Hz to 3MHz. The internal trigger threshold is 5 mV, and the external 100 mV.

The SB 3M takes about 20 watts from the 240V mains, weighs 4.5kg, and measures 150mm wide by 340mm deep by 280mm high. The price is £99.00, plus VAT; delivery is ex-stock.


MICRO BREADBOARD

The first Eurocard size breadboarding system designed specifically for microprocessor based circuit designs will be launched at this year's Breadboard Exhibition by Boss Industrial Mouldings Ltd.

Comprising a central MPU Section capable of accommodating a mixture of 24, 28, 40 and 64 pin microprocessors, and flanked on both sides by Auxiliary breadboarding sections for RAM's, ROM's and peripheral chips, this 'world first' system enables complex designs to be rapidly built whilst keeping interconnection link lengths to an absolute minimum. Dual and single bus strips on all sides, plus 5 incoming power line turret terminals all contribute to make this remarkably versatile and rugged breadboarding system. Easily replaceable, double sided, nickel silver contacts, rated at 1A and typically 10m ohms resistance will accept a wide range of lead sizes enabling d.i.l. i.e.'s, transistors, capacitors and diodes etc to be readily plugged in. The rigid High Impact Polystyrene body is rated up to 75°C and has non-slip rubber backing for working stability.

Capable of accepting .3", .4", .5" and .6" pitch d.i.l. packages without needlessly wasting auxiliary pin positions and breadboarding areas, every contact is alpha-numerically indexed, this being imperative for education and training applications where step-by-step build-up instructions are used.

Boss Industrial Mouldings Ltd, 2 Herne Hill Road, London SE24 OAU (01-731 2383).

SUPER STRIPPER

Tele-Production Ltd. have recently come up with a simple but effective wire stripper, the Telpro Automatic Wire Stripper.

A single squeeze operation strips the insulation from single and stranded wires without damage. Its wide jaws permit fast and accurate stripping without any nicking or scrapping of the wire and a gauge is supplied to ensure consistent lengths of stripping during fast production work. Five diameters of wire can be used on this tool, which has the following size cutter: 1.0, 1.6, 2.0, 2.6 and 3.2mm. Of an all metal construction, it is available ex-stock priced £10.50.

Also available from Tele-Productions is a new p.c.b. holder with a quick release trigger which allows a p.c.b.to be removed and replaced in seconds. There is also a special attachment which when fitted to the holding arms of the unit can be repositioned to hold...
small components such as switches etc., during soldering. The unit can hold boards up to 12in long and can revolve through 360 degrees. The quick release trigger works by spring tension and can revolve through 360 degrees. The power consumption circuitry also eliminates drifts caused by internal heat generation and improves long term stability.

The price of the 1503 is £139 ex VAT and p&p. Thurlby Electronics Ltd. Coach Mews, St. Ives, Huntingdon, Cambs. PE17 4BN.

LUCKY DIPS

The latest range of dual-in-line sockets from OK Machine & Tool can provide the ideal solution to many MPU data output decoding and display requirements. Two versions (DM180/1) provide simultaneous decoding and display from multi-plexed b.c.d. inputs. Additional options allow for either Hex or Code B displays. The DM180/1 will operate over a voltage range of 3-5V to 6V at 20µA in either the 3-5 or 4 digit display format.

The ADC 1660 is a high speed 16 channel analogue to digital interface board which will connect directly into a standard Acorn 64 DIN bus. The unit provides A to D conversion of 16 inputs at a rate of 16K conversions per second to 8-bit resolution. To the processor the card appears as a block of 16 memory locations which by using 12 d.i.l. switches can be placed in any of 4096 positions in a 64K map. No special software is required to control the interface, a write pulse from the processor to any of the 16 memory locations loads the analogue multiplexer with the low order address bits and initiates the conversion sequence. Sample and hold timing is carried out on board and 60 micro-seconds later the conversion is complete. The processor can time out or an interrupt from the card can inform it that data is available to be read from the same memory location that was written to.

At present the ADC 1660 is available in eurocard form with a 64 way indirect connector for the Acorn bus, but can be link programmed to suit any other 64 way bus. The ADC 1660 costs £82.00 in kit form, or ready assembled and tested with front panel and 34 way connector for £110.00. Stoneage Electronics, The Cottage, 70 Albion Drive, London, E8 4LX. (254 4727).
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period of a year which embraced crippling strikes in engineering and steel. In the circumstances a creditable performance.

On crucifixion, incomes have kept ahead of inflation and personal savings have not, if not at an alarmingly high. And those wanting a late continental holiday were disappointed to find planes fully booked. Of course there is inconvenience, even hardship, deserving of every sympathy and assistance in individual cases, but even these hardly merit the ‘crucifixion’ label.

**Employment**

Employment is the most emotive issue, especially when presented in lurid terms as unemployment in numbers of people rather than percentage of the total workforce. The electronics industry finds itself in a unique position in this delicate area by simultaneously creating new jobs in a new industry while destroying existing ones in long-established industries.

Every new advance in industrial automation developed by electronic engineers and fabricated in an electronics plant has had a single purpose, that of increasing productivity per unit cost elsewhere. Thus, to give but one example, a battery of programmable numerically-controlled machine tools could, in theory, be supervised by a single operator rather than having a skilled manual operator for each machine. One of the tragedies of British industry over the immediate past years is that the attitude to such changes in manufacturing practice has been little different from that of the Luddites of 169 years ago. Hence, the tardy progress in modernisation and excesses in over-manning which are now being rectified at considerable social cost to the individual and to the nation as a whole.

At the same time electronics industry itself has had to adjust to new work patterns resulting in changes of technology as well as to variations in markets. On the latter, one notes that the small-boat radar business of Decca is being discontinued by Racal, new owners. This is no surprise and is a result of being unable to compete commercially with Asian manufacture. Some 350 jobs are said to be at stake but transfers to more profitable areas within the Racal group and imminent retirement of other Decca people will ease the blow and enable most to be absorbed.

Improved technology rather than lack of market is said to be the reason for Thorn cut-backs at their consumer electronics plant at Colwick. The TX9 and TX10 television chassis were designed for easier assembly. Not only are there far fewer components (through LSI) but automated insertion means that assembly is far less labour-intensive.

In fact the number of people in electronics goods manufacture is increasing but only at a fraction of the rate of growth of cash turnover. This is still an increasing demand for engineers and technicians but the armies of girls assemblers once needed for wiring up and soldering are no longer required. The circuits are now supplied already wired in the shape of ICs and LSI from the semiconductor manufacturers, interconnected in PCBs, and are machine soldered in final assembly.

One can’t help reflecting on the good fortune that the electronics industry has remained comparatively free from Luddite attitudes, otherwise it would not and could not exist today.

**Forecast**

At the risk of treading hazardous ground I still forecast continuing prosperity for the electronics and aerospace industries. I include aerospace because of its huge electronic content. The two are interdependent, especially in the higher and more sophisticated branches of technology.

There will still be ups and downs, mainly in consumer electronics (a perennial problem) but taken as a whole, growth curve has got to be upwards.

I base this assessment on past and present performance of the larger well-established companies on which, like the motor industry, many smaller companies feed, and on continuing investment such as the £8.5 million recently announced for expansion of GIM’s plant at Glenrothes. There is also heartening news from Lmos with a promising development in a 16k static ram although we must wait to see how technical design is converted to production and sale.

Another favourite indicator is the exhibition scene. The Farnborough Air Show was the best for many years. The production equipment show, in its new home at the Brighton Conference Centre has 400 exhibitors, the greatest number yet. Also new to Brighton this year (from London) was the International Broadcasting Convention packed with professional studios and transmitting equipment from a whole gamut of companies from Acron Video to Zoom Television. Across the channel in Paris the British-run Automatic Testing 80 was also a success with a complete sell-out of space and record attendance.

There is every reason for cheer in high technology industry. In fact the proposed core curriculum which calls for a minimum number of hours per week to be devoted to study—of what? You guessed right first time, the study of mathematics, English and science.

It is now abundantly clear that technology is the road forward. And this is the area where we can and should sell profitably to all countries including our own. Not only electronics but in other high technology areas, too.

I remain optimistic, at least for the technology-based industries. But even taken overall, for all industries, our export performance has consistently improved in cash terms over the years, more than doubling in the ‘difficult’ years of 1975-79. As I have often said in this column, the real high-flyers do well in good times and bad and there is plenty of life in the old dog yet.

---

*Practical Electronics, December 1980*
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Practical Electronics December 1980
THANKS FOR THE MEMORY

At last our very own "Silicon Valley" Company, Inmos, has lifted a corner of the veil to reveal a glimpse of the goodies to come.

In fact, the "Silicon Valley" tag with its California connections is not strictly accurate since the action is actually spread between plants in Colorado Springs, Colorado, USA. and Bristol, Avon, UK., with future production facilities scheduled for a site in South Wales. But apart from its geographical position(s) the Inmos outfit is deeply engaged in the business of producing innovative yet practical microcircuits

The first device out of the Inmos stable, a 16K static RAM coded IMS 1400, looks like a real winner because it employs ingeniously different techniques to give a memory which has a larger capacity than any of its rivals, is faster, and is also potentially cheaper to produce. Innovation is the name of the game in the cut-throat memory market-place, as has been demonstrated by such giants as Intel and Mostek, but innovation alone is not enough, the clever new products have to be producable in large enough volumes to swamp the competition. With the IMS 1400, Inmos appear to have made an excellent start. Until the IMS 1400, most memory improvements have been made by simply shrinking device geometries so that more and more cells could be squeezed onto a given area of silicon. While this has been an important process of improvement, it does mean that memories have been getting more and more difficult to produce. The Inmos approach does not depend on scaling but on changes to the circuit design

used for each memory cell which together produce a more efficient element which is, in manufacturing terms, actually simpler than rival chips of lower capacity. The performance of the IMS 1400 is adequate for all present and projected microprocessor and minicomputer applications, and it exceeds by a comfortable margin the performance of today’s fastest (but smaller) 4K 2147 device.

The IMS 1400 is housed in a 20 pin 0.3 inch wide package which has an extended version of the 2147 4K pin-out. The chip runs from a single five volt line and has a very low power consumption of 375 milliwatts (active) and 35 milliwatts (standby). Perhaps the most significant performance feature is the access time of just 30 nanoseconds, too fast for most of today’s microprocessors, but useful for other memory applications currently filled by exotic and expensive bipolar devices of much lower capacity. As if all this alone wasn’t enough to make Inmos a blue chip investment, the designers in Colorado Springs have hedged their bets by building in spare columns of memory cells which can be selected after chip fabrication by means of fusible links which map one or more of the spares into the active area to replace defective columns discovered during wafer test.

If future Inmos devices are as ingenious, I think I will retire on the proceeds!

ELECTRIC DRAWING BOARD

You can draw pictures on a CRT in one of two basic ways, direct vector or raster scan. In the direct vector scheme, lines are drawn by tracing them onto the tube face with a moving beam of electrons, in a scheme somewhat similar to that employed by an oscilloscope. To draw a line from A to B the beam is turned on in position A and the correct waveforms are applied to the X and Y deflection plates or coils to move the beam so that its intersection with the display surface describes a straight line on the screen. In raster scan on the other hand, a beam of electrons is constantly scanning the screen in TV raster format and the drawing of a straight line involves no out-of-sequence movement of the electron beam at all. With raster graphics, the screen is arbitrarily divided up into picture elements as "pixels" each of which has a unique bit reserved for it in the screen memory array. To draw a straight line, the start and end points are used to calculate which of the bit cells in the screen memory need to be "on". As the raster is built up, every memory location will be scanned in sequence, but only those bit cells which are "on" will cause the beam to excite the screen phosphors. The result is a line as before, although in this case the line may appear jagged if the screen memory resolution is limited.

The advantage of raster graphics lies in the fact that multicolour displays using readily available television monitors can be easily constructed, whereas direct vector systems need special long persistence tubes and cannot easily produce multicolour pictures.

Complete raster graphics systems are available from several manufacturers, and are widely used for engineering design and other similar applications where the cost is acceptable. Resolution is typically 512 x 512 pixels for a 625-line monitor, giving a memory requirement of at least 16K bytes per colour, a factor which has ruled out such desirable high definition graphics for home computer applications until now.

Thanks to cheap dynamic memory and a new chip from Thompson CSF, the EF 9365, all that is about to change and we can expect to see much wider application of the "Electric drawing board" in low cost systems. The new chip performs many of the functions currently performed by the proprietary raster display systems costing hundreds of pounds, yet it comes in a 40 pin package and will eventually cost less than £20! Teamed with a microprocessor and a group of dynamic RAM chips the EF 9365 will turn complex input specifications such as vectors, symbols, shapes and points of origin into the appropriate bit patterns in the screen refresh memory. To cater for the necessary but more mundane alphanumeric display requirement (to label graphics pictures for example) the Thomson device also has an on chip character generator for a full 96 character ASCII set. When drawing vectors on the screen, a mean writing rate of 1.36 milliseconds per pixel is possible, and when this device becomes freely available in 1981 we can expect to see a colourful revolution in microprocessor display peripherals.
PE has taken a pride in bringing readers some excellent offers over the months. Offers arranged to enable the purchase of technical products at exceptional prices. Back in April we arranged a special offer on Videotone speakers. That offer was so successful that Videotone have again come up with exceptional prices, this time on in-car-entertainment products, just for PE readers. We believe these products represent incredible value for money, and that this is one of the best offers we have ever been able to arrange. The equipment and speakers on offer, shown and described here, are all covered by a full one year guarantee and money back facility if you are not satisfied.

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**TAPE PLAYER** Autoreversing, 4 track 2 channel stereo, wow and flutter <0.3% (WRMS), signal to noise >40dB, crosstalk >-40dB, i.e.d. indication of tape direction, manual tape reverse button, fast forward and rewind.

**GENERAL** Output 7W per channel, frequency response 80Hz – 12kHz, output impedance 4 – 8Ω, supply voltage 12V (11 – 16V d.c.) negative earth only, tone, balance, volume and tuning controls, range switch, scale illumination, size 180 x 44 x 148mm deep, weight 1.9kg, supplied with fixings for in-dash mounting, in line fuse holder and fuse and instructions for mounting, wiring and operating the unit.

**BASIC SPEC. FOR THE CASSETTE PLAYERS**

Autoreversing, 4 track 2 channel stereo, wow and flutter <0.3% (WRMS), frequency response 50Hz – 10kHz, output impedance 4 – 8Ω, supply voltage 12V (11 – 16V d.c.) negative earth only, tone, balance, volume and tuning controls, range switch, scale illumination, size 180 x 44 x 148mm deep, weight 1.9kg, supplied with fixings for in-dash mounting, in line fuse holder and fuse and instructions for mounting, wiring and operating the unit.

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Countdown

Please check dates before setting out, as we cannot guarantee the accuracy of the information presented below.

**Semiconductor International** 80 Nov. 25 – 27. Metropole Convention Centre. T1

BEX 80 Nov. 26 – 27. Exhibition Centre, Bristol. K

Breadboard Nov. 26 – 30. Royal Horticultural Halls, Westminster. T

BEX 81 Feb. 4 – 5. Pavilion, Bournemouth. K


**INSPEX** 1981 March 16 – 20. NEC, Birmingham. Z1

Semtex 81 (seminars only) March 23 – 27. Imperial College, London. H1


The Northern Electronic Test & Measurement Exhibition 81 March 31 – April 2. Wythenshawe Forum, Manchester. T

Laboratory 81 April 1 – 2. Glasgow. I

BEX 81 April 8 – 9. Centre Hotel, Liverpool. K

Laboratory 81 April 8 – 9. Manchester. I

**All Electronics Show** 81 April 22 – 24. Grosvenor Ho., Park Lane, London. F1


Entertainment 81 May 9 – 17 (weekday mornings trade only). NEC, Birmingham. B2

The European Consumer Electronics Show 81 May 10 – 13. Nuremberg, West Germany. I

The European Consumer Electronics Show 81 May 10 – 13, Nuremberg Fair Centre. W. Germany. (Trade) I

BEX Train May 11 – 22. Calling at: Cambridge, Norwich, Leicester, Sheffield, Newcastle, Middlesbrough, Hull, Nottingham, Reading and Portsmouth. K

**Defence Components Expo** 81 May 12 – 14. Brighton Metropole. I

Scotex 81 June 2 – 4. Royal Highland Exhibition Hall, Inglis, Edinburgh. A1

SemiLab 81 June 2 – 5. Grand Hall, Olympia, London. The international scientific, educational, medical and industrial laboratory equipment exhibition. (Trade) I


Laboratory 81 Sept. 8 – 10. Grosvenor Ho., Park Lane, London. I


Electronics 82 (Sub-titles International Electronics Control and Instruments Exhibition) May 24 – 28, 1982. NEC. I

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The PE Microtune is a general-purpose automotive tester which, as well as featuring volts, amps and resistance measurement, can also check r.p.m. and ignition dwell angle. The voltage and current ranges also have an a.c. function, making the meter extremely useful on car radios, cassettes etc., as well as being suitable for general electrical or electronic diagnostic use. The digital read-out gives a far higher accuracy than is attainable from analogue “pointer” type meters. Use of an I.C.D. display gives large, easily read digits, visible even in bright sunlight, and giving very long battery life.

A total of seven functions (DC Volts, AC Volts, DC Current, AC Current, Resistance, RPM, Dwell) and twenty ranges, makes this the most versatile car tester yet. It is suitable for use on positive or negative earth vehicles, fitted with normal or electronic ignition, and four, six or eight cylinder engines are catered for.

**Microtune Basics**

As with the PE DMM (July 1980), the Microtune uses the Intersil 7106 as the heart of the instrument, the single range voltmeter. This is a 3½ digit analogue to digital convertor, which drives an I.C.D. display directly. The July article outlined the operation of a dual-slope A/D Convertor, so the explanation will not be repeated.

The heart of the Instrument is the single range 200mV voltmeter formed by IC1, the 7106. The input impedance is greater than 100MΩ, to ensure that negligible current is drawn from the circuit under test. An input filter to limit noise voltage is formed by C6 and R6; the latter also increases the overload protection by restricting the input currents. An on-chip reference voltage is provided at pin 32 of IC1, which is maintained at approximately 2.8V below the positive supply rail. The voltage reference is the critical part of any A/D convertor as all inputs are compared against it. To optimise reference stability, a bandgap voltage reference IC3 is used, which operates from the on-chip 2.8V reference. The reference voltage output of bandgap devices depends inherently on the properties of transistor junction potentials. The Vbe of a junction depends upon bulk properties and doping levels of the semiconductor material; its long term stability being essentially unaffected by surface phenomena. A potential divider is formed by resistors R3, R4, R5, and VR1 to adjust the 1-2V output of IC3 and produce an extremely stable 100mV reference, while C7 eliminates any noise voltages.

The frequency of the interval clock oscillator is controlled by C5 and R2, the values chosen providing a frequency of approximately 48KHz, to produce a conversion rate of three readings per second with good rejection from 50Hz pick-up.

The A/D convertor is inherently auto-zero in its' operation, such that when the inputs are shorted together the digital outputs are guaranteed to be zero, to eliminate the need for offset adjustments. The auto-zero capacitor C2 prevents noise voltages affecting the above function. The integrator time constant is set by C1 and R1.

**Display Requirements**

The 7106 drives liquid crystal displays direct and the square wave backplane signal is provided at pin 21. L.C.D.s require a.c. drive signals since steady d.c. potentials can burn-in the segments. For a particular segment to be turned on, it must be driven by a signal of equal amplitude but opposite phase to the backplane signal.

Voltage comparator integrated circuits are designed to produce a logic “1” output when the difference between the inputs is positive and a logic “0” when the difference is negative. This is the basis of the auto-polarity circuitry within IC1 which drives the negative polarity bar directly from pin 20. Decimal points are selected by sections of the range switches S2-S5 and the correct I.C.D. drive is provided by dual-input EXCLUSIVE-OR gates within IC4. Examination of the truth table of an EXCLUSIVE-OR gate will show that the output is high if one or other of the inputs is high, but the output is low if both inputs are high. If one of the inputs is used as a control input, when it is low it will allow through the gate a high or low level, as applied to the second input. When the control input is high it will invert the level applied to the second input. Resistors R7, R8 and R9 hold the control inputs, pins 8, 13 and 6 of IC4, at a normally low level by using the test output, pin 37, of IC1. The backplane signal is applied to IC4 pins 9, 12, and 5. When a control input is
taken to a high level by the range switch, the respective gate acts as an inverter to provide an output in antiphase to the backplane input and so provide the required I.C.D. drive signal.

When using battery-operated instruments, it is important to know when the battery voltage is dropping to a level where performance of the instrument may be impaired. The liquid crystal displays supplied by Lascar have "LO-BAT" wording which can be turned on when the battery voltage has dropped such that 20 per cent of useful life remains. The operator therefore receives advance warning of battery failure while being able to maintain accurate readings until the battery can be changed.

A potential divider is formed across the supply rails by R10 and R11. When the supply voltage drops to approximately 7 Volts TR1 collector is taken high and IC4d becomes an inverter for the backplane signal, and turns on the low battery warning display segments.

**INPUT CONDITIONING**

All of the signal inputs to the Microtune must be converted to 0-200mV d.c. levels to ensure compatibility with the A/D converter.

**(a) D.C. VOLTAGE AND CURRENT MEASUREMENT**

Four d.c. voltage ranges are provided with f.s.d. of 200mV, 20V, 200V and 1kV. The four range switches S2-S5 are interlocked with the Off Switch S1 such that any range selection switches the instrument on. Sections of the function switches then select appropriate areas of circuitry to minimise current drain in unwanted circuitry. Switch S1b also isolates the main signal input when the power is off to prevent damage to the A/D converter. When the Voltage function is selected by S7, the input is applied to the 10M compensate for the input voltage drops to 20 deg. C with 20A flowing, and then the cross sectional area was calculated. From the resistivity of annealed copper, the length of the required track for a resistance of 10M was then calculated.

No protection is provided on the current range and care must be exercised when connecting this range in circuit. The d.c. voltage developed across the shunt resistor R24 is switched by S9a, and the decimal point on the display is set for 19.99A by S9b.

**(b) A.C. VOLTAGE & CURRENT MEASUREMENT**

When a.c. functions are selected by S10, capacitor C8 is connected in series with the input to remove any d.c. component. Voltage inputs are fed through the 10M attenuator as before and current input is applied to the shunt resistor. Integrated circuit IC5 is a TL061 operational amplifier, connected as a precision rectifier. Alternating inputs are rectified by diodes D4 and D5 with the positive component.
100mV would be read as 100.0. For resistance measurement, the arrangement shown in Fig. 2 may be used. The bandgap reference IC3 forms a stable voltage source which is applied across the reference resistor Rr and the unknown resistor Rx. The voltage developed across each resistor is dependent upon the ratio of the two resistors and the ratiometric method of operation of the 7106 permits the value of the unknown resistor to be read directly.

\[ \text{Reading} = \frac{1000}{R_r} \times \frac{Rx}{Rr} \]

(c) RESISTANCE MEASUREMENT

One method of measuring an unknown resistor is to apply a constant current and measure the voltage developed across the resistor. The PE DMM used such a method but the Microtune with its increased space to provide more intricate switching, uses a more streamlined method of resistance measurement. The Intersil 7106 analogue inputs are fully differential as are the reference voltage inputs. In the normal mode of operation a fixed reference voltage is applied to the 7106 and the signal input voltage is measured across the resistor. The PE DMM used such a method but a constant current and measure the voltage developed there across the resistor. The PE DMM used such a method but a constant current and measure the voltage developed there. The PE DMM used such a method but a constant current and measure the voltage developed there.
Fig. 1. Full circuit diagram.
**Fig. 2. Ratiometric resistance measurement**

The measurement of engine r.p.m. can be very useful when servicing cars and we shall see later that specific tests carried out whilst monitoring the speed of an engine enable its efficiency to be optimized.

Although the internal combustion engine has changed very little over the years, there have been distinct changes in the area of the ignition system. A large number of new vehicles still employ the conventional contact breaker, driven from the distributor, to trigger the ignition coil and hence produce h.t. voltage to the sparking plugs. However, an increasing number of engines are being fitted with electronic ignition units usually triggered by the contact breaker, and capable of producing higher voltage at the sparking plugs from lower supply voltages. Some electronic ignition systems dispense with the mechanical contact breaker and are triggered by a Hall effect switch which detects the passing of a magnetic vane to control the timing. Amidst the variety of ignition systems, one component usually remains unchanged and that is the ignition coil. By monitoring the triggering of the ignition coil, measurement of engine r.p.m. may be made without the need for expensive transducers.

Fig. 4 shows the simplified ignition arrangement of a negative earth vehicle.

For a four-stroke engine, the distributor shaft rotates at half the speed of the crankshaft and the number of trigger pulses applied to the ignition coil is given by:

\[
\text{Pulses/Min} = \frac{\text{r.p.m.} \times \text{number of cylinders}}{2}
\]

Alternatively,

\[
\text{r.p.m.} = \frac{\text{Pulses/Min} \times 2}{\text{Number of cylinders}}
\]

Therefore, for a given engine, the r.p.m. varies linearly with the pulses/min applied to the ignition coil.

Measurement of the pulse rate is most easily carried out by conversion to an analogue voltage with a frequency-to-voltage convertor and then measuring the d.c. voltage on the 7106-based voltmeter.

The basic diode pump circuit is dependent upon pulse width and amplitude but may be improved by feeding it from monostable which delivers a pulse of fixed amplitude and duration each time the ignition coil is triggered.

Integrated circuit IC6 is a monolithic frequency-to-voltage convertor based upon a charge pump whose output voltage is buffered by an op-amp.

Due to the ignition coil inductance, high transient voltages can be found superimposed upon the normal 12V trigger pulse on the coil primary and the input voltage to the f/v convertor is clipped by R32 and D6. The input signal is fed through C14 as the comparator input is required to pass through zero to ensure correct triggering. The output voltage of the LM2907 is referenced to its power supply zero volt line but the 7106 input is not able to operate down to its zero volt line, therefore a separate supply is used for the tachometer section. Output voltage is proportional to timing capacitor C15 and load resistor R34 + VR3, whereas filter capacitor C16 suppresses ripple but will also lengthen the convertor response time. Resistors R49 and R36-R38 form an attenuator to reduce the output voltage when switching between 4, 6 and 8 cylinders, since r.p.m. is inversely proportional to the number of cylinders as shown earlier. Full scale output of IC6 is set at 2V.

The normal range-switch selection of decimal points is overridden on engine functions by S8b, and S11b sets the d.p. for 19.99 (x 1000) r.p.m. for 4, 6 or 8 cylinders.

**Fig. 3. Switch configuration for resistance 200Q range**

The instrument against applied high voltages. Transistor TR2 will turn on at approximately 10V and shunt the applied voltage. Thermistor R31 has a nominal value of 1kΩ at room temperature, but when TR2 draws current through R31 the thermistor temperature rises and due to the positive temperature coefficient the resistance increases so limiting the input current.

**(d) R.P.M. MEASUREMENT**

The measurement of engine r.p.m. can be very useful when servicing cars and we shall see later that specific tests carried out whilst monitoring the speed of an engine enable its efficiency to be optimised.

**Fig. 4. Ignition system triggering**

Next month: Construction and Use.
Most people have seen the fascinating rotating and radiating displays available from modern "zoning" or "matrixing" lighting systems. The PE Starspinner can produce 62 dynamic effects of this type plus two static effects and a sound to light advance facility—full circuit and construction details start next month.

**SOLAR POWER SATELLITES**

Will solar power solve our energy problems? Can we build the satellites? How will they work? When will they be available? How much will it all cost? For answers to these and other questions the SPS raise, see our article next month.

**FREE TANDY 132 PAGE CATALOGUE with every U.K. copy**

**INTERFACING COMPUKIT**

Computers make smashing toys but sooner or later they must pay for their keep by doing some real work. Next month we start a series on interfacing the UK101 with the outside world, using such things as joysticks, l.d.r.s, power controllers, D/A and A/D converters, etc.

**PRACTICAL ELECTRONICS**

*Our January issue will be on sale on Friday, December 12, 1980*
I t is some twenty years since the first commercial attempts
were made to simulate the role of a drummer using
electronic principles, and despite continuous criticism of
monotony and lack of instrument quality the utilisation of
this type of musical aid has grown enormously to the present
time where, in addition to almost universal incorporation
into commercial electronic organs, it is used by Spanish
guitarists in Tenerife, Greek singers in London restaurants,
Scottish dancers and by practice musicians anywhere.

DEVELOPMENT

Basic design philosophy has changed little over the
twenty years but the method of realisation has altered con-
tinuously along with the advances made in semiconductor
technology. Ignoring tape playback systems early rhythm
generators contained a limited number of simple patterns
programmed during construction by a diode matrix. This
type of system has had a long life and to many musicians its
pattern simplicity is still preferable to many of the later "ad-
vancements". The advent of high capacity semiconductor
memories seemed to provide the perfect answer to rhythm
pattern generation—four, eight, twelve, sixteen rhythms on
a single chip—then twenty four or more plus extra instru-
ments and measures per bar using multiple chips.

All this looked marvellous, however the technique depen-
ded on the fixing of the patterns and instrument channels
during the latter stages of manufacture of the integrated cir-
cuits and what i.c. manufacturer or commercial electronic
musical instrument design house could resist putting in the
most complex patterns possible to give his equipment the
gimmick appeal required by the general public. Hence the
next generation of design realisation known as "Cancel But-
tons". This allows a degree of low pass gimmick filtering and
there present systems have rested.

The ability to leave the programming function to the musi-
cian has been restricted by the relatively slower develop-
ment of read/write memories, commonly known as RAMs,
as opposed to read only memories, or ROMs. This situation
has only fairly recently changed in two important respects,
the size of RAM available at an economic price and the
standby power required to retain the patterns in an easily
reprogrammable memory between periods of active use. The
CMOS technique of semiconductor manufacture now gives
reasonably low cost i.c.s which may be easily configured
to give a 4096 bit capacity, similar to the common
preprogrammed rhythm generator ROMs, with instant user
programming and reprogramming capabilities and a standby
data storage current of a few microamps.

The PE Master Rhythm makes use of this type of in-
tegrated circuit to give a small easily constructed rhythm
generator on two p.c.b.s which is completely under the
programme control of the musician. At the end of the series
a full set of patterns will be given which may be used by the
constructor to gain familiarity with the operation of the in-
strument. These are open to experiment and can be used as
a base for further rhythms.
SCOPE OF THE INSTRUMENT

This instrument is capable of storing between twelve and twenty four selectable rhythmic patterns, invented, modified, and entered by the operator onto eight instrument tracks. A three position "Instrumentation" control expands the number of instruments available to twelve, grouped into sounds typical of playing with drumsticks, brushes, or on Latin American bongos and claves. The incorporation of pattern sections containing twelve, sixteen, twenty four, and thirty two measures per section, coupled with dual section selection on the main "Rhythm Select" control which allows a maximum capacity of twenty four discrete rhythms. However the two sections may be programmed with related rhythms, the B section for example containing a drum roll pattern or turn-round riff which will only be played if the "Section Selector" is set to the "B" or "Sequence" position. In the latter case the sequencer switch will determine how often the B pattern appears which on the first eight rhythms can be switched to alternate bars, four bar repetition, or eight bar repetition. Rhythm positions nine to twelve contain double length patterns—i.e. twenty four or thirty two measures per section, and whilst the longer sections may be used to give more measures per bar, they may also be programmed as two bars each which extends the maximum sequence to sixteen bars.

PLAY MODE

When the instrument is in the play mode depression of the "Play" switch starts the rhythm sequence which continues until "Rest" is depressed. The start of the pattern is indicated by a pulse on the i.e.d. Restart will always be at the commencement of the pattern and sequence, and the "Section Selector" and "Sequence" switches may be altered at any time during the play condition without disturbance to the synchronisation of the rhythm. The "Instrumentation" and "Cymbal" switch positions may also be altered during performance to introduce further variety as required.

INSTRUMENTATION

The memory system can be considered as an eight track digital recorder in which recording is executed one track at a time and playback occurs on eight simultaneously. Using the "Instrumentation" control the eight tracks may be fed to one of three groups of instruments as shown in the specification. The instruments will be familiar to the reader except possibly to any position during programming. Corresponding instrument sounds will be heard as the rhythm pattern is at its starting point. This will be indicated by illumination of the i.e.d. as the program mode is selected. During programming the "Sequence" control should be in the "A+B" position and the operator can choose to programme "A" and "B" either separately or together by the position of the "Section Select" control.

The "Instrumentation" and "Cymbal" switches can be set to any position during programming. Corresponding instrument sounds will be heard as the rhythm pattern is developed, but the sounds on playback will be determined by the switch settings at that time.

When an instrument track is selected on the "Program Control" (Ten positions) Program (write) Tracks—Eight

Play (read) Mode—Two positions

Instrumentation (Three position control)

<table>
<thead>
<tr>
<th>TRACK</th>
<th>STICK</th>
<th>BRUSH</th>
<th>L-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eight</td>
<td>Accent</td>
<td>Accent</td>
<td>Accent</td>
</tr>
<tr>
<td>Seven</td>
<td>Short Cymbal</td>
<td>Short Cymbal</td>
<td>Short Cymbal</td>
</tr>
<tr>
<td>Six</td>
<td>Long Cymbal</td>
<td>Long Cymbal</td>
<td>Long Cymbal</td>
</tr>
<tr>
<td>Five</td>
<td>Rim-Shot</td>
<td>Short Brush</td>
<td>Claves</td>
</tr>
<tr>
<td>Four</td>
<td>Snare Drum</td>
<td>Long Brush</td>
<td>High Bongo</td>
</tr>
<tr>
<td>Three</td>
<td>High Tom-Tom</td>
<td>High Tom-Tom</td>
<td>Low Bongo</td>
</tr>
<tr>
<td>Two</td>
<td>Low Tom-Tom</td>
<td>Low Tom-Tom</td>
<td>Conga Drum</td>
</tr>
<tr>
<td>One</td>
<td>Bass Drum</td>
<td>Bass Drum</td>
<td>Bass Drum</td>
</tr>
</tbody>
</table>

Memory Capacity—4,096 bits configured as 512 x 8
Power Source—4 x HP7 or similar
Operating Current—Typically less than 10mA
Standby Current—Typically less than 10μA
Nominal Output—100mV into 50kilohm
Approx. Dimensions—8¼in x 5in x 2¾in

Program Control (Ten positions)

<table>
<thead>
<tr>
<th>TRACK</th>
<th>STICK</th>
<th>BRUSH</th>
<th>L-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eight</td>
<td>Accent</td>
<td>Accent</td>
<td>Accent</td>
</tr>
<tr>
<td>Seven</td>
<td>Short Cymbal</td>
<td>Short Cymbal</td>
<td>Short Cymbal</td>
</tr>
<tr>
<td>Six</td>
<td>Long Cymbal</td>
<td>Long Cymbal</td>
<td>Long Cymbal</td>
</tr>
<tr>
<td>Five</td>
<td>Rim-Shot</td>
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<td>Low Tom-Tom</td>
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</tr>
<tr>
<td>One</td>
<td>Bass Drum</td>
<td>Bass Drum</td>
<td>Bass Drum</td>
</tr>
</tbody>
</table>

Memory Capacity—4,096 bits configured as 512 x 8
Power Source—4 x HP7 or similar
Operating Current—Typically less than 10mA
Standby Current—Typically less than 10μA
Nominal Output—100mV into 50kilohm
Approx. Dimensions—8¼in x 5in x 2¾in

RHYTHM CAPACITY

Each position of the "Rhythm Select" control selects a portion of the memory, split into two sections A and B. The "Section Selector"' switch can isolate each section which may therefore contain totally different repeating patterns for a maximum capacity of twenty four discrete rhythms.

Program Mode

The program mode is automatically attained by moving the "Program Control" to any of the eight instrument track positions. Prior to carrying out this operation the Master Rhythm should be run in the play mode and the "Rest" button depressed to ensure that the rhythm pattern is at its starting point. This will be indicated by illumination of the i.e.d. as the program mode is selected. During programming the "Sequence" control should be in the "A+B" position and the operator can choose to programme "A" and "B" either separately or together by the position of the "Section Select" control.

The "Instrumentation" and "Cymbal" switches can be set to any position during programming. Corresponding instrument sounds will be heard as the rhythm pattern is developed, but the sounds on playback will be determined by the switch settings at that time.

When an instrument track is selected on the "Program Control", depression of the "Play" button dictates that the relevant instrument will play during that measure of the pattern. Depression of the "Rest" button keeps the instrument...
silent for the corresponding measure. Thus for four beats on sixteen measures per bar the pattern of one “Play” plus three “Rest” is pressed four times. In formulating a complete rhythm this action is repeated on each of the eight instrument tracks, an operation which soon becomes very quick. An individual track may be chosen for modification at any time without disturbing the other tracks. All instruments previously programmed plus the instrument under current modification, play during programming which allows a continuous audible check on the growing rhythm pattern.

**PATTERN STORAGE**
The play mode is automatically regained by turning the “Program Control” to either of its extreme switch positions, and the programmed information will be retained in the memory until modified, provided that the battery continues to give the required standing storage current of typically 5μA and does not fall below 2V, which represents virtually a shelf life condition for the battery. When a battery change becomes necessary, indicated by a loss of instrument quality, the battery may be removed for up to five minutes without the loss of the rhythm patterns.

**MEMORY OPERATION**
The heart of the unit is the block of four CMOS memories type 5101. These are 22 pin packaged devices each containing 1024 memory cells arranged as 256 rows four columns wide. By interconnecting the four integrated circuits in a series parallel configuration the final memory has 512 rows, eight columns wide.

Fig. 1 shows the operation of a single 5101 in simplified form, indicating that the chip consists of a set of memory cells plus control circuits. Each row in the memory has a unique address which can be selected by the voltages present on eight address lines due to the normal binary relationship of 2^8 = 256. Thus for one combination of address input voltages only one row will be selected. In the unit some of the address lines are connected to the “Rhythm Select” switch which defines the row at which the pattern will start, whilst the others are connected, via the “Section” and “Sequence” switch logic, to a counter which automatically increments the row selection process up to the point at which the pattern is intended to be repeated.

When a row is selected the four corresponding memory cells are potentially available at both inputs and outputs. A read/write control line ensures that information can be put into the memory only when the control line voltage is low, and this is inserted on the rows (measures) as required using a positive voltage equal to the supply to indicate that an instrument requires to be played. On playback, with the read/write control line high, pulses will appear at the outputs to drive the instrument circuits when required.

Two chip selection control lines are also provided in the 5101, one of which, CE1, causes the chip to be active when its input is low and the other, CE2, when high. Unless both inputs are in the corresponding active states the chip presents an open circuit at its outputs preventing any influence on other chips which may be connected into the system. Thus C ET is used in a similar manner to the address lines allowing selection of only the first pair of i.c.s with 256 rows and eight columns, or only the second pair of i.c.s with a further 256 rows giving 512 total. CE2 is used by the system clock which beats at one pulse per musical measure, to pulse the chosen address to give the output drive pulses to the instruments.

The remaining connections to the memory are its single supply and ground plus the grounding of pin 18, OD, which is not used in this application. The relative timing and periods of various activities in this integrated circuit are important and are covered by the detailed circuitry.

**SYSTEM OPERATION**
A schematic of the system is given in Fig. 2, ignoring the detailed operation of the memory. The mode detector senses whether the “Program Control” switch is in either of the two play positions and signals the mode switching circuitry accordingly. This holds the read/write control voltage up to ensure that when the “Play” key is pressed, and its output latched, the clock will start and be fed through the counter, “Sequence” and “Section Select” switches, to the memory address inputs, coupled with the fixed starting address determined by the position of the “Rhythm Select” switch. A pulse is also transmitted to the chip select inputs CE2 for each measure within the rhythm pattern, and the down beat indicator is pulsed for each twelve or sixteen measure period. The memory output pulses are fed to the instruments via the “Instrumentation” and “Cymbal” selectors where applicable.

When the “Program Control” is in an instrument track position the mode detector gives a high output which sets the mode switching circuitry such that the counter is disconnected from the clock but increments on each depression of the “Play” or “Rest” key. High and low level signals corresponding to play and rest respectively pass through the “Program Control” switch to the instrument track selected and replace the level previously stored in that memory cell as a falling pulse is applied to the read/write control input from the mode switching network. The instrument tracks not selected at this time retain the previously recorded information due to the prior state feedback network.

**CONTROL CIRCUITS**
The complete control circuit detail is shown in Fig. 3. NAND gates IC1c and IC1d form the latch, one output of which is fed to the “Program Control” switch. Resistor network R17 and R18 produces a voltage of approximately 3V at the inputs to the two comparators which make up the mode detector, leading to a detector output of approximately 6V. However when the “Program Control” switch is in either of the “Play” positions the resistor network is overcome and the detector input becomes 0V or 6V dependent on the state of the latch connected to “Play” and “Rest” keys. In either case the detector output becomes zero which prevents any signals passing through IC2b to the write enable portion of the circuit. Under these circumstances the clock, which comprises IC1a and IC1b, is connected via IC2c and IC2d to
the counter input. Depression of the "Rest" key will reset the complete counter through IC3b, IC3a and D12, whilst the "Play" key will start the clock.

The counter consists of eight synchronously switched divider stages, the first four of which are decoded by diodes D5 to D8 to produce down beat indicator pulses in conjunction with D4. Outputs from the third and fourth dividers are decoded by diodes D10 and D9 to produce reset signals on the first four counters via D11 after every twelfth measure when R33 is raised by selection of a twelve measure category rhythm. The last four stages of the counter are decoded by diodes D13 to D20 which link with the "Sequence" select switch S5 to pass sequence address information via the "Section Select" switch S6. Counter outputs provide the incrementing address information required by the memory, whilst the fixed starting addresses are provided through diodes D27 to D41 from the "Rhythm Select" switch. As described earlier the memories work in pairs, IC6 plus IC8 and IC7 plus IC9. The changeover chip enable signals CE1 are provided in opposite sense through the inverter IC3c.

When the "Program Control" is in an instrument track position the high output from the mode detector prevents the passage of the clock through IC2c and enables IC2b to pass the pulses, which occur at the output of IC2a each time either the "Play" or "Rest" key is depressed, forward to IC2d and IC4c. The former provides the stepped clock required during the programming operation whilst the latter provides a negative sense write enable pulse timed by R6/C4 and R10/C5. The prior state feedback network consists of resistors R20 to R27 which protect the information on the non-operative tracks during programming.
Fig. 3. Control circuit
COMPONENTS

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>33k</td>
</tr>
<tr>
<td>R2</td>
<td>88k</td>
</tr>
<tr>
<td>R3</td>
<td>1M</td>
</tr>
<tr>
<td>R4</td>
<td>10k</td>
</tr>
<tr>
<td>R5</td>
<td>22k</td>
</tr>
<tr>
<td>R6</td>
<td>150k</td>
</tr>
<tr>
<td>R7</td>
<td>10k</td>
</tr>
<tr>
<td>R8</td>
<td>220k</td>
</tr>
<tr>
<td>R9</td>
<td>2M2</td>
</tr>
<tr>
<td>R10</td>
<td>10k</td>
</tr>
<tr>
<td>R11</td>
<td>100k</td>
</tr>
<tr>
<td>R12</td>
<td>150k</td>
</tr>
<tr>
<td>R13</td>
<td>330R</td>
</tr>
<tr>
<td>R14–19</td>
<td>150k (6 off)</td>
</tr>
<tr>
<td>R20–28</td>
<td>470k (9 off)</td>
</tr>
<tr>
<td>R29–32</td>
<td>150k (4 off)</td>
</tr>
<tr>
<td>R33</td>
<td>68k</td>
</tr>
<tr>
<td>R34–40</td>
<td>150k (7 off)</td>
</tr>
<tr>
<td>All resistors</td>
<td>0.25W, 5% carbon film</td>
</tr>
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<table>
<thead>
<tr>
<th>Switches</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Single pole 10 way rotary</td>
</tr>
<tr>
<td>S2</td>
<td>Single pole 12 way rotary</td>
</tr>
<tr>
<td>S3–4</td>
<td>Single pole push-to-make (2 off)</td>
</tr>
<tr>
<td>S5–8</td>
<td>2 pole 3 way sliders (4 off)</td>
</tr>
<tr>
<td>S9</td>
<td>Single pole (see potentiometer VR2)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Values</th>
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<tbody>
<tr>
<td>C1–C3</td>
<td>1µ/16V axial electrolytic</td>
</tr>
<tr>
<td>C4</td>
<td>220p ceramic plate</td>
</tr>
<tr>
<td>C5</td>
<td>2n2 ceramic plate</td>
</tr>
<tr>
<td>C6</td>
<td>100µ/16V axial electrolytic</td>
</tr>
<tr>
<td>C7</td>
<td>100p ceramic plate</td>
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<thead>
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<th>Diodes</th>
<th>Values</th>
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<tr>
<td>D1–41</td>
<td>1N4148 (41 off)</td>
</tr>
<tr>
<td>D42</td>
<td>I.e.d.</td>
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<tr>
<th>Integrated Circuits</th>
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<tbody>
<tr>
<td>IC1</td>
<td>CD4011</td>
</tr>
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<td>IC2</td>
<td>CD4093</td>
</tr>
<tr>
<td>IC3</td>
<td>CD4011</td>
</tr>
<tr>
<td>IC4</td>
<td>MM 74C909</td>
</tr>
<tr>
<td>IC5</td>
<td>CD4520</td>
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<tr>
<td>IC6–9</td>
<td>TC5501P (4 off)</td>
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<th>Potentiometers</th>
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<tr>
<td>VR1</td>
<td>500k lin</td>
</tr>
<tr>
<td>VR2</td>
<td>25k log with switch</td>
</tr>
<tr>
<td>VR3</td>
<td>25k log</td>
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<table>
<thead>
<tr>
<th>Miscellaneous</th>
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<tr>
<td>0-040µm terminal pins</td>
<td>12 off</td>
</tr>
<tr>
<td>22 pin i.c. sockets</td>
<td>4 off</td>
</tr>
<tr>
<td>16 pin i.c. sockets</td>
<td>1 off</td>
</tr>
<tr>
<td>14 pin i.c. sockets</td>
<td>4 off</td>
</tr>
<tr>
<td>control knobs</td>
<td>1 in dia 2 off</td>
</tr>
<tr>
<td>control knobs</td>
<td>3 in dia 3 off</td>
</tr>
<tr>
<td>printed circuit board</td>
<td>1 off</td>
</tr>
</tbody>
</table>

A complete kit can be obtained from Clef Products, 16 Mayfield Rd., Bramhall, Cheshire SK7 1JU

CONTROL P.C.B.

From the photograph it can be seen that in addition to containing the control circuitry the Control p.c.b. acts as a mechanical support for all switches and the "Level," "Tempo," and "Program" potentiometers. Diode D24 is shown in brackets and is the twelve measure connection for position 4 on the "Rhythm Select" switch. Since the sample pattern given later for rhythm 4 is based on sixteen measures this diode is omitted. The corresponding twelve measure diodes for positions 1, 2, 3, 11 and 12 are D21, D22, D23, D25 and D26 respectively and may be omitted as required. Rhythms 5 to 10 inclusive are permanently arranged on a sixteen measure basis.

ASSEMBLING THE P.C.B.

The Control p.c.b. has a considerable number of interconnection tracks and it is advisable to inspect closely the p.c.b. before proceeding, particularly ensuring that bridges are not present between the memory tracks or the large switch pads. Figs. 4 and 5 show the track layout and component overlay for the p.c.b.

The twelve terminal pins should first be inserted in the board, note that many of the interconnections are made from the rear of the p.c.b. where pins are not required. All resistors and diodes can be inserted and soldered next. It is advisable to use a small soldering iron with a maximum bit size of 3/32" in, and in particular it will be found to help if 22 s.w.g. solder is used rather than thicker variants which aggravate the possibility of solder bridges. Wire links can be inserted after soldering the i.c. sockets, advisable throughout, followed by the capacitors.

The three position switches are pushed into the holes in the p.c.b. and are a tight fit. The "Sequence" switch requires two tags to be cut off before insertion and care should be taken not to damage the switches. However it is important for front panel alignment that the switches should seat on the p.c.b. and it may be necessary to slightly increase the size of the switch tag mounting holes due to the mechanical spread on the switches. To assist in later alignment of the front panel it is also suggested that at this stage the I.e.d. is soldered temporarily some 0.5in off the p.c.b. The "Play" and "Rest" keys should be easy to locate with the four pin fixing provided.

ROTARY SWITCHES

The rotary switches are single pole, twelve position, and when supplied they have a small metal ring, concentric with the shaft, which can be repositioned to alter the switching compass. In the case of the "Rhythm Select" switch the ring should be removed completely to allow the full twelve positions to be used. The "Program Control" should be set to give ten positions by adjustment of the ring position to its second slot.

Wiring of the rotary switches to the p.c.b. is carried out from the track side using single core tinned wire of 22 s.w.g. The numbers enclosed by squares on the component ident side of the p.c.b. correspond with the switch tag numbers. Note that pins 1 and 10 on the "Program Control" switch are shorted together and that the connection points for the centre keys are some distance away requiring insulation. These are marked SEL for the Selector Switch and PROG for the "Program Control" switch. It is also worth noting that tag 8 on the "Rhythm Select" switch and tags 11 and 12 on the "Program Control" do not have connections to the p.c.b.

POTENTIOMETERS

The "Tempo" control is soldered to the three pads on the p.c.b. again using wire links, whereas the potentiometer sections of the "Level" and "Tempo" controls are later connected to the instrument p.c.b. only. Fig. 6 shows all the connections, from the switch S9 integral with the "Level" control VR2, to the control p.c.b. supply points. These are important since they control the standby system in addition to switching on the main operating power.

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ALTHOUGH designed to interface a Nascom 1 microcomputer with a KSR33 Teletypewriter, this current loop needs very little or no modification to suit other printers and microcomputers with 20mA serial output. The circuit is in three sections; power supply, opto-isolator, and 20mA (or 60mA) current loop mounted on a single, easily drawn p.c.b.

POWER SUPPLY
On test it was found that 400mA at 9V was more than sufficient to activate the selector magnet of the teletype, normal being 500mA at 20V. A 14.5V 500mA transformer was chosen to power the circuit, as these are easily obtainable for a very modest outlay, as are the 1A bridge rectifier, 1000μF 40V electrolytic capacitor and 13.5V Zener diode, all of which provide a stabilised power supply. With the exception of the transformer, the components are mounted on the p.c.b.

OPTO-ISOLATOR
R1 is chosen to protect the i.e.d. and any resistance value between 470 and 1k should be sufficient. The reverse-parallel diode D5 bypasses negative peaks across the i.e.d. The light emitted by the i.e.d. causes current to flow through the photo-transistor, which is amplified by TR1 and TR2. The high gain causes a square wave to appear at the collector of TR2. VR1 is used to adjust the current to 20mA or 60mA as required. It also serves as a final adjustment to achieve 500mA at the output to the printer selector magnet.

CURRENT LOOP
TR3 and TR4 can be any power transistors of the 3053 and 3055 n.p.n. types respectively. D7 can be any 1 or 2A diode. Because of the heat generated around the junction of R9 and R10, R7, R8 and R9 should be 2 to 4 Watt wirewound resistors and R10 a 10 Watt wirewound. These resistors run much cooler when the selector magnet is connected than they do whilst under test before installation. R6 might require changing to adjust the current gain to produce 500mA at the output.

Similar to those installed in converted teletypes, enhancing the price by anything up to £80, yet can be built for only a few pounds.
For a mark input a positive current is applied to the anode of D2. This provides a positive bias to the base of TR3 which overcomes the normal negative bias supplied through R5 and stabilised by D5. TR3 will turn off as the increasing positive current reaches one half of its final value. The collector of TR3 then goes negative and this negative potential is applied to the base of TR4 which turns TR4 on. R8 provides emitter bias to TR3 and supplies a regenerative action to the transistor.

The selector magnet of the teletype is connected between the collector of TR4 and the junction of R9, R10. On marks the current rises to 500mA and energises the magnet. On spaces the positive input bias decreases and TR3 is turned on at the half line current point by negative bias through R5. The collector of TR3 rises towards a zero potential, applying reverse bias to TR4, de-energising the magnet. The selector magnet opposes the change in current and applies a transient potential to the collector of TR4. D3 now conducts and passes the transient potential to C2 and R11 which limits the potential to a value well under the breakdown voltage of TR4, while selector magnet energy is being dissipated.

CONSTRUCTION

R10 gets very warm in operation and should be mounted away from the p.c.b. to aid heat dissipation.

D4 should be mounted on long leads and bent over the photo-transistor. They are joined with a short length of coaxial sleeving. The ends should be left open while tests are carried out so that room light shining through the end and activates the photo-transistor, thus preventing the printer from chattering. When the unit is connected to a 20mA current a plastic pen-cap makes a neat cover.

Should a photo-transistor not be available, the top can be carefully cut from a BC107 and the base exposed.

COMPONENTS

Resistors
- R1 1k nom. see text
- R2 1M5
- R3 12k
- R4 1k5
- R5 4k7
- R6 390 see text
- R7 2R7 w.w. 2W
- R8 1 w.w.
- R9 270 w.w.
- R10 15 10W
- R11 150

Capacitors
- C1 100µ/40V
- C2, C3 10µ/25V (2 off)

Transistors and Diodes
- REC1 1A bridge rectifier
- D1, D2 4148 or similar (2 off)
- D3 4001 or similar
- D4 0-2 in. red l.e.d.
- D5 12V or 13V Zener 1-5W
- TR1, TR2 BC107 (2 off)
- TR3 2N3053
- TR4 2N3055
- TR5 n.p.n. photo-transistor

Transformer
- T1 240V 50Hz prim. 14-5 to 20V 500mA sec.

Constructors' Note
A complete kit of components is available from Watford Electronics.

Fig. 1. Circuit diagram of opto-coupled 20mA loop. When in opto-isolated mode, the OUT from VR1 is connected to IN at D2 (as on p.c.b.) The input at D2 can be used as a non-isolated RS232 input.
Fig. 2. Printed circuit (actual size)

Fig. 3. Component layout
THE SHUTTLE TELESCOPE

This infrared instrument is a natural addition to the joint United States, United Kingdom and Netherlands venture, which is expected to be launched in 1982. Its full title is Shuttle Infrared Telescope Facility. It is an observatory 1 metre class instrument. It will be in operation outside the atmospheric difficulties such as the absorption and emission of radiation. This will mean that the degrading quality, which is suffered by telescopes in lower orbits, can be avoided. In fact the limitations of the SIRTF will be due to the natural background of space.

To the techniques to be used in this mission, which is scheduled for 1987 or thereabouts, will be added the advantages of cryogenic control. Such control can provide considerably greater sensitivity. Part of this will be derived from the fact that the operational area will be outside that which limits sensitivity, namely below the wavelength of 30 micrometres and above 300 micrometres. The normal background in these ranges is spoiled by water vapour and carbon dioxide. It is possible to overcome some of this by the use of aircraft and balloons. However there is still the line of sight difficulty due to random absorption and emission. So important are data that can be retrieved in this part of the spectrum that pressure from astronomy has virtually demanded that the latest techniques are used. At the present time detectors are available which, in ground based telescopes, are limited only by photon background. Much of the noise and the atmospheric limitation is at a level several orders of magnitude above the sources to be studied. The use of cryogenic techniques enables this background to be overcome with the result that a cryogenic system outside the atmosphere will offer up to a 1,000 times increase in sensitivity above current equipment. For the first time it will be possible to study high-luminosity extra-galactic sources and stellar formations.

The value of scientific advantages such as the SIRTF lie in the ability to look forward in time as well as backward. The early history of the expansion of the Universe with the formation of galaxies may lie in this cosmological area because of the redshift. Once again the real workload lies with the electronics of control for which the specification is severe. It is required that there shall be a pointing accuracy + 1-arc/second and a guidance system to ensure a stability of 0.25-arc/second. Other requirements are that the primary mirror must be held below 12 Kelvin for the first half of each 7 to 14 day mission and thereafter below 16 Kelvin. The secondary mirror must also have a low temperature control of 10 Kelvin or less for the first part of missions and then 15 Kelvin maximum for the rest of the period.

For a nominal 14 day mission SIRTF would need to carry about 1,300 litres of supercritical gaseous helium. This will be held at a pressure of 6 atmospheres to cool the telescope optics and the body. There will be facilities to carry superfluid helium to cool the instrument chamber to a level of 2 Kelvin. There are current investigations to get the temperature down to a few tenths of a degree Kelvin using the isotope helium 3. This is a case of the sword into ploughshares for Helium 3 is a byproduct of weapons technology.

There are difficulties in attaining the ultimate goals but already there are satisfactory signs of progress. For example the optical systems will be diffraction limited at 5 micrometers. This can be achieved using optical grade beryllium. There is a doubt as to whether that beryllium can attain the 2 micrometre diffraction. This figure is of importance for the observation of proto-galaxies, these are galaxies that are forming and would show a high redshift. Other materials are being investigated and these matters will be going on during this continuing updating. The first flights will be about 14 hours duration rising to 30 hours. The reusable system is expected to reach mission durations of 30 days with a reusable condition free of replacement of any kind for 20 missions.

The aperture of the telescope is 85 metres in diameter and 9.2 metres in length. The cryogenic tanks, the electronics and the pointing systems are housed outside the main shell. There is a sun shield and a collapsible cover to reduce the off-axis radiation in to the telescope. This allows the main axis of the telescope to come within 45 degrees of the sun or the earth. The optical arrangement is that of a primary and secondary mirror arranged in what is known as the Ritchey-Chretien-Cassegrain configuration. The telescope can be used for over a wide range of studies which include—

The observation of quasars, star formation, normal galaxies; objects in the solar system such as asteroids, comets and the satellites of the outer planets, also the observation of mass exchange between stars and the interstellar medium. It would also be possible to detect the massive halos of cool stars surrounding galaxies, with the identification of high redshift galaxies in formation.

THE HEART OF A SUPERNOVA

With optical activities growing all the while it is easy to miss the new developments in radioastronomy. However the 5 kilometre radio telescope at the Mullard Radio Astronomy Observatory has been in operation investigating the Tycho Brahe supernova remnant. This was observed to explode in 1572. This is a Type I supernova, a most bright and energetic star explosion.

The discovery made at the observatory at Cambridge by Steven Gull and Guy Pooley was a very small but intense source of radiation at the centre of what remains of the supernova. Until now only one other nebula has been shown to have a Pulsar and this was the Crab Nebula which is within our own galaxy. The radiation from the Tycho remnant was detected at a wavelength of 11 cm. With the high resolution of this radio telescope the picture of the collapsed star can be built up in considerable detail. The observer's suggest that the pulsar or neutron star is in fact the collapsed star. It is not yet finally decided what the real answer is because there could be other reasons for the small star like object being present. If it is in fact the final 'bit' of the original star then it must be moving at 2000 k/m/s a second. This is about 10 times faster than known pulsars. Other observatories are now checking on this star but it may be some time before it is confirmed.

THE SOLAR WIND

Back now to the Earth itself. There is a new collaboration of scientists from 11 countries which began in November. It is perhaps one of the more ambitious projects to undertake the study of the physics of the upper atmosphere. Some 200 scientists are involved. It is expected that nearly fifty rocket launches will be made and observations from 37 ground stations supplemented by satellites and balloons will provide data about the upper atmosphere. The main object of the exercise is to study the atmosphere from 80 to 200 kilometres above the Earth during a magnetic storm.

Magnetic storms are severe disturbances of the earth's magnetic field by the solar wind. There is a continuous radiation which forms the solar wind but this is enhanced by flares and sunspots. The magnetosphere round the earth becomes distorted and the tadpole like tail which appears on the side of the earth away from the sun is extended. The plasma which is composed of ionised particles mostly of hydrogen carries tremendous energy. The particles are dissipated in the upper atmosphere. The solar wind expelled radially from the sun is composed of protons and electrons. When they near the magnetosphere they are luffed out of their straight paths and focussed towards the poles. As the denser part of the atmosphere at about 150 kilometres is reached larger protons are inhibited but the electrons move on. As a result there is a drift of high energy current in a westward direction. This leaks into the atmosphere away from the poles.

Following the article by Frank Hyde on Velikovsky in the April 1980 Spacewatch, we have received many letters from readers, expressing varying opinions. Frank Hyde's final reply to these letters is printed in Readout on page 30.
and revolve around numerical words such as “two”, “thirty”, “pounds” etc.

One of the advantages of the fixed-word approach is the extreme ease of interface with any logic system. To aid in the evaluation and addition of speech to any computer or logic device, the interface is described below, as a constructional article. The speech board is available separately, however, with a full technical specification for the user to design his own interface in any way he wishes.

**TSI SPEECH SYNTHESIS BOARD**

Telesensory Systems Inc (TSI) are the manufacturers of several products for the synthesis of human speech. They produce a talking calculator which has found obvious application for the blind. The units of particular interest, produced by TSI, are the fixed 24 and 64 English word units, consisting of a controller chip (called the CRC), and one or two 2K ROMs, respectively. The photograph shows the chips mounted on a p.c.b. with one or two other discrete components, and a gold-flashed edge connector. The size of the board is 66 x 73 x 13mm, with 0.156in. pitch edge connector tracks. The 64-word versions have two ROMs on the board and are slightly larger.

**INTRODUCTION**

Converting the theory of last month’s article into practice at the “one-off” small computer level, was, until recently, rather difficult. Texas Instruments, for instance, have not made their speech products available on this experimentation level, and most other companies are only interested in the large volume “OEM” buyer, who needs expensive customised speech sets. To experiment with the technology, the alternatives include some excellent, but relatively expensive phoneme analysis boards, whereby any word may be synthesised by sending it information of the phonemes which make it up. To “try out” speech synthesis, a far better approach is to use a cheap, mass produced fixed-word synthesiser giving digitally controllable speech on demand from any computer or logic system. If more than one speech set is also available then so much the better. It is with this in mind that Modus have imported a range of fixed-word speech synthesisers, for applications where a customised vocabulary is unnecessary. The words available are basic...
The CRC is a general speech synthesis chip which requires data of pronunciation, pitch, word-length etc. from a ROM to create the necessary sounds. To store the raw data of a word on a read only memory, a complex computer program accepts speech through a microphone and converts it to data suitable to the CRC. TSI have commissioned ROMs, by this method, for several different speech 'fonts', and standard vocabularies in a number of different languages (German, French, Arabic etc). The words available here are detailed in Table 1.

S2A (Calculator type 24-words) | S2B (Standard English 64-words) | S2C (ASCII 64-words) \\
---|---|---
oh | Same as S2A plus: | space, X-point, quote, number, dollars, percent, and, apostrophe, left parent, right parent, star, plus, comma, minus, point, slash, zero, one, etc. nine, colon, semicolon, less than, equals, greater than, mark, at, A, B, C, (etc.) Z lower case, case, upper case, up arrow, control

times-minus | volts, ohms, amps, hertz, d.c., a.c., | N.B. The ASCII set is of course arranged in exact ASCII order to convert any standard binary code into a verbalisation of the corresponding ASCII character.
times minus | volts, ohms, amps, hertz, d.c., a.c., |
percent | down, up, go, step, low and high tones | over
root | em(M) |
times | times | upper case, up arrow, control
point | point |
overflow | overflow |
minus | minus |
plus | plus |
clear | clear |
swap | swap |

TABLE 1. Vocabulary of the three TSI speech boards available

The speech board acts by accepting a control word of six bits to identify the spoken word to be output, followed by a start pulse to tell it to begin speaking. The board is also equipped with a "busy" line to tell external devices that a word is in the process of being spoken. Fig. 2.1 shows a block diagram with timing signals to illustrate the process. The timing shows that the speech output itself does not occur until the "start" signal has fallen to zero. In a typical interface set-up, a set of six latches would feed the control word to the CRC, the "start" signal would fall after 140 micro seconds or more, and the output would be forthcoming. It must be noted that if the "start" line should rise at any time during the speech output, the output is stopped in mid flow. When the "start" line falls again, the word is started from the beginning. To assist in preventing this occurrence, the "busy" line should be monitored by the external system, and the "start" line only operated when the machine has finished talking.

INTERFACING

As is clear from the above, the logic interface requirements are straightforward, and the only problems arise from the rather strange power supply requirements, which are -5V and -15V. However, by a simple trick, the -5V level can be derived from the normal supply of a microcomputer, while the -15V supply must be derived separately.

The final requirement of the board is for audio circuitry of essentially two types, a filter and an amplifier. The sound is produced by the CRC via a digital to analogue converter (DAC). This implies that the output waveform is not completely smooth. Its variation from level to level is by a set of steps. A sinewave derived from a DAC will have the form shown in Fig. 2.2. Note that the horizontal width of each step is constant, while the vertical steps vary to approximate the sinewave. This shows that the waveform thus formed may be viewed as a sinewave modulated by a constant frequency squarewave. However, a squarewave contains the elements of many frequencies mixed together (depending on how square it is), and hence the voice output must be passed through a band-pass filter allowing just the band of frequencies needed for voice to pass. To give an idea of the frequencies needed and some typical characteristics, Fig. 2.3 reproduces TSI's suggested op-amp filter response. The three decibel level is often used as a method of comparing squarewaves, however, squarewave contains the elements of many frequencies mixed together (depending on how square it is), and hence the voice output must be passed through a band-pass filter allowing just the band of frequencies needed for voice to pass. To give an idea of the frequencies needed and some typical characteristics, Fig. 2.3 reproduces TSI's suggested op-amp filter response. The three decibel level is often used as a method of comparing such responses, and the frequencies at which this level cuts the graph are called the "corner frequencies". The reason for their importance is that at these frequencies, the incoming waveform's amplitude is exactly halved by passing through the filter.

Fig. 2.2. Sine wave output from D to A converter

In considering the TSI output, however, it was found most advantageous to be able to vary the response to different ears, and for different loudspeaker arrangements. After much experimentation, a very simple single op-amp bandpass filter was selected, which, together with an integrated circuit power amplifier gave acceptable results. This circuit is
shown in Fig. 2.4, and includes a tone control, which varies the filter's pass characteristics.

THE INTERFACE UNIT
As explained above, interfacing is dependent upon three main systems: logic, power and audio sections. All these are included on the interface board described here, along with such important details as the correct edge-connector into which the TSI speech unit plugs.

Fig. 2.5 shows a complete circuit diagram of the interface unit, which is designed to be as complete as possible. A separate 5-volt supply is needed for the logic, as well as a small 10 to 20 volt transformer (at around 250mA) and an 8 ohm speaker.

The word to be spoken is requested by supplying a set of bits (DO to D5) along with a positive going "latch enable" pulse. The word is latched into IC2 and presented to the speech synthesis board. When the "start" line changes from high to low, and held there, an audio signal is output from the synthesiser. IC1 filters this audio signal in a manner partly determined by the setting of VR1. The filtered signal is a.c. coupled to a volume control and the i.c. power amplifier IC3 which feeds an 8 ohm speaker through C4. The power supply on the board adds 10 volts to the 5 volt supply from the external logic, and just requires an external mains transformer as indicated. The "busy" signal output swings through 15 volts and to convert this to a 5 volt swing, D5 and R5 are included.

CONSTRUCTION
The p.c.b. design and component layout for the unit is shown in Fig. 2.6.

Assembly of the unit is straightforward, and the sockets for the i.c.s should be inserted and soldered first, followed by the edge-connector and ribbon cable connector. Note that the ribbon cable connector has some spare pins for expansion. Discrete components and regulator should be fitted next, observing the correct polarities with great care. It is a very good idea to check that there are 10 volts between −5V and −15V lines from IC4, before proceeding. The 5 volt
supply can then be connected and a check performed for 15 volts across IC1 and IC3 sockets. Check, also, that the correct supply levels are present at the speech synthesis connector and IC2 socket. When you are fully satisfied, switch off and insert IC3. With the volume fully up, a hum should be audible at the loudspeaker when the wiper of VR2 is touched with a finger. Turn the volume down to ensure that this causes the hum to disappear. This will verify IC3's operation.

Next, insert IC1, IC2 (the correct way round) and the speech synthesis board, with the component side inwards as shown. The unit will sound highly unstable unless the "start" line is held at "one" or "zero" (TTL levels). The line should be taken to zero (−5V) through a low resistance (100 ohm for instance). The line may then be taken high and back to zero to check for word output. If none appears, connect all the inputs of IC2 to zero, and pulse the "latch enable" low, then high. This should load the word "Oh". VR1 and VR2 should be adjusted for the best sound. It is useful to note that the word's pitch may be adjusted by the pot on the speech synthesiser p.c.b.—the pot should be set at half way initially—the total number of turns for its full travel is about four and a half, the pot should be turned one way until obviously at its end, and a couple of turns added in the opposite direction. If no sound appears, use a logic probe, meter (or I.e.d. in series with a 1k resistor), to check that the data bits from IC2 to the speech synthesiser board are all zero. If nothing is forthcoming, power should be removed and the whole unit
checked with the greatest care for any incorrect soldering or component location.

When the unit is working, adjust the two pots on the interface, and the pot on the synthesis board for the best sound. Any tendency toward instability will almost certainly be removed by adding to the power supply decoupling capacitors. Experimentation with the loudspeaker mounting is very worthwhile. Try mounting the speaker in a closed cardboard box with just the speaker cone exposed through a hole of the same diameter. The prototype gave excellent results with a speaker in a transistor radio housing. The speaker should be around two inches or more in diameter for the best results, any smaller and the important base responses will be lost.

**COMPUTER SPEECH**

It is expected that a number of readers will want to attach the unit to a microcomputer and this section deals with its interface to the Compukit, and the Edukit. The interface requirements for the two machines are sufficiently different to provide an excellent illustration of the process.

In order to operate the speech board effectively, the host computer should have two output lines and one input, as well as the six data lines, usually derived from the data bus, to supply details of the exact word to be spoken. One of the output lines is used to clock the six bit word into the data latch, the other output is used as a "start" signal to the speech board, and the input line is connected to the "busy" line and monitored by the computer to ensure that a new word is not requested before the current one is finished. This last line is not necessary if a delay loop is used by the computer to ensure that the next word is never output too soon.

The Edukit has several input and output lines for these purposes, and its interface is very straightforward. Fig. 2.7 shows a tried and tested arrangement. The Edukit is based around the RCA 1802 MPU which has a number of special and useful features for hardware control. One of its lines, called the Q line, is a flip-flop output whose condition may be set by a couple of dedicated machine-code instructions—one to set and one to reset. This output is used here as a "start" signal. The Edukit has a transistor connected to the Q line, and a couple of pins on the board give access to its collector (through a 100 ohm resistor). A load resistor (2k2 at least) should be connected across the pins, and the collector end of the resistor (pin nearest to the keyboard) should be connected, as shown, to the "start" line of the interface. Thus, the Q output from the 1802 is inverted, and starting of the speech output is effected by first setting Q (giving zero at the "start" line), resetting and setting Q again. This provides a short pulsed "one" on the "start" line.

The Edukit also has a number of input lines, called "External Flags" (EF lines). The states of these lines may be examined by a comprehensive set of jump instructions in the 1802. The "busy" line, therefore, may be examined by EF1, for instance, and the next word sent when the "busy" line returns to a "one".

To transfer data from the computer, the lower six data lines are used, and a further output line is necessary to latch these data bits into the interface's latches. Again, the 1802 is well designed to allow the presence of "output" data on the "data bus" to be signalled by a particular set of output lines (NO and N2). On the Edukit, one of these lines is inverted and used to allow data to be shown on the digital display. The signal appears at pin 3 of the display drivers, (IC11 or IC12), and it is from here that the latch enable of the interface should be drawn.

To ensure that the unit is interfaced correctly, write a program to turn the Q line off, then on, then off again.

**Fig. 2.7. Edukit interface board**

Whatever word is held on the latch (IC2) will now be heard when the program is run. If this is working, the hex equivalent of the word spoken will appear on the digital display.

Fig. 2.8 gives a flow chart of a typical piece of software to output all the words offered by the speech board. Either 24 or 64 words are offered on the board, and this will decide when the last word has been spoken. The routine starts by setting the Q line to a "one", and setting the contents of the

---

**COMPONENTS...**

**Resistors**
- R1, R2, R5: 1k (3 off)
- R3: 180k
- R4: 4k7
- All resistors ±5% carbon

**Potentiometers**
- VR1: 100k hor. preset
- VR2: 5k hor. preset

**Capacitors**
- C1, C2: 10n ceramic disc (2 off)
- C3: 470 nF 50V
- C4, C5, C6, C7: 100µF 15V elect. (4 off)
- C8, C9, C10: 100nF disc ceramic (3 off)

**Semiconductors**
- D1–D4: 1N4001 (4 off)
- D5, D6: 1N4148
- IC1: 741
- IC2: 74LS174
- IC3: LM380
- IC4: 7805

**Miscellaneous**
- P.c.b.
- PL1: ribbon cable plug and connector
- SK1: edge connector socket (10 double way at 0-156in.
- pitch with polarising plug)
- Mains transformer 10-20V sec 250mA 8Ω loudspeaker
- S2A: S2B or S2C speech synthesis board
- i.c. sockets

**Constructor's Note**

All components including the speech boards are available from **Modus Systems Ltd., 29A Eastcheap, Letchworth, Herts, SG6 3DA (04626 74468/76392)**.

The interface board (ex. transformer and loudspeaker) is £14.95 ex. VAT and p&p, and the S2A board is £39.95 ex. VAT and p&p.
memory location (called “I” here) to the number 0, which is the first word to be spoken. The OUT instruction is then used exactly as for outputting to the digital display. “I” is then incremented and Q set to 0 for a short time. The word spoken should agree with the digital display reading. A loop is then entered which simply repeats until the “busy” line returns to a 1 level. When this happens, a check is done to determine whether the last word has been spoken; if not the process is repeated, otherwise the end is reached. This routine, does, of course, form the basis for operating any system, though the exact manner in which the checks are made, and the data output, depends upon the hardware set-up involved.

Interfacing to the Compukit is a rather more difficult business as there are no I/O lines on the board. There are two approaches which may be considered. Which is chosen depends upon whether a quick experimental set-up is sufficient, or a fully operational unit capable of controlling the speech fully is required.

A quick interface to the Compukit, which is by no means a finished set-up, but will give a flavour of the use of speech for a later more sophisticated approach is shown in Fig. 2.9. Here, the top 2K of RAM i.c.s are removed, and their “data” lines, “supply” lines and “chip select” lines are used to drive the speech unit. Notice that the RS lines from the Compukit need inverting before being able to drive the “start” line. The easiest solution is to use any small signal transistor for the job. This interface proved perfectly satisfactory, and should be realised by a couple of d.i.l. headers, rather than by soldering to the p.c.b. When the Compukit is reset and cold started, the Monitor does a memory test, and hence the RS lines are activated. This should cause a word to be output. The theory of operation of this interface is as follows. When a word is to be output, a POKE statement is performed to any memory location in the top 1K of memory. This causes RS7 to go low when the “data bus” contains the desired word. The word is then latched by the speech interface. The next operation is to POKE any location in the next to last 1K of memory—any value will do. This causes RS6 to fall to a zero for a short time, which, via the transistor inverter, causes the “start” line to rise for a short time and the speech board outputs the latched word. No provision is made for monitoring the “busy” signal, and if a string of words is to be output, then it is necessary to include a delay loop such as:

```
FOR I = 1 TO 1500: NEXT I
```

between each word output.

The upper 1K of memory starts at decimal 7168, and the next 1K below at 6144. Thus, for instance, the following program will “say” all the words on the 24-word version of the speech board.

```
10 FOR J = 0 TO 23
20 POKE 7168,J
30 POKE 6144,0
40 FOR I = 1 TO 1500
50 NEXT I
60 NEXT J
```

The upper value in line 40 depends upon the frequency of the clock on the speech board, and hence may need to be adjusted to ensure that nothing is lost.

The above interface should not be viewed as a long term method of providing the Compukit with speech. The correct approach is to use a PIA type device such as that detailed in the PE Compukit articles. By this means, the “busy” signal can be used to ensure that nothing is lost, and the top 2K of RAM remains free. An excellent and general interface project for the Compukit is described in a set of articles by D. E. Graham, starting in the next issue of PE. The project is perfectly set up to control the speech board as well as many other things. Another advantage of this interface is that it allows the use of digital to analogue converters. The need for such devices, with reference to speech, is mentioned below.

**GENERAL NOTES**

Any digital device which displays decimal information, such as a digital clock, digital car instruments, test gear etc. should be able to be interfaced with the speech unit described here. Some demultiplexing may be required, and the on-board latch provides the basis of such circuitry. Though a major application is for computer speech, a computer is by no means necessary to drive the unit.

In using the speech unit, it is worth pointing out that any word spoken to the human ear out of context may be mis-
heard or misunderstood by the listener. It is therefore a good idea to listen through the complete vocabulary, at least once, while following a written copy. This should adequately attune the ear to the sound being produced.

To experiment with voice output fully, the pitch of the utterance must also be controlled in real time. The speech boards allow the clock frequency to be supplied from an external source, and an external D to A converter followed by a voltage controlled oscillator would be a method of allowing computer control of pitch. Volume could also be adjusted at IC3, and, along with pitch, ultimate control of the process would result. The next step would be to produce a piece of software which automatically determines and controls the pitch and volume depending upon context and syntax of the utterance. Although the speech unit presented here is relatively simple, it is more than adequate for these and many other sophisticated experiments in speech synthesis. Indeed, the unit is actually useful, and provides the user with yet another source of output from electronic equipment. This is especially true when the eyes are busy with other tasks, but constant monitoring of numerical data is required.

Finally, the author would like to thank Mr. M. Terekow of Modus Systems for his assistance in prototyping and checking many of the ideas presented in these articles.

**Readout...**

A selection from our Postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.

Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

Velikovsky: Frank Hyde Replies

I offered to answer specific questions from Mr. Austin but so far none have come to hand. However, since Messrs Warlow and Williams have added their criticisms on this matter it gives me an opportunity to assume that, certain main themes are themselves statements of belief if not scientific fact, accepted by these gentlemen.

First let me make it clear that I am dealing with the matter from my own original edition of Velikovsky's "Worlds in Collision". Most of the book consists of statements without any support other than quotations from random works of the past. Much of the support for his own ideas are drawn from the biblical text. It is here that quotation is regarded as confirmation of physical facts and as is all too common with this kind of "proof" is not sufficient to substantiate the claims.

Dominant among the statements which serve to antagonise physicists and astronomers are the claims that a comet was ejected from Jupiter. Let us take this as a starting point and I quote page 48 of "Worlds in Collision": "In the middle of the second millennium before the present era, as I intend to show, the earth underwent one of the greatest catastrophes of its history. A celestial body that only a short while before had become a member of the solar system—a new comet—came very close to earth." Then for some 14 pages of quotations of various happenings interspersed with statements such as "the tails of comets are composed mainly of carbon and hydrogen gases. Lacking oxygen, they do not burn in flight, but the inflammable gases, passing through an atmosphere containing oxygen, will be set on fire." Well the earth passed through the tail of Halley's comet in 1910 but no one noticed it nor was the tail visible, let alone on fire. It is perhaps wise to point out here that the "tail" of a comet appears as the comet approaches the body which determines its perihelion passage. If the comet is large the "tail" will be produced in a direction away from the body if approaches and will continue as it passes round the body to point away from it. It may be that more than one "tail" appears. Sometimes the tail is insignificant and sometimes there is no visible "tail". Halley's comet is due in 1986 and between now and then there is to be a mission to observe the comet at first hand. Thus will all doubt as to the composition be settled. Beyond saying that there is an abundance of literature available about comets which when read will give some of the answers, I will leave the actual comet in order to test the statement by Velikovsky that Venus was originally a comet ejected from Jupiter. This he says occurred around the year 1500 BC. The Book of Exodus provides the details of what happened when the comet grazed the earth. Many very strange things are told such as, the houses of the Egyptian people were destroyed, the Nile ran red etc. The curious thing about all this was that the houses of the Israelites were not affected. After forty years the comet came back and caused further trouble, to go off and again return, and, after hitting the earth, again bringing it to a standstill before going on to upset Mars into its present orbit and itself settling down as Venus. The earth regained its place and continued on as it was, before all these events took place. All this supported by historical facts quoted from the Bible and other writings from various parts of the world. These are very far reaching statements and thus need careful examination. Many so-called scientific predictions have gone awry even when evidence appears to be adequate to make a forecast. However there are certain everyday facts of natural science which must be satisfied before new and astounding statements can be accepted. Let us then look at what the statements of Velikovsky imply in relation to comets.

The basis of many of the statements attends on "belief". Because many of the cometary orbits lie near Jupiter a number of people including Laplace and Pierre Simon put forward the view that Jupiter might be the source of cometary bodies. However there are no writings in support of this nor indeed are there any sightings of it ever happening nor has Jupiter ever been observed to have unusual events occurring in its vicinity. One person, V. S. Vachksvatsky does believe that comets are ejected from volcanoes on the satellites.

I will not resort to writing out the mathematics in this reply but will give the consequences as are known and used in astronomical physics. Of course if anyone would like to have the full mathematics I will send them, if a stamped addressed envelope is supplied. The effect of projection of a portion of Jupiter of the density and size to end up as a planetary body like Venus, would be to raise the temperature of Jupiter several thousands of degrees centigrade. This would have melted the body being ejected and therefore it would probably be dispersed as dust or vapour. Thus it is unlikely that even a comet (assuming that a comet is not anything like current thinking) could exist or survive such an experience. There is another problem also. The escape velocity at Jupiter is of the order of 20km/second. Whatever the escape mechanism might be it would not be aware of this fact for if the velocity of escape was 70km/second the comet/planet would fall back into Jupiter, if it were 73km/second it would escape from the solar system. In either case it is more likely that Jupiter would be considerably changed and not the body itself as has been observed over a far longer period of time than as recently as 1500 BC.

There is still a further problem. This is the mass of Venus. It amounts to rather more than 5 x 10³⁰ grammes. The total kinetic energy that would be required to propel Venus to the escape velocity of Jupiter is of the order of 10¹⁴ ergs. This poses an even greater problem than all the others put together for 10¹⁴ ergs is equivalent to all the radiation energy of the sun for a year. Or in other terms one hundred million million times more powerful than the largest solar flare ever observed.

A final word on this situation, which is occupying more space than is justified. Velikovsky has quoted several rapidly occurring collisions involving planets yet the odds against it happening once in a millennium is 30,000 years. Surely unwritten folk stories and legends must defer to practical and demonstrable facts, for this is why David Birch was dismissive.

Frank W. Hyde, FSE, PEng, FRAS.

This correspondence is now closed—Ed.
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Practical Electronics December 1980

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
LARGE CHARACTERS
The ZX80 is unusual among microcomputers in that its character-set is stored in ROM alongside the BASIC interpreter, and characters are written to the display by software. Bob Sharp, of Corby, has discovered how to PEEK the ROM and produce displays of large characters. His three programs generate displays of 32, 8 or 2 characters of increasing size. They can give the alphanumeric characters and graphics symbols, together with the symbols "# $ . . .". As well as being extremely revealing about how the ZX80 works, the programs would be useful for creating large displays for teaching or shop-window advertising.

In the ZX80 the character set is stored, starting at address 448*8 in the ROM, as a sequence of 8 bytes per character. Each byte codes the bit pattern for one line of the character matrix. A "1" in that byte is displayed as a black dot, and a zero as a white dot. Thus, for example, the 8 lines for the character with code N can be printed, in decimal, by executing:

```
10 INPUT N
20 FOR R=0 TO 7
30 PRINT PEEK((448+N)*8+R)
40 NEXT N
```

Converting these decimal numbers to binary will then reveal the shape of the character.

HUGE EIGHT
The simplest program of the three to understand is Huge Eight, see Fig. 1, which generates 2 lines of 4 characters; for example, see Fig. 2. The Huge Eight program prints a space character, or an inverted space character, for each bit in the character matrix, thus giving an enlargement of 16 times and filling the screen with two characters. The program works in a similar way to Huge Eight, except that now I(0) to I(7) hold the bytes of the character matrix for the first character, and I(8) to I(15) hold the matrix for the second character.

BIG THIRTY-TWO
The third of Bob Sharp's programs, shown in Fig. 4, gives four lines of eight characters, and is at first sight the most baffling to understand. It displays each block of four bits in the characters as the relevant graphics symbol, thus giving an enlargement of four times.

The program looks up two rows of each character, in lines 60 to 100, and calculates in Y a 4-bit binary number which specifies the
states of the four squares in the graphics symbol. Thus Y=0 is a space, and Y=15 is an inverted space. However, finding the correct graphics symbol for the other values of Y is by no means an easy task, since the codes for the graphics symbols are apparently quite haphazard on the ZX80; the symbols and their ZX80 codes are shown in Fig. 5. Bob Sharp gets around this problem by providing a string, ZS in line 120, whose characters specify the order of the first 8 graphics symbols. Lines 130 to 160 select the required character in this string, and then lines 170 to 180 convert this to the graphics symbol, and print it. The symbols for Y between 8 and 15 are obtained by inverting one of the first 8 graphics symbols in line 175.

This process is repeated to give the 32 graphics symbols for each line, and for the 16 lines of symbols, and the whole program takes almost two minutes to execute.

These three programs for generating large characters can be modified to give other punctuation and arithmetic signs, in addition to the alphanumerics, by replacing the reference to CODE(A$) with: 121-ABS(121-CODE(A$)).

MEMORY-MAPPED DISPLAY

Another unusual feature of the ZX80 is that there is not a precise mapping between the characters in memory and what is displayed on the screen, instead the display is generated from a "display file" which can reside anywhere in memory, and which can contain lines of different lengths so that trailing blanks do not have to be stored.

However, it is sometimes useful to be able to use the display as if it were memory-mapped, so that POKing to a specific memory location will cause the code for that character to appear at a predetermined position, and PEEKing will read the code of the character at that position. The program of Fig. 8, submitted by S. J. Duggins of Birmingham, shows how to achieve this, and demonstrates its use by drawing lines, using inverted spaces, between two pairs of coordinates. The top left-hand corner of the screen has coordinates (1,1), and the bottom right-hand corner has coordinates (32,18). As an example, Fig. 7 shows four lines drawn by the program.

Mr. Duggins describes the operation of the program as follows: "The display file is first created in lines 20-40 by printing spaces. The coordinates are then entered as X1,Y1, and X2,Y2. If 99 is entered as the first coordinate the program will stop. The peculiar LET statements in lines 100 and 110 are used to save having to put four IF statements; their use is explained in the manual. The start address of the display file is then obtained in line 120 from the system variable D-FILE; since the file does not reside in a fixed area of memory the address is obtained before each POKE statement is executed, because even if a variable is assigned the display file will be moved. The reverse space is then POKEd in line 130 to the display position of the coordinates X1,Y1. Then V1 coordinate (line number) is multiplied by 33 instead of the line width, 32, because a 32-character line does in fact contain 33 characters, the last one being inserted by the monitor as a newline marker. Line 140 checks to see if the second coordinates have been reached, and lines 150 and 160 increment or decrement the plotting coordinates to the next position.

10 LET N=16396
20 FOR A=1 TO 10*32
30 PRINT " ";
40 NEXT A
50 INPUT X1
60 IF X1=99 THEN STOP
70 INPUT Y1
80 INPUT X2
90 INPUT Y2
100 LET X=X1<X2 AND 1 OR X1>X2
AND =1
110 LET Y=Y1<Y2 AND 1 OR Y1>Y2
AND =1
120 LET D=PEEK(N)+PEEK(N+1)*256
130 POKE D+(y1-1)*33+x1,128
140 IF X1=X2 AND Y1=Y2 THEN GO TO 150
150 LET X1=X1+X
AND =1
160 LET Y1=Y1+Y
AND =1
170 GO TO 20
160 LET y1=y1+y
150 LET x1=x1+x

10 LET N=16396
20 FOR A=1 TO 10*32
30 PRINT " ";
40 NEXT A
50 INPUT X1
60 IF X1=99 THEN STOP
70 INPUT Y1
80 INPUT X2
90 INPUT Y2
100 LET X=X1<X2 AND 1 OR X1>X2
AND =1
110 LET Y=Y1<Y2 AND 1 OR Y1>Y2
AND =1
120 LET D=PEEK(N)+PEEK(N+1)*256
130 POKE D+(y1-1)*33+x1,128
140 IF X1=X2 AND Y1=Y2 THEN GO TO 150
150 LET X1=X1+X
AND =1
160 LET Y1=Y1+Y
AND =1
170 GO TO 20
160 LET y1=y1+y
150 LET x1=x1+x

Fig. 6. Program draws lines by POKEing to the ZX80 display file

Fig. 7. Graphics drawn by the program of Fig. 6

Note that the program does not check that the coordinates are legal, and drawing to coordinates outside the display area may ruin the program."

STRING ARRAYS ON THE ZX80

Although the ZX80 provides strings and integer arrays, it does not provide string arrays, and this can be very tiresome when strings are being manipulated by a program. Jeremy Ruston of Kensington has devised an ingenious way around this restriction. A short routine, Fig. 8(a), sits below the main program and uses the string variables AS, BS, CS . . . etc. as one string array of up to 25 elements. The number of the required element is passed in Z$, and the string is transferred in Z$. The routine then POKeS the reference to CS in line 2 or 4 to alter it to the required string variable. On the ZX80 the first line of the program begins at address 16424, and the POKe addresses in lines 6 and 9 of the routine give the addresses of the "C"s in lines 4 and 2 respectively. Obviously the routine should not be altered without changing these POKe addresses.

The routine is used as follows. Instead of:
LET AS$="HUGO DRAX"
(which is illegal on the ZX80) you write:
LET ZS=X
LET ZS="HUGO DRAX"
GO SUB 6.

Similarly, to print an element, instead of:
PRINT AS$(k)
you would write:
LET Z=8
GO SUB 9
PRINT ZS

The program in Fig. 8(b) gives a simple demonstration of how the routine can be used; it reads in ten strings, and then prints them all out.

MAZE

The final program of Fig. 9 is very simple, but quite fun; it was devised by D. Stocker of Cardiff, and it draws a random maze on the screen using the ZX80's graphics symbols. His instructions are:
"The object of the game is to try and find a path between the letters A, B, C, D, W, X, Y or Z. Note that the letters may be joined by black or white paths, or they may not be joined at all."

Note that the computer does not ensure that a path exists; this is a much harder task, possibly beyond the capability of an expanded ZX80.

10 REM MAZE
70 CLS
75 PRINT "A","B","C","D";
80 FOR A=1 TO 750
90 PRINT CHR$(END(3));
100 NEXT A
105 PRINT
110 PRINT "W","X","Y","Z";

Fig. 9. Program to draw a random maze
If nickel-cadmium batteries are used then the three links N1, N2 and N3 should be soldered. If alkaline batteries are to be used then the only link required is A1.

Each channel of the Sentinel can provide either a delayed or immediate alarm signal when an intrusion is detected. The channels which will be used to monitor the normal entrances and exits should have a delayed alarm. Any channel will give an immediate alarm if D11, D21, D31, D41, D51 or D61 are soldered. So this diode should be omitted from any channel where a delayed alarm is required.

SETTING UP

Before carrying out the following adjustments ensure that the batteries are fully charged. Connect a 100kΩ resistor and a 1N4148 diode across each pair of alarm channel inputs with the cathode connected to the ‘a’ terminal as shown in Fig. 2.3.

![Fig. 2.3. Terminal block connections](image)

Rotate VR10 to VR60 fully anti-clockwise (from the front of the p.c.b.). Insert the batteries depress all alarm channel select switches and release the activate switch. The ‘operational’ I.e.d. should illuminate in approximately three quarters of a second. None of the channel ‘alarm’ I.e.d.s should illuminate. Depress the ‘system’ switch to the ‘activate’ position and using an insulated screwdriver adjust VR10 slightly clockwise. Release the ‘system’ switch to the ‘activate’ position. When the ‘operational’ I.e.d. illuminates depress the ‘system’ switch to the ‘defeat’ position. Repeat the above procedure until the channel ‘alarm’ I.e.d. illuminates the ‘system’ switch is released to the ‘active’ position. Back VR10 off slightly and release the ‘system’ switch to the ‘activate’ position. Repeat this procedure until the channel ‘alarm’ I.e.d. does not illuminate when the ‘system’ switch is released. Repeat this procedure for the remaining five alarm channels. If any channel displays an erroneous alarm adjust the preset of the offending channel slightly anti-clockwise until normal operation resumes.

REMOTE MIMIC

The remote mimic (Fig. 2.4.) should be installed near the door which is normally used to leave the house. If the pre-siren option is used then the system alarm I.e.d. cannot be used.

![Fig. 2.4. Remote Mimic wiring](image)

PRE-SIREN SIGNAL UNIT

A small piezoelectric sounder can be driven (Fig. 2.5.) instead of the remote system alarm I.e.d. The sounder can be...
Fig. 2.1. P.c.b. designs and component layouts
used to provide an alarm in advance of the siren being triggered. If this option is used then the value of resistor R89 should be increased to 3M6 to increase the ‘immediate alarm’ delay time to 30 secs. This enables the system to be defeated before the siren is triggered.

![Fig. 2.5. Pre-signal unit wiring](image)

**SIREN**

Selecting a location for the siren is just as important as selecting the location of the control centre. An ideal arrangement is to have one siren mounted inside the house in a secluded place and a second unit mounted in a high, inaccessible location outside the house. Most systems will only use one unit and this should be mounted near the eaves with the wiring routed through the loft.

**ALARM LOOP INSTALLATION**

The wiring of the alarm unit will be determined by the layout of the house and the degree of protection required.

**SENSORS**

Each alarm channel must include one ‘tri-mode’ sensor and can have up to a maximum of four. An unlimited number of ‘bi-mode’ sensors, conventional switches, window foils, trip wires and pressure pads may be incorporated in the loop together with fire sensors and ‘panic switches’.

**TRI-MODE SENSORS**

These sensors provide protection against an opened door or window, a magnetically shunted or an electrically shorted sensor. All large windows and external doors should have ‘tri-mode’ sensors.

**BI-MODE SENSORS**

These sensors provide protection against an opened door or window and a magnetically shunted sensor. These sensors should be used on external doors and windows when the number of doors and windows in a loop exceed the number that can be protected by ‘tri-mode’ sensors. The ‘tri-mode’ sensors should be fitted to the most vulnerable windows and doors with ‘bi-modes’ fitted to the remainder.

**CONVENTIONAL SENSORS**

Conventional sensors consist of magnet and reed switch combinations used alone. They can be fitted to windows on first floors to reduce installation costs. They can also be used to provide back-up protection by fitting them to between adjoining rooms. This would however prevent the system being used when the house is occupied.

**SHUNT DEVICES**

Shunt devices normally take the form of pressure mats fitted under carpets. Magnet and reed switch combinations can also be used in this configuration if they are used to sense a door being closed. Pressure mats are normally fitted near windows, doors and passages between rooms. The use of shunt devices also prevents the system being used when the house is occupied.

**WINDOW FOILS**

Window foils are inexpensive and easy to install but are very conspicuous and easily shunted. If a ‘tri-mode’ switch is added to the middle of a foil loop it can be made virtually tamper-proof.

**‘TRI-MODE SWITCH ASSEMBLY**

Before any ‘tri-mode’ switches are fitted into the system it should be decided how many are to be used in each channel (remember at least one per channel is required to establish the loop impedance). The number of switches will determine the value of resistor Ra (Table 1).

<table>
<thead>
<tr>
<th>Number of ‘tri-mode’ switches (per channel)</th>
<th>Value of Ra</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100kΩ</td>
</tr>
<tr>
<td>2</td>
<td>47kΩ</td>
</tr>
<tr>
<td>3</td>
<td>33kΩ</td>
</tr>
<tr>
<td>4</td>
<td>24kΩ</td>
</tr>
</tbody>
</table>

**TABLE 1: All the ‘tri-mode’ switches in a particular channel should have the same value resistors.**

The selected resistor Ra should first be soldered to a germanium diode (0A91) and then fitted into the reed switch assembly as shown in Fig. 2.6.

![Fig. 2.6. After soldering, the resistor and diode should be fitted inside the switch. Note the reed switch is fitted inside the body of the switch and cannot be seen.](image)

**DESIGNING A LOOP**

The basic principle of the alarm loop is that it presents a resistance of 100kHz during one phase of the multi-vibrator. If the resistance of the loop decreases to 80kΩ or less an alarm is sensed. During the other phase of the multi-vibrator the loop should present a resistance less than 10kΩ. If the resistance of the loop increases to 100kΩ or greater an alarm is sensed. The first phase monitors the loop for short circuits and shunt sensors being activated the second phase monitors the loop of continuity of the series sensors.

When designing a loop there are three basic rules that must be followed:

a) In order to maintain maximum noise immunity twin conductor wire should be used from sensor to sensor. This is important if the sensors are some distance...
apart or the alarm wiring is in close proximity to the electrical wiring in the house. Wiring in one area, say around a large set of windows, can be separated into single cores whenever it is convenient to do so.

b) The reverse resistance of the loop should be approximately 100kΩ when the loop is safe. This resistance is determined by the sum of the resistors in the 'tri-mode' sensors. (cathode of diode D positive with respect to its anode).

c) The forward resistance of the loop should be less than 10kΩ when the loop is safe. This resistance is determined by the series resistance of the wire and the diodes in the 'tri-mode' sensors. (cathode of diode D negative with respect to its anode).

A basic system would take the form of a 'tri-mode' switch at the external door and at any windows which can be forced open to provide access for the average size person. 'Bi-mode' switches should be fitted to the remaining windows. Doors and windows which are in dark or secluded areas require extra attention as these areas will be the most likely points of attempted access. Tamper proof window foils should be installed on all glass panes in these localities.

One of the major advantages of the 'tri-mode' concept which requires only one twin-conductor wire from the control panel to the area being protected is that only one 'tri-mode' switch need be fitted initially. When time and budget allow, the loop can be expanded without disturbing the existing installation. Wiring is also greatly simplified by this design.

An unlimited number of bi-mode switches can be developed from conventional switches and although bi-mode and tri-mode switches can be used in either leg it is easier to wire all the series devices in 'a' leg and use the 'b' leg as the return.

**OPERATION OF THE SYSTEM**

Operation of this system is straightforward due to the built-in automatic test facilities. When you are ready to leave the premises close all windows and doors that are monitored and release all of the channel selector switches to the 'activate' position. As you leave release the 'system' switch to the 'activate' position. When the 'operational' I.E.D. illuminates the system is completely clear of alarms and has initiated the exit delay. You now have one and a half minutes to make your exit and close the door behind you. If the system goes to 'fault' when it is activated the channel which is causing the alarm will be identified by the flashing channel 'alarm' I.E.D. If you wish you can depress the channel selector switch to 'defeat', cycle the 'system' switch to 'defeat' and then back to 'activate'. The system will now ignore the alarm sensed on this channel and you can make your exit. The facility to 'defeat' selected channels was provided for use mainly when you use the system to protect the house when it is occupied and you only wish to protect key areas of the premises. When the house is unoccupied the source of the alarm should be identified and corrected before you depart. When you return and re-enter the house you will trigger the system immediately. The entry delay timer allows you one minute to reach the control centre and depress the 'system' switch to 'defeat' before the siren is triggered. The 'operational' status when you depart and the 'system alarm' status when you re-enter are verified by the remote I.E.D. mimic as confirmation that the system is operating correctly.
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BOSE SPEAKERS

European patent application no. 0 007 453 originates from the Bose Corporation of Framingham, Massachusetts. The aim of the invention is to provide the electronic equivalent of mechanical adjustments which are necessary on some of Bose loudspeakers. According to Bose design philosophy a loudspeaker should radiate more sound energy onto a reflecting surface, such as a room wall, than directly into the listening area. This is said to simulate the sound received in a concert hall where the listener receives significantly more reflected energy than direct energy from the sound source on the stage.

This (highly controversial) approach can result in an unnaturally broad sound image which spreads across the entire surface of the wall which is reflecting the indirect sound from the loudspeakers. Some control of the image spread is possible if the user physically adjusts the angle of the loudspeakers with respect to the nearest wall. But as Bose admit in the new patent application, this is "impractical in many situations". The new idea is to provide additional circuitry which enables the user to vary the image without altering the loudspeaker position.

The Bose 901 loudspeaker is shaped rather like a chunky slice of cake and (see Figure 4) four identical full range loudspeaker drivers 21–24 and 25–28 are mounted on each of the two rearwardly facing and mutually angled panels 120 and 121. A single front facing driver 29 is mounted on the front panel 30 to fire directly into the listening area. The nine drivers are connected in a series between loudspeaker terminals 31 and 32 with the junction of front driver 29 and inside rear driver 25 connected to an extra terminal 33. As shown in figure 5, the audio signal input 44 is split between an "inside" channel of amplifier 47, resistor 48 and amplifier 51 and an "outside" channel of amplifier 52, resistor 53 and amplifier 54. The gains of amplifiers 47 and 52 are of equal magnitude but opposite sense to provide phase reversal. Capable 55 couples the arm 42 of a potentiometer or "spatial control" 41 to earth. Central terminal 33 of the loudspeaker system is also connected to earth. In this way the spatial control alters the ratio of sound energy generated by the inside and outside panels, but only above a frequency of around 300Hz. Frequencies below 300Hz, which are largely nondirectional, are unaffected and radiated at equal level by both the inside and outside panels of the loudspeaker. Moreover the overall radiated power from both rear panels remains constant, irrespective of the changing ratio of radiation between panels. Adjustment of the potentiometer arm 42 should thus vary the perceived image without audible change of volume.

According to Bose the modification is immediately applicable to Model 901 loudspeakers which already have the necessary three terminals, but models 501 and 601 speakers will need some modification. It will be interesting to chart the progress of application no. 0 007 453 through the European Patent Office because the text contains self-congratulatory statements which are arguable and of a type normally inadmissible in a patent document, e.g. according to Bose the 901 system "has met with wide critical and consumer acclaim throughout the world, receiving an unprecedented series of rave reviews"!

Copies of Patents can be obtained from: the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price 95p each.

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POINTS ARISING

THE PERSONAL COMPUTER BOOK by Robin Bradbeer in PE October 1980 (Review)

NOTE: Input Two-Nine, the publisher of this book has been taken over by Gower. Those who read this review should note that the book is now available from: Gower Publishing Company, 1 Westmead, Farnborough, Hants, GU14 7RU.
In this part the 12V subsystem, output routing and monitoring, together with wiring, will be detailed.

**Panel Wiring**

The mounting of the components and interwiring is a large task and must be approached systematically. All steps must be carefully checked, because the correction of small errors at a later stage can be very time consuming. A wiring colour code is extremely helpful provided you are not colour blind, in which case the choice of colours would be limited. A table (next month) gives a suitable colour code.

Begin by mounting components on the front panel. Set the rotary switch spigots for the appropriate number of switch positions. When mounting the slide pots and microphone transformer, ensure that the screws do not extend more than 1 mm beyond the tapping, otherwise damage may result. The sliders are mounted on spacers so that a standard length screw may be used. Use Selotape to hold the spacers in place whilst the slider bezel, screws, panel and slide pot are aligned. Note that although the slider bezels specified are self-adhesive, they are drilled to accept the slide pot's fixing screws. Next, mount all the components on the edge panel. These can be wired directly to their respective barrier strips and the panel can be bolted in place. Then mount barrier strip no. 7 under the turntables. If the relays are mounted on a plate, then it is convenient to wire these up on the bench to their associated components, and then to mount the plate next to barrier strip no. 7 and complete the interwiring. At this stage all the wiring in Fig. 15 can be completed. When the front panel components are all mounted, this panel should be bolted to the console frame by means of hinges along the top edge. The panel should be arranged to sit in the position shown in dashed lines on this figure; this arrangement greatly eases the task of wiring up.

Before beginning the wiring, check the switch positions, ensure that the cards fit their respective edge connectors, especially when the panel is lowered and ensure that the edge connectors are the right way up, so that they connect with the card terminals when the components are facing you. Most important of all, the log sliders must be correctly orientated; pins 11 and 21 are 'earthy' and go to OV, i.e. these are uppermost when the panel is hinged back.

Wiring begins with the 'chassis earths'. Unlike the OV connections, these go directly to the mains earth from screens and all exposed metalwork, which must be permanently earthed. The OV connections on the other hand can be 'ground-lifted' to prevent hum loops. It must be emphasised that the chassis and OV earths should be regarded as being entirely separate. Connect all handles, panels, screens, turntables, gooseneck arms and other exposed metalwork via 16/0.2 wire to the chassis earth commoning point.

**12V Subsystem**

The 12 volt subsystem should be wired next and the relays, lamps and monitor amplifier can be tested if a 12V supply is to hand. The lamps are normally wired via the spare contacts on each push-button switch. However, extra switch elements may need to be added to certain switches to ensure a consistent pattern, i.e. 'lamps on = function on'. Also test for isolation between chassis earths and the 12V 'OV' connections. Before wiring the left-hand edge connector socket, attach a generous length of wire to the VU meters. These will be wired later, but they are difficult to reach once the adjacent sockets are wired. Likewise, be sure that the 12V subsystem switches adjacent to the right-hand (Cards 3 and 4) edge connectors are correctly wired. Remove edge connector 2 and commence wiring connector 1. Sleeve alternate connections and cut off generous lengths of wire. It will only be possible to connect a few cables as yet, but route the cables as far as possible, using self-adhesive aluminium cable clips to hold them in place temporarily, in conjunction with re-usable cable ties.

When all the connections to the Card 1 edge connector have been made, replace edge connector No. 2 and recommence. As the work progresses, the cable looms will take shape and the loose ends will be tied up. However, where multiple connections are to be made, as on the routing switches and at the power supply bus-bars, the easiest course of action is to attach and solder all the connections simultaneously, and for this reason they are best left until the remainder of the wiring is completed.

**Next Month: Completing the wiring**
Fig. 14 (Above) 12V subsystem showing turntable and lamp remote switching relays (these are mounted under the turntables)
(Right) Output routing and monitor switching
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HERE is an electronic substitute for a polyphonic electromechanical keyswitch assembly. The 4416 is a quad bilateral switch. When a logical '0' is applied to all control inputs, switches A and D are open and switches B and C are closed. When a logical '1' is applied to all control inputs, the reverse happens – A and D are closed and B and C are open.

In my design there are two 4416 i.c.s for each keyboard contact. The keyboard can now use simple single pole contacts. When a keyboard contact is pressed, a logical '1' is supplied to the 4416s of that keyboard contact activating the s.p.d.t. switches, and that particular voltage is supplied to VCO1 hold. If any further keys are pressed they will supply simultaneously the relevant voltages to the VCO holds and so on. The voltage divider is now situated between the i.c.s and not on the keyboard contacts. (Power supply connections are omitted from the figure for simplicity – all pin 14s to +9V, pin 7s to 0V.)

The system only uses three of the s.p.d.t. switches, but it can be expanded to provide simultaneous programming for more. 8 or 10 notes played together might be feasible. Alternatively the unused s.p.d.t. switch can be used to provide the –ve voltage for the triggering of the envelope shapers etc. The ohmic resistance of the 4416 switches provides isolation for the VCO hold circuits. All the usual rules should be observed when handling CMOS i.c.s.

R. M. Pimlott,
Bexleyheath,
Kent.

A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought. Why not submit your idea? Any idea published will be awarded payment according to its merits. Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it has been tried and tested, is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere.

KEYBOARD SWITCHES
A TRUE PEAK-READING D.C. VOLTMETER

THE accompanying circuit shows a simple method of reading the peak rather than the average of a d.c. waveform. Of course, this may be applied to an a.c. signal simply by rectification prior to feeding the signal to this circuit. Two 741-type op-amps are used, in this case in the form of a dual device. The peak voltage is held in a capacitor $C_x$, which is charged further whenever the comparator IC1a detects that the input voltage exceeds the value on $C_x$. $D_2$ prevents reverse leakage into IC1a output, while $D_1$ restores the d.c. offset caused by $D_2$.

IC1b is a simple voltage follower to preserve the leakage resistance from $C_x$ at a high value. In fact, this value will be of the order of 10 megohms. With a 0.22µF capacitor at $C_x$, the time constant is of the order of 1.5 seconds, giving a good response to a music or audio signal. By using a value as high as 100µF (tantalum) at $C_x$, a “peak-hold” effect is obtained, with a time constant of some minutes. D.c. offset at the output has not been found to exceed a couple of mV, when using 2 x PP3 for the supplies. Supply-line current drain is about 4mA.

R. J. Crowther, Stourbridge, West Midlands.

SIMPLE PULSE GENERATOR

SHOWN is the circuit of a simple pulse generator which is useful for testing the operation of digital circuits. It uses a type 4011 CMOS integrated circuit and functions as follows.

The monostable formed from IC1a and IC1b is triggered by momentarily grounding pin 6 through $S_1$ and then generates a negative-going pulse of duration $T_1$, at output A, and a positive pulse, of duration $T_2$, at output B. With the component values shown $V_R_1$ will set the duration $T_1$ in the range 50 milliseconds to 1 second. If the triggering pulse or closure of $S_1$ has duration $T$ then for:

- $T < T_1$ then $T_1 = T$
- $T > T_1$ then $T_2 = T$

Thus output B can also provide a “de-bounced” digital signal corresponding to the position of $S_1$.

IC1c and d are interconnected to form an astable which can generate pulses of duration $T_3$ varying from about 2 to 100 milliseconds depending on the setting of $V_R_2$. With $S_2$ set to “Pulse” the astable is gated by output B and is therefore controlled by $S_1$ to give either a train of N pulses, where $N \approx T_2/T_3$, or a continuous pulse train at output C. If $S_2$ is set to “Run” then output C provides a continuous pulse train independent of $S_1$.

When $S_2$ is set to “Pulse” and $V_R_1$ at maximum, $V_R_2$ can be set so that $N = 1$ to 10. Output C can then be used to check a counter/decoder/display circuit, each momentary closure of $S_1$ advancing the counter system by N pulses.

Alternatively, with $S_1$ set to “Run”, output C can be used as a source of “clock” pulses, whilst outputs A and B are used for “gate” or “data” pulses. The supply voltage $V_+$ should be equal to that of the circuit under test and can conveniently be taken from the supply rails of the latter. Each output will drive two TTL or 20 CMOS inputs.

G. B. Wills, Ealing.
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Aug. 67
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Quiz Win Indicator by J. Sarns
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Nov. 69
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March 67
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May 60
Simple d.c. Power Controller by J. M. Lucas
May 60
Simple Pulse Generator by G. B. Wills
Dec. 65
Slave Flash Controller by R. C. Mackay
Sept. 68
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July 61
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June 53
Soldering Iron Controller by T. Austin
Sept. 68
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Dec. 65
Solderless Printed Circuit by R. J. Crowther
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Oct. 41
Shoot Game by L. Privett
Nov. 71
Simple d.c. Power Controller by J. M. Lucas
May 60
Simple d.c. Power Controller by G. B. Wills
Dec. 65
Simple Pulse Generator by G. B. Wills
Dec. 65
Slave Flash Controller by R. C. Mackay
Sept. 68
Stepset Sequencer by P. R. Williams
July 61
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June 53
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The biggest name in solder worldwide

Arax Multicore Solder.
Economy pack for general non-electrical use.
Replaces solid wire and stick solder. (B.S. 219 Grade L).
Econopak 200g reel of 3mm dia. Size 16A.
£4.14 per reel.

Toolbox Reels.
Multicore 5-core solder for general use. Suitable for electrical joints (B.S. 219 Grade C).
£3.91 per reel.

Savbit.
Multicore 5-core solder for radio, TV and similar work.
Reduces copper erosion. Suitable for service engineers and manufacturers using small quantities of solder.
1.2mm dia. Size 12. £3.91 per reel.

Handy Dispensers
Per pack
PC115 for printed circuits £1.15
SV130 for radio and TV repairs £1.61
AR140 for non-electrical applications, except aluminium £1.38
SS160 for stainless steel and silver jewellery £2.53
19A for printed circuit boards - non-corrosive 96p
AL150 for aluminium £1.93
BCA16 solder cream for stainless steel, jewellery and house hold products (non-electrical) £3.22
BCR10 solder cream for electronic and electrical use £1.38
BCA14 all purpose solder cream, non-electrical jointing and repairing £1.38

Multicore Wick.
Multicore solder-wick for removing solder from virtually any joint.
1.7mm dia. Size AB10. £1.38 per reel.

Soldering Flux Pastes.
Multicore soldering flux paste. Extra fast, non-corrosive, resin flux for electrical and general purpose soldering.
Rosin R130. 35g net 69p per pack.
Multicore soldering flux paste for soft metals (except aluminium) and stainless steel. Non-electrical.
Arax AF34. 35g 69p per pack.

Tip Kleen.
Multicore Tip Kleen.
Soldering iron tip wiping pad.
Replaces wet sponges. Should not be used above 350°C.
81p per pack.

Aluminium Soldering.
Alu-Sol Multicore 4-core solder for soldering most types of aluminium. No extra flux needed.
1.6mm dia. Size 4. £1.13 per reel.

Wire Stripper and cutter.
Wire stripper and cutter with precision ground and hardened steel jaws. Adjustable to most wire sizes.
With handle locking catch and easy-grip plastic covered handles.
Ref: 9. £2.69 per pair.

Econopak.
Econopak 5 Core solder. Contains non-corrosive flux for electrical applications.
1.2mm dia. 200g Econopak. Size 13A. £4.14 per reel.

Metal Soldering.
Arax Multicore 4 acid-core solder for metal fabrication (not aluminium) and repairs.
40/60 tin/lead. 1.6mm dia. Size 11. £3.91 per reel.

TV and Radio Soldering.
Savbit Multicore for radio, TV and similar work. Reduces copper erosion.
1.2mm dia. Size 5. £1.93 per handy dispenser.
Econopak General purpose solder suitable for all electrical joints.
40/60 alloy. 1.2mm dia. Size 6. 58p per handy plastic dispenser.

Products that help you make a better job of it.

All recommended retail prices shown are inclusive of VAT. If you have difficulty in obtaining any of these products send direct with 40p for postage and packing. For free colour brochure send S.A.E.
## SEMICONDUCTORS

### CERAMIC PAK

<table>
<thead>
<tr>
<th>Code</th>
<th>Value</th>
<th>Comment</th>
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<tr>
<td>16166</td>
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</tr>
<tr>
<td>16168</td>
<td>22 ohms 5%</td>
<td></td>
</tr>
<tr>
<td>16169</td>
<td>2.2 ohms 5%</td>
<td></td>
</tr>
<tr>
<td>16172</td>
<td>22 ohms 5%</td>
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</tr>
<tr>
<td>16173</td>
<td>2.2 ohms 5%</td>
<td></td>
</tr>
<tr>
<td>16176</td>
<td>80 ohms 5%</td>
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<tr>
<td>16178</td>
<td>1% 10k ohms</td>
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<tr>
<td>16180</td>
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<tr>
<td>16181</td>
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<td>16167</td>
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<tr>
<td>16168</td>
<td>5 percent resistor</td>
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<tr>
<td>16169</td>
<td>2.2nF capacitor</td>
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<tr>
<td>16170</td>
<td>1nF capacitor</td>
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<tr>
<td>16172</td>
<td>0.1uF capacitor</td>
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<tr>
<td>16173</td>
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<tr>
<td>16175</td>
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<td>16176</td>
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<td>1pF capacitor</td>
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</tr>
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### CMOS IC'S

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### CMOS IC'S

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<td>16231</td>
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### LINEAR IC'S

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<td>16219</td>
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### METAL FOIL CAPACITOR PAK

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<td>16204</td>
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<tr>
<td>16205</td>
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<tr>
<td>16206</td>
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<td>16207</td>
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### SLIDER PAKES

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<td>6 slider mixed</td>
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<tr>
<td>16191</td>
<td>6 slider mixed</td>
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<tr>
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## TRANSISTORS

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<td>16301</td>
<td>BC107</td>
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</tr>
<tr>
<td>16302</td>
<td>BC108</td>
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<tr>
<td>16303</td>
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<td>16304</td>
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<td>16305</td>
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<td>16306</td>
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## IC PAKS

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<tr>
<td>16220</td>
<td>60 mixed 820k ohms</td>
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<tr>
<td>16221</td>
<td>60 mixed 820k ohms</td>
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<td>16222</td>
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<tr>
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## ELECTROLYTIC PAKS

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## UNTESTED SEMI CONDUCTOR PAKES

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<td>16225</td>
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<tr>
<td>16227</td>
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## TANTALUM CAPACITORS

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<tr>
<td>16302</td>
<td>100nF 150V</td>
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<tr>
<td>16402</td>
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<tr>
<td>16403</td>
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## G.P. SILICON DIODES

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## ACCESSORIES

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<td>16703</td>
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## G.P. SWITCHING TRANSISTORS

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<tr>
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### Accessories

- Mammam IC PAK
- Jumbo PAK Semi Conductor
- Untested Semi Conductor PAKES
- Tantalum Capacitors
- Linear IC's
- Metal Foil Capacitor PAK
- Sliders PAKS
- Diodes
- G.P. Silicon Diodes
- G.P. Switching Transistors

---

Access & Barclaycard accepted. Giro a/c no. 388 7006. All prices include VAT.
Add 50p postage per order.

---

Practical Electronics  December 1980
SUPPLIES TO 10 Case  |  Price  
---|---
2034  |  £1.21
2035  |  £3.68
2040  |  £1.60
2041  |  £1.21
2175  |  £0.04

ACCESSORIES

ACCESSORIES  |  Price  
---|---
139  |  £9.72
140  |  £7.79
151  |  £0.21
166  |  £0.10
175  |  £0.08
213  |  £0.59
214  |  £0.71
224  |  £0.81

TERMINAL BLOCKS

TERMINAL BLOCKS  |  Price  
---|---
120  |  £0.08
121  |  £0.07
122  |  £0.06
123  |  £0.05
124  |  £0.04
125  |  £0.03
126  |  £0.02

ZENER DIODES

ZENER DIODES  |  Price  
---|---
1000  |  £0.47
1500  |  £0.71
2500  |  £1.43
5000  |  £2.85
10,000  |  £5.71

Terms cash with order. Cheques/Postal Orders made payable to Bi-Pak at above address.
YOUR SOUNDEST CONNECTION IN THE WORLD OF COMPONENTS AND COMPUTERS

PETS & SYSTEMS

NEW

32K with 80 col Screen £825
Twin Disk Drive 950K £995
All with new keyboard and green screen

Friction Feed Printer £375
Tractor Feed Printer £425

COMPLETE 32K SYSTEM £1789

MEMORY EXPANSION KIT

Suitable for UK101, Superboard expansion using 2114's each board has 16K ram capacity kit contains:

* On board power supply
* 4K Eprom expansion
* Fully buffered for easy expansion via 40 pin socket
* 8K kit £89.95
* 16K kit £122.95
* Printed Circuit Board £29.95
* 40 pin-40 pin header plug £8.50

CASES

Available for U.K. 101, Superboard Nascom. Appx. DIM. 17" x 15" 435 x 384 mm PRICE £24.50

Post + Packing £1.50

UK101 P.P.I.

Built & tested. Interfaces TX80 printer direct, can be programmed to operate relays, motors, various other peripherals. "Centronics compatible". Plugs into IC socket. LED binary display. Fully documented. £29.95

UK101

£179 IN KIT FORM
£229 READY BUILT & TESTED
£255 COMPLETE IN CASE (8x2114)

4K EXPANSION NOW ONLY £18.00

No extras required
★ Free sampler tape
★ Full Qwerty keyboard
★ 8K basic
★ Ram expandable to 8K on board (4K inc.)
★ Kansas City tape interface
★ New monitor allows full editing & cursor control £22.00

PRINTERS

EPSON TX-80 £349

Dot-matrix printer with Pet graphics interface: Centronics parallel, options: PET, Apple and serial.

Please add VAT 15% to all prices. Postage on computers, printers and cassette decks charged at cost, all other items P&P 30p. Place your order using your Access or Barclaycard (Min. tel order £5). Trade and export enquiries welcome, credit facilities arranged.
### NEW SHOP & SHOWROOM
**NOW OPEN**

**TELEPHONE 01-883 3705-01-883 2289**

**UK101 SOUND**

- Sound generator and combined parallel in out port kit containing P.C.B., AS-3-8910, 6520 PIA, fully documented and demo tape.

<table>
<thead>
<tr>
<th></th>
<th>£</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AY-3-8910</strong></td>
<td>29.95</td>
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</tbody>
</table>

**Price List or Phone 01-883 3705**

**OTHER ELECTRONICS**

- **Assembler Editor**
- **Screen Monitor**
- **Game Pack III**
- **Game Pack II**
- **Game Pack**
- **Othello**
- **Chequers**
- **Real Time Clock**
- **Space Invaders**
- **AY -3-8910 demo tape.**
- **PIA,**

**CPU**

- **Z80 2.5 Meg**
- **Z80A 4 Meg**
- **6502**
- **6800**
- **8080**
- **8090**

**SUPPORT CHIPS**

- **Z80 CTC**
- **Z80A CTC**
- **Z80 PIO**
- **280 A PIO**
- **6520**
- **6532**
- **6821**
- **6850**
- **6852**
- **8212**
- **8216**
- **8224**
- **8228**
- **8251**
- **8253**
- **8255**
- **TM59901**
- **TM59902**
- **TM59904 (2465362)**

**MEMORY**

- **D. RAMS**
- **S. RAMS**

<table>
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<tr>
<th>RAM Type</th>
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<tr>
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<td>2112A</td>
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<td>2114/4045</td>
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<td>4035</td>
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**EPROMS**

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**EPROMS**

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**EPROMS**

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**IC Sockets**

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**BUFFERS**

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**UARTS**

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<td>AY-3-1015</td>
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<td>TMS6011</td>
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**BAUD RATE GENS**

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<tr>
<td>MC14411</td>
<td>8.75</td>
</tr>
<tr>
<td>MMS307</td>
<td>8.75</td>
</tr>
</tbody>
</table>

**Price List or Phone 01-883 3705**

**ESTABLISHED 1975**

**ALL THESE ADVANTAGES...**

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

**..in kit form**

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

The superb technical design of the Sparkrite circuit eliminates problems of the contact breaker. There is no mistake due to contact breaker bounce which is eliminated electronically by a pulse suppression circuit which prevents the unit firing if the points bounce open at high R.P.M. Contact breaker burn is eliminated by reducing the current by 95% of the norm. There is also a unique extended dwell circuit which allows the coil a longer period of time to store its energy before discharging to the plugs. The unit includes a built-in timing light, function light, and security changeover switch. Will work all rev counters.

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

**THE KIT COMPRISES EVERYTHING NEEDED**

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

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

**SPARKRITE HIGH PERFORMANCE ELECTRONIC IGNITION**

**Electronics Design Associates, Dept. PE 12/80, 82 Bath St., Walsall, WS1 3DE**

**QUANTITY RQD**

<table>
<thead>
<tr>
<th>Item</th>
<th>QUANTITY RQD</th>
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<tbody>
<tr>
<td>X5KIT</td>
<td>£16.95</td>
</tr>
</tbody>
</table>

**SEND S.A.E. FOR COMPLETE PRICE LIST OR PHONE 01-883 3705**

Practical Electronics December 1980
**CLEFT KITS**

P.E. MASTER RHYTHM

A User Programmable Rhythm generator for creating up to 24 versatile patterns on eight tracks. Three programmation settings select from twelve instruments, and sequence variation gives up to 16 bar pattern groups.

**COMPONENT KIT - £75**

**ELECTRONIC ROTOR**

Three stage high simulation plus a three phase chorus generator. Easily integrated with existing system.

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| **49 NOTE C-E** | £33.80 |
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All Keyboards are easily cut to provide your required length and compass. Quantity enquiries welcome.

**BUILDING SERVICE**

We are specialists in Electronic Piano Manufacture and can build your Piano for you.

**INFORMATION**

Please send SAE quoting items of interest. Telephone (BARCLAYS) orders can be accepted for all prices include V.A.T., carriage & insurance.

**SHOWROOM** - 64a Bromhall Lane South.

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Enquiries welcome — in Australia please contact J.T. TAYLOR and CO. LONDON.

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### CLEFT PRODUCTS (ELECTRONICS LIMITED)

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**QUALITY REEL TO REEL & CASSETTE TAPE HEADS & MECHANISMS**

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| **81-03 Stereo Recording** | £39.00 |
| **81-04 Mono Playback** | £39.00 |
| **81-05 Mono Playback** | £39.00 |
| **81-06 Stereo Recording** | £39.00 |
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- **Profusely illustrated throughout.**
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**interface Components Limited**

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Casio and Seiko watches are water resistant and won't drown in the rain. They do not eat expensive batteries. The quality cases won't wear your cuffs away, nor will plating wear off in a few months. Unlike the usual plastic type, the mineral glass faces will not easily scratch or mark. The high quality modules have a failure rate of around 1% or less - not 25% or more. They are guaranteed accurate and functions do not interact. Spares and servicing are available after the guarantee expires from UK service departments.

**THE ULTIMATE WATCHES**

**CASIO’S giant step forward in time.**

**AA81****

**LCD ANALOGUE/DIGITAL**

**Alarm Chronograph with countdown**


**ONLY £29.95**

For around 40 functions.

**12 MELODY ALARM CHRONOGRAPHS**

**Countdown alarm. Date memories.**

Hours, minutes, seconds, am/pm, 12 or 24 hour. Day, date and month calendar. Alarm. 7 melodies, one for each day of the week. Date memory. Select either “Wedding March” or Hourly time signals. With “Big Ben” type tune. Alarm. 7 melodies, one for each day of the week. Net, lap and 1st and 2nd place. Start/stop and 10 minute signal. Alarm. For 30 seconds with custom display. Countdown Alarm. Normal and set times to 1 hour, with amazing “Star Burst” flashing display. Time signal. Half hourly and hourly chimes. Tone control, battery, light, 12/24 hour. Resin case. £29.95.

**ONLY £29.95**

For around 40 functions.

**100 METRE WATER RESISTANT**


**£24.95**

For around 40 functions.

**12 PRE-PROGRAMMED MELODIES**


**£29.95**

For around 40 functions.

**12 PRE-PROGRAMMED MELODIES**


**£24.95**

For around 40 functions.

**SEIKO ALARM CHRONOS**

FROM £37.50.

DPT 048 (left) Alarm, countdown alarm, hourly chimes. 100 second stopwatch. £24.95. £29.95. DPT 038 100 meter water resistant version £49.95.

**£37.50**

DOU DISPLAY Analogue/digital watches from £57.50.

**TEMPUS**

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Price includes VAT and P&P.
Keelmoor Ltd is a company which has been established for a long time — we supply the products you have often bought from other companies. Our precision watches and electrical goods are renowned for their superb quality and reliability. We differ from other companies in that we import direct world-wide — that difference is passed on to you at unbeatable prices. You receive the goods faster and we provide a service and no catch guarantee of which we are justly proud.

We employ experts world-wide whose job it is to seek out products of the highest quality at the lowest possible prices. Illustrated here is just a tiny selection of our comprehensive range. Just compare these items with those seen elsewhere — we are confident the prices will amaze you. You can save $$$'s.

**GENTS 5 FUNCTION LCD**

This is the foundation of our range and is ideal for the man requiring the basic functions of hours, minutes and seconds, with month and date. A backlight is included and the stainless steel strap provided is fully adjusted to suit any size of wrist. Guaranteed for one year, this watch represents fantastic value at only £4.95p.

**ILLUSTRATED BELOW IS THE LADIES 5 FUNCTION LCD.**

This watch has the same time and auto calendar functions as the basic gents model described above, together with backlight and adjustable strap to suit the daintiest of wrists. It's compact, pleasing appearance makes it a very practical day watch and it is also often used for boys and girls. Available in black or white face.

These are just a few of our fantastic offers remember. A free colour catalogue is posted with every order. Or just send large S.A.E. and we'll send you one.

**GENTS LCD ALARM WATCH**

This model represents fantastic, incredible value for money. The 6 digit display continuously shows hours, minutes and seconds, or may be changed at will to hours, minutes and date. Its effective alarm is extremely useful and may be set to any time within a 24 hr. period. In addition, there is an alarm indicator, 4 year calendar and snooze repeater.

**FULLY GUARANTEED**

We must emphasize all these items are fully guaranteed for one year. All electronic goods come complete with demonstration batteries which cannot be guaranteed. New batteries are available for only 60p.

**THE ULTIMATE GENTS LCD CALCULATOR/ALARM WATCH**

If you want a watch from the top end of the market this is the one for you. Full calculator functions plus memory and percentage are combined with time and alarm functions to make this item an outstanding buy. Manufactured in Japan at the same factory that produces models for probably the most famous name in the watch business, this device represents sheer quality at an unbelievable price. Comes complete with backlight and button operating tool carried in the strap clasp. We advise you to order quickly whilst stocks last.

**£39.95p**

**Here is the amazing 12/24 hour alarm/chronograph**

Along with the usual time and date displays, this multi-functional timepiece has a 24 hour alarm and a second stopwatch. The time may be set to operate in 12 or 24 hour mode and the date can be in English or American format. The day of the week is continuously indicated and the stopwatch display may, on command, be frozen to show split/lap time while the stopwatch continues to run. Stopwatch operation does not affect normal time keeping. £12.95 only for this model. Also available with solar energy panel to conserve energy during daylight hours for £14.95.

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at Keener Prices

We don’t think you’ll find items of this quality anywhere else at the price we offer. Order now, Christmas is round the corner and this is the way to make gift buying easier — and cheaper too.

WE ARE PROUD TO INTRODUCE THE AMAZING MELODY ALARM CHRONOGRAPH

ACTUALLY PLAYS

THE YELLOW ROSE OF TEXAS

BUT AS YOU CAN SEE FROM THE DETAILS BELOW THIS CHRONOGRAPH IS NO MERE NOVELTY

Today’s technology has produced this fine watch which incorporates a musical alarm which plays a complete verse of ‘The Yellow Rose of Texas’. Other functions included are as for model number 1 with stop watch.

G

£14.95p

NEW TO OUR RANGE, WE COMBINE PRECISION AND STYLE IN THIS—THE SUPER SLIM GENTS 5 FUNCTION CHRONOGRAPH

JUST TO GIVE YOU AN IDEA OF THE ULTRA SLIMNESS OF THESE WATCHES WE HAVE ILLUSTRATED A SIDE VIEW OF THE SUPERSLIM DIGITAL. BELOW, WE HAVE ELABORATED ON SOME OF THE TECHNICALITIES:

These watches need no special functions to make them stand out in a crowd — their slimness serves that purpose. If you’ve been put off digital quartz watches in the past because you require an ultra-slim design, now is the time to change. Is equipped with standard 5 functions and backlight.

£9.95p

AND FINALLY, WHAT MUST BE THE ULTIMATE IN SQUEEZING A QUART INTO A HALF PINT POT! THE INCREDIBLE MINIATURE LCD TRAVEL/ALARM CLOCK

As you can see from the photograph above this device is tiny and yet it continuously displays hours and minutes with auto calendar and night light. Invaluable for the busy traveller or simply for use in the modern home, it comes complete with its own travelling case and can easily be carried in top pocket or the smallest of handbags. It has even got a stand for upright position on table, shelf or sleeping compartment. An unusual gift to yourself or others at only £10.95.

£10.95p

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Keelmoor Ltd, 78 Castle Street, Melbourne, Derbyshire, DE7 1DQ.

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Keelmoor have a tremendous reputation to uphold both in the retail and wholesale trades and so, with every product sold, we automatically give the Keelmoor Promise. This includes —

• NO RISK GUARANTEE

Try any of these items for 15 days and if you are not completely satisfied with the quality and value simply return it for a complete refund.

• ONE YEAR’S FULL GUARANTEE on all products

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Big colourful Keelmoor catalogue featuring hundreds of products at bargain prices.

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Please send me the items indicated in the boxes below. I understand that if I am not completely satisfied, I may return the goods undamaged within 15 days and my money will be refunded in full.

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NAME Mrs. Miss. Mr. Ms.

ADDRESS

TOTAL — £

Please add 50p per item P&P.

The advertisements to watch for quality precision at the right prices.
3 CHANNEL SOUND/LIGHT CHASER
LB31000SL £29.90

A high performance sound to light system which automatically switches to a chase when the music slows. Super sensitive with an anti interference circuit, the unit will operate from practically any amp and control up to 1,000W/square foot. 24V to 240V. Controls: bass/mid/treble/master sensitivity. Please state when ordering.

3 CHANNEL SOUND/LIGHT CHASER
LB31000SL £21.40

All the advantages of the SLC without Chase. Controls: bass/mid/treble/master sensitivity.

2/4/8 CHANNEL CHASER
LB41000CL £26.50

4 Channel sequencer
For banks of lamps up to 500W per channel. Two speed control, cross fader to provide settings between seconds and equal burst.

A new channel sequencer generator for banks of lamps up to 500W per channel. Two speed control, cross fader to provide settings between seconds and equal burst.

POWER AMPLIFIERS

Tough driving power amps to suit your systems. Operating point crossover and protection. Medium grade transistors and rugged op devices (all operating down to 4 ohms).

SET L1D £17.50

A stereo h.p. preamp and tone stage for mag., guitars, etc. Can be used with any LB amps. Set of pots £3.47. Includes £4.49. Includes £5.25.

STEREO DISCO MIXER/PREAMP
LBPA3 £30.70

A high performance sound to light system which automatically switches to a chase when the music slows. Super sensitive with an anti interference circuit, the unit will operate from practically any amp and control up to 1,000W/square foot. 24V to 240V. Controls: bass/mid/treble/master sensitivity. Please state when ordering.

A high performance sound to light system which automatically switches to a chase when the music slows. Super sensitive with an anti interference circuit, the unit will operate from practically any amp and control up to 1,000W/square foot.

MINIATURE TRANSFORMERS

Don't let your environment dehydrate teel. As we have

STEREO DISCO MIXER/PREAMP
LBPA3 £30.70

A high performance sound to light system which automatically switches to a chase when the music slows. Super sensitive with an anti interference circuit, the unit will operate from practically any amp and control up to 1,000W/square foot. 24V to 240V. Controls: bass/mid/treble/master sensitivity. Please state when ordering.

MINIATURE TRANSFORMERS

Don't let your environment dehydrate teel. As we have
Guys who builds this great

Logic Probe...YOU for only £11.92

With this easy-to-build Logic Probe Kit from CSC and just a few hours of easy assembly—thanks to our very descriptive step-by-step manual—you have a full performance logic probe.

With it, the logic level in a digital circuit is indicated by light from the Hi or Lo LED; pulses as narrow as 300 nanoseconds are stretched into blinks of the Pulse LED, triggered from either leading edge. You'll be able to probe deeper into logic with the LPK-1, one of the best tools from CSC.

CONTINENTAL SPECIALTIES CORPORATION

C.S.C. (UK) Limited, Dept. 52
Unit 1, Shire Hill Industrial Estate, Saffron Walden, Essex. CB1 3AQ
Telephone: Saffron Walden (0799) 21682
Telex: 817477.
### MINI KITS

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

#### MK1 TEMPERATURE CONTROLLER/CHANGER

Uses LM3911 IC to sense temperature (60°C max) and triac to switch heater. Uses LM3911 IC to sense temperature (60°C max) and triac to switch heater.

#### MK2 SOLID STATE RELAY

Supplied without triac. Select the required component from the table below.

<table>
<thead>
<tr>
<th>Current</th>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5A</td>
<td>DVM</td>
<td>£20.00</td>
</tr>
<tr>
<td>1A</td>
<td>DVM</td>
<td>£25.00</td>
</tr>
<tr>
<td>1.5A</td>
<td>DVM</td>
<td>£30.00</td>
</tr>
<tr>
<td>2A</td>
<td>DVM</td>
<td>£35.00</td>
</tr>
</tbody>
</table>

 sexuales operation up to 1Kw on and off at preset times over 24 day periods. May be realised by minor component from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component from 20 minutes to 35 hours. Longer or shorter periods may be realised by minor component from 20 minutes to 35 hours. 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IN EASY REACH OF ALL THE MAJOR NORTHERN ROUTES, (M1, M62, M61, M18, A1, A38 ETC.). NO PARKING PROBLEMS AS OUR MODERN SHOWROOM IS ADJACENT TO THE MAIN MULTI-STOREY CAR PARK. PHONE US, AND WE WILL DIRECT YOU PERSONALLY TO OUR DOOR!

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**WERSI**

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CLASSICAL CHURCH MODEL

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**CHOOSE AN I.L.P MOSFET POWER AMP** when it is advantageous to have a faster slew rate, lower distortion at higher frequencies, enhanced thermal stability, the ability to work with complex loads without difficulty and complete absence of cross-over distortion. I.L.P's exclusive encapsulation technique within fully adequate heatsinks has been taken a stage further with specially developed computer-verified 'New Profile' extrusions. These ensure optimum operating efficiency from our new MOSFETS, and are easier to mount. Connections are via five pins on the underside.

I.L.P MOSFETS ARE IDENTICAL IN PERFORMANCE TO THE COSTLIEST AMPLIFIERS IN THIS EXCITING NEW CATEGORY BUT ARE ONLY A FRACTION OF PRICES CHARGED ELSEWHERE.

<table>
<thead>
<tr>
<th>Model</th>
<th>Output Power RMS</th>
<th>Distortion Typical at 1KHz</th>
<th>Slew Rate</th>
<th>Rise Time</th>
<th>Signal/Noise Ratio DIN AUDIO</th>
<th>Price &amp; VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOS120</td>
<td>60W into 4-8Ω</td>
<td>0.005%</td>
<td>20V/µs</td>
<td>3µs</td>
<td>100dB</td>
<td>£25.68 + £3.88</td>
</tr>
<tr>
<td>MOS200</td>
<td>120W into 4-8Ω</td>
<td>0.005%</td>
<td>20V/µs</td>
<td>3µs</td>
<td>100dB</td>
<td>£32.46 + £5.02</td>
</tr>
</tbody>
</table>

**BIPOLAR**

**CHOOSE AN I.L.P BIPOLAR POWER AMP** where power and price are first consideration while maintaining optimum performance with hi-fi quality and wide choice of models. From domestic hi-fi to disco and P.A., for instrument amplification, there is an I.L.P Bipolar to fill the bill, and as with our new MOSFETS, we have encapsulated Bipolars within our New Profile extrusions with their computer-verified thermal efficiency and improved mounting shoulders. Connections are simple, via live pins on the underside and with our newest pre-amps and power supply units, it becomes easier than ever to have a system layout housed the way you want it.

**ILP POWER AMPS ARE ENCAPSULATED FOR THERMAL STABILITY AND LONGER LIFE**

<table>
<thead>
<tr>
<th>Model</th>
<th>Output Power RMS</th>
<th>Distortion Typical at 1KHz</th>
<th>Slew Rate</th>
<th>Rise Time</th>
<th>Signal/Noise Ratio DIN AUDIO</th>
<th>Price &amp; VAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>HY30</td>
<td>15W into 4-8Ω</td>
<td>0.015%</td>
<td>15V/µs</td>
<td>5µs</td>
<td>100dB</td>
<td>£6.34 + £9.50</td>
</tr>
<tr>
<td>HY60</td>
<td>30W into 4-8Ω</td>
<td>0.015%</td>
<td>15V/µs</td>
<td>5µs</td>
<td>100dB</td>
<td>£7.24 + £1.09</td>
</tr>
<tr>
<td>HY120</td>
<td>60W into 4-8Ω</td>
<td>0.01%</td>
<td>15V/µs</td>
<td>5µs</td>
<td>100dB</td>
<td>£15.20 + £2.28</td>
</tr>
<tr>
<td>HY200</td>
<td>120W into 4-8Ω</td>
<td>0.01%</td>
<td>15V/µs</td>
<td>5µs</td>
<td>100dB</td>
<td>£18.44 + £2.77</td>
</tr>
<tr>
<td>HY400</td>
<td>240W into 4Ω</td>
<td>0.01%</td>
<td>15V/µs</td>
<td>5µs</td>
<td>100dB</td>
<td>£27.68 + £4.15</td>
</tr>
</tbody>
</table>

**The New Profile Extrusions**

The introduction of standard heatsink extrusion for all I.L.P power amplifiers achieves many advantages: - Research shows they provide optimum thermal dissipation and stability. Slotted shoulders allow easy mounting; standardisation enables us to keep our prices competitive. Surfaces are matt black, anodised for lower thermal conductivity. Extrusions vary in size according to module number.
NEW PRE-AMPS

HY6 (mono) and HY66 (stereo) are new to I.L.P's range of advanced audio modules. Their improved characteristics and styling ensure their being compatible with all I.L.P power-amps both MOSFET and BIPOLAR, giving you chance to get the best possible reproduction from your equipment. HY6 and HY66 pre-amps are protected against short circuit and wrong polarity. Full assembly instructions are provided. Mounting boards are available as below:

Sizes
- HY6 - 45 x 20 x 40 mm
- HY66 - 90 x 20 x 40 mm

Active Tone Control circuits provide +12dB cut and boost.

Inputs Sensitivity
- Mag. PU. -3mV: Mic - selectable 1-12mV: All others 100mV

Tape O/P - 100mV: Main O/P - 500mV

Frequency response - D.C. to 100KHz - 3dB.

HY6 mono £5.60 + 84p VAT Connectors included
HY66 stereo £10.60 + 1.59 VAT Connectors included
B6 Mounting Board for one HY6 78p + 12p VAT
B66 Mounting Board for one HY66 99p + 15p VAT

NEW POWER SUPPLY UNITS

Of the eleven power supply units which comprise our current range, nine have toroidal transformers made in our own factory. Thus those I.L.P power supply units are space-saving, more efficient and their better overall design helps enormously when assembly building. All models in the range are compatible with all I.L.P amps and pre-amps with types to match whatever I.L.P power amp you choose.

- PSU30 ±15V at 100mA to drive up to 12 x HY6 or 6 x HY66 £4.50 + 0.68p VAT
- PSU36 for use with 1 or 2 HY30's £8.10 + £1.22 VAT
- All the following use toroidal transformers
- PSU50 for use with 1 or 2 HY60's £9.75 + £1.46 VAT
- PSU60 for use with HY120 £9.75 + £1.46 VAT
- PSU65 for use with MOS120 £9.75 + £1.46 VAT
- PSU70 for use with 1 or 2 HY120's £13.61 + £2.04 VAT
- PSU75 for use with 1 or 2 MOS120 £13.61 + £2.04 VAT
- PSU90 for use with HY200 £13.61 + £2.04 VAT
- PSU95 for use with MOS200 £14.75 + £2.21 VAT
- PSU180 for use with HY400 or 2 HY200 £23.02 + £3.45 VAT
- PSU185 for use with 1 or 2 MOS200 £24.20 + £3.63 VAT

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When, in 1971, Ian L. Potts founded his now world-famous company, he saw the need for a different and more rational approach to exploiting to the full, the potential that lay in modular construction. New thinking was badly needed. The result was a range of modules revolutionary in concept. The rightness of this new thinking is shown by the size of the company today, its new factory, its vast exports, its acceptance by constructors as the modules to build with. The range grows bigger and better. Exciting new lines (in no way conflicting with existing ones) are well past drawing board stage. This is why I.L.P are simply ahead and staying there.

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AC/DC CURRENT 22 RANGES

6100
6200

CHOOSE FROM FOUR MODELS
- 3½ digit autoranging (volts/Ohms)
- 200 hours battery life (2 pencells)
- 10 amp AC/DC (6220 & 6100)
- 1000v DC 600v AC
- 200 mA AC/DC (6200 & 6100)
- Range hold facility (6100 & 6110)
- Unit and range sign (6110 & 6220)
- Continuity buzzer (6100 & 6110)

RESOLUTION
100 μV, 1 milliV
10 μA AC/DC, 0.1 Ohm
10 mA on 10A AC/DC

ACCUARCY 6100/6110
- 0.05% DC Volts
- 0.1% DC Current
- 0.5% Resistance

OTHER FEATURES
- Low power Ohms range.
- Zero Adjust key.
- Battery Warning.

In circuit resistance test.
Size 155 x 85 x 28 mm. 260 g.
Order by post or telephone with Barclay or Access.

RESOLUTION
200 μV
200 μA AC/DC
200 mA AC/DC
1000v DC

ACCUARCY 6200/6220
- 0.8% DC Volts
- 1.3% DC Current
- 1.4% AC Current
- 0.6% Resistance

OTHER FEATURES
- Range hold facility.
- Unit and range sign.
- Continuity buzzer.
- Battery Warning.

In circuit resistance test.
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Order by post or telephone with Barclay or Access.

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Surefire has sold in its thousands in ready made form from big name accessory firms, but it is now available in quality kit form to fit all vehicles with coil ignition up to 8 cylinders.

ES200: A high performance inductive discharge ignition incorporating a power integrated circuit (special selection), electronic variable dwell circuit (maximises spark energy at all speeds) pulse processor (overcomes contact breaker problems), coil governor (projects coil) Long burn output. Negative earth only. Compatible with most rev. counters. (Low cost adaptors available for rare cases. Application list enclosed with each kit. Note: Vehicles with Smiths/ Jaeger rev. counters code RVI on dial will require adaptor type TCI).

What's in the kits. Surefire's own precision anodised aluminium extruded case. P.C. mounted security changeover switch, static timing light, Special selection Motorola semi-conductors, Capacitors, resistors etc. selected after 5 years experience. Glass fibre pcb, solder, complete down to last washer. Fully illustrated comprehensive instructions and full technical back up service.

C300/ES200 £39.95
C300 £49.95
C300 neg £39.95
C300 pos £49.95
Tacho Adapt. TCI £3.90

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Address ................................................................

Please supply ... Qty ... Models
WE enclose (incl. 65p post)
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Or debit Barclay/Access No.
If you’re into MICROPROCESSORS then they should be into an M P UroBreadBoard

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**Only £15**

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- MPU Section accepts 24, 28, 40 & 64 pin DIL microprocessors
- Auxiliary Areas accept any .3” or .6” RAM, ROM or peripheral chip
- Power Bus Strips on all sides
- 5 incoming turret Power Terminals
- 20 AMP DIODES untested £60
- 20 WAY LUCAR TAG CONNECTING BLOCK £60
- POWER TRANSISTORS 2N700 £4.00, 2N701 £4.00
- PLASTIC BC 108 or BC 212 TRANSISTORS £5.00 for 50p

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- POWER TRANSISTORS 2N700 £4.00, 2N701 £4.00
- PLASTIC BC 108 or BC 212 TRANSISTORS £5.00 for 50p
AS DESCRIBED IN THIS ISSUE OF P.E.

The basic speech boards which we offer provide fixed 24 or 64 word highly intelligible vocabularies at a remarkably low cost. The unit is based around the excellent Telesensory Instruments (TSI) speech products for which Modus is the sole UK distributor. These boards require a TTL interface, binary latches, special power supply, audio band-pass filter, edge-connector, plug and socket to driving computer or logic system. All this is included on a speech unit based around the excellent Telesensory Instruments (TSI) speech products for which Modus is the sole UK distributor.

SPEECH SETS AND PRICES:

<table>
<thead>
<tr>
<th>S2A (24-words)</th>
<th>S2C (64 words)</th>
</tr>
</thead>
<tbody>
<tr>
<td>£39.95 + VAT</td>
<td>£80.95 + VAT</td>
</tr>
</tbody>
</table>

THE EDUKIT

The EDUKIT has proven a great success providing an excellent introduction to silicon chip technology from the bottom upwards. Many schools and colleges are using the kit, and sales now extend worldwide. The machine is not designed to form the basis of a large and expandable personal computer system. The EDUKIT teaches all those things which a purely BASIC running machine cannot. I.e. the basis of hardware electronic control, down-to-earth Bits and Bytes, Machine Code etc. – and all this at a truly throw-away price. The manual is written by Dr. A. A. Berk to impart educational understanding from the beginning.

2192 USER'S MANUAL (essential for full understanding of MPU used in EDUKIT)

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<th>SECONDARY RMS CURRENT</th>
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<tr>
<td>1X010</td>
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<td>2.30</td>
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<tr>
<td>1X011</td>
<td>9 + 9</td>
<td>1.66</td>
</tr>
<tr>
<td>1X012</td>
<td>12 + 12</td>
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<td>0.60</td>
</tr>
<tr>
<td>1X017</td>
<td>30 + 30</td>
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- Weight: 0.9 Kg
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<tr>
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<th>SECONDARY RMS CURRENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2X010</td>
<td>6 + 6</td>
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</tr>
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<td>30 + 30</td>
<td>0.03</td>
</tr>
<tr>
<td>2X018</td>
<td>35 + 35</td>
<td>0.03</td>
</tr>
</tbody>
</table>

### 80VA

- 90mm dia. x 30mm
- Weight: 1 Kg
- **£5.76**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>SECONDARY RMS VOLTS</th>
<th>SECONDARY RMS CURRENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>3X010</td>
<td>6 + 6</td>
<td>0.64</td>
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<tr>
<td>3X011</td>
<td>9 + 9</td>
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<td>3X013</td>
<td>15 + 15</td>
<td>0.27</td>
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<tr>
<td>3X014</td>
<td>18 + 18</td>
<td>0.22</td>
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<tr>
<td>3X016</td>
<td>22 + 22</td>
<td>0.22</td>
</tr>
<tr>
<td>3X018</td>
<td>25 + 25</td>
<td>0.22</td>
</tr>
<tr>
<td>3X020</td>
<td>30 + 30</td>
<td>0.19</td>
</tr>
<tr>
<td>3X029</td>
<td>110</td>
<td>0.06</td>
</tr>
<tr>
<td>3X030</td>
<td>240</td>
<td>0.03</td>
</tr>
</tbody>
</table>

### 120VA

- 90mm dia. x 40mm
- Weight: 1.2 Kg
- **£6.72**

<table>
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<th>TYPE</th>
<th>SECONDARY RMS VOLTS</th>
<th>SECONDARY RMS CURRENT</th>
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<tr>
<td>4X011</td>
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<td>4X014</td>
<td>18 + 18</td>
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<tr>
<td>4X016</td>
<td>22 + 22</td>
<td>0.27</td>
</tr>
<tr>
<td>4X018</td>
<td>25 + 25</td>
<td>0.20</td>
</tr>
<tr>
<td>4X020</td>
<td>30 + 30</td>
<td>0.14</td>
</tr>
<tr>
<td>4X029</td>
<td>110</td>
<td>0.06</td>
</tr>
<tr>
<td>4X030</td>
<td>240</td>
<td>0.03</td>
</tr>
</tbody>
</table>

### 160VA

- 110mm dia. x 40mm
- Weight: 1.8 Kg
- **£8.88**

<table>
<thead>
<tr>
<th>TYPE</th>
<th>SECONDARY RMS VOLTS</th>
<th>SECONDARY RMS CURRENT</th>
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<tr>
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<td>5X014</td>
<td>18 + 18</td>
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<tr>
<td>5X016</td>
<td>22 + 22</td>
<td>2.00</td>
</tr>
<tr>
<td>5X018</td>
<td>25 + 25</td>
<td>1.50</td>
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<tr>
<td>5X020</td>
<td>30 + 30</td>
<td>1.00</td>
</tr>
<tr>
<td>5X029</td>
<td>110</td>
<td>0.60</td>
</tr>
<tr>
<td>5X030</td>
<td>240</td>
<td>0.40</td>
</tr>
</tbody>
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