"With the right connections I could control this town"

Into the REAL WORLD...
Control Circuits

Plus - BATTERY to MAINS INVERTER and MICROFILE
New developments in UK Robotics

ADVANCED DESIGNS FOR EDUCATION, INDUSTRY AND THE HOME CONSTRUCTOR

Robotic experience is becoming as essential a subject as computing. MICROGRASP provides the lowest cost means of acquiring that experience but despite its ultra low price the robot has considerable versatility. There are 5 axes each using a servo motor and there is feedback from each of the arm movements. Control is by any computer with an expansion bus – the ZX81 being particularly suitable. Servoing is achieved with hardware on the interface board to keep programming simple and the robot is operated under BASIC commands with no computer-specific software required. The interface board is memory mapped using only 64 bytes at any of 1024 switch selectable locations.

MICROGRASP robot kit with power supply £125.00
Universal computer interface board kit £48.50
23 way edge connector £2.50
ZX81 peripheral/RAM Pack splitter board £3.00

HEBOT II is a turtle-type robot which takes programming out of the two dimensional world of the VDU into the real three dimensional world. Given a DC supply of 9-15V it can perform a bewildering number of moves under computer control – forwards, backwards, left and right – with each wheel independently controlled. It has blinking eyes, beeps with a choice of two tones and has a solenoid operated pen to chart its progress. Touch sensors coupled to its shell return data, about its environment, to the computer for it to calculate evasive or exploratory action. HEBOT II connects directly to an I/O port or alternatively with the universal interface board to the expansion bus of a ZX81 or other computer.

HEBOT II kit
Universal computer interface board
23 way edge connector
ZX81 peripheral/RAM Pack splitter board

GENESIS S101 AND GENESIS P101 WITH PROCESSOR BOXES AND HAND-HELD CONTROLLERS

With prices starting below £1,000 the Genesis range of general purpose robots provide a first rate introduction to robotics for both education and industry. Each has a self-contained hydraulic power source, which enables loads of several pounds to be smoothly handled. The system operates from a single phase 240 or 120V AC supply or a 12V DC supply. The machine can be supplied with up to 6 axes each of which is fully independent but capable of simultaneous operation. Position control is achieved by means of a closed-loop feedback system based around a dedicated microprocessor. Movement sequences can be entered, stored and replayed by use of a hand held controller, alternatively the systems can also be interfaced to an external computer via a standard RS 232C link.

Example prices and specifications

Genesis S101
Base: 19.5" x 11" x 7.5"
Lifting capacity: 1500gm
Arm lift: 8.6'
Weight: 29Kg
4 axis model in kit form £390
5 axis model in kit form £445
5 axis model READY BUILT £790

Genesis P101
Base: 19.5" x 11" x 7.5"
Lifting capacity: 2000gm
Arm lengths between axles 14.0'
Weight: 34Kg
4 axis model in kit form £495
6 axis model in kit form £595
6 axis model READY BUILT £960

COMPLETE SYSTEMS AS SHOWN IN PHOTOGRAPH ABOVE

Genesis S101
4 axis system in kit form £835.50
5 axis system in kit form £895.00
5 axis system READY BUILT £1395.00

Genesis P101
4 axis system in kit form £742.00
6 axis system in kit form £852.00
6 axis system READY BUILT £1525.00

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SEMICONDUCTOR UPDATE by R. W. Coles  
Featuring the Am 7910, LC502, Micro/J11  
PROGRAMMABLE UNIJUNCTION TRANSISTORS by P. Gatehouse  
A few PUTs are a useful investment  
INGENIETY UNLIMITED  
Short-cut to ‘short’ detection—Cassette tape timer—Low cost multiple bargraph driver  
MICROPROMPT  
Hardware and software ideas for PE computer projects

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PE MICROCONTROLLER: DATA SHEET 1 by M. Tooley BA and D. Whitfield MA, MSc  
SPECIAL OFFER—CASSETTES  
STRICTLY INSTRUMENTAL by K. Lenton-Smith  
Konosuke Matsushita and the SX-U90P

SPECIAL SUPPLEMENT

MICRO-FILE by R. W. Coles  
Filesheet 4  
between pages 38 and 39

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BIPOLAR MODULES

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<td>18/24</td>
<td>160</td>
<td>290</td>
<td>£37.00</td>
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- MOSFET: 125
- MOSFET: 126
- MOSFET: 35
- MOSFET: 36

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<th>Hi Fi Separates</th>
<th>Price inc.</th>
<th>VAT</th>
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<td>30 x 30/4-8Ω</td>
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<tr>
<td>UP2X</td>
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| Power Slaves | 60W/4Ω | Bipolar | Power Slave | £59.95 |
| US2X | 120W/4Ω | Bipolar | Power Slave | £79.95 |
| US3X | 60W/8Ω | MOS | Power Slave | £69.95 |
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MINIATURE TOOLS FOR HOBBYISTS

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<td>Clip driver</td>
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<td>Digital Volt Meter Module</td>
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<td>Silicon Bridge Rectifiers</td>
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<td>MOS Power Processors</td>
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<td>REGULATED VARIABLE</td>
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<td>Miniature FM Transmitter</td>
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- Over 300 components to assemble

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C. Auto Headlight Reminder. Auto headlight reminder beeps for ten seconds! LED flashes until you turn off your lights! 270-110 ..... £3.49

D. Engineers Notebook II. Revised to give more practical circuits and data. Large, schematic diagrams. Various tips for beginners too. 128 pages. 276-5002 ..... £1.99

E. Auto Electrical System Analyzer. LEDs show condition of battery, alternator and regulator. Plugs into lighter socket. 12V DC neg. gnd. 22-1635 ..... £4.49

OVER 300 STORES AND DEALERSHIPS NATIONWIDE

Known as Radio Shack In the USA

Prices may vary at individual stores. Offers subject to availability.
EFFICIENT RECESSION

We have recently heard many comments about how the recession will make sure businesses are run in a highly efficient manner, will weed out the dead wood and eventually lead to a boom in the UK economy and a long period of prosperity. Although this is little consolation for those that have been made jobless over the past couple of years, it does appear to have some foundation and a promise of better things ahead.

Having worked in a Government department there is no doubt that some of them need to be more efficient and cost effective. Can you believe that the British Standard for Electronic Symbols (Section 20 Semiconductor Devices) has not been changed since 1968?

There have been many changes in the semiconductor area since 1968 and this was brought home recently when we looked in BS3939 for a programmable unijunction transistor symbol. Of course such a device is simply not covered.

NEW GROUND

A development that we feel may have more than a little to do with the recession is the recent introduction of retail sales operations by a couple of industrial suppliers. EMOS, part of Grenson Electronics was formed to supply the hobbyist, and we on PE like to think we had something to do with it. Back in February '82 we published a design for a Bench PSU, which had been developed by Grenson and they supplied a kit for it. The kits sold so well it encouraged Grenson to start EMOS—something they had been considering anyway. Of course the recession and available stock may have had some bearing on their intention to break new ground and find extra outlets for their products.

The same may be true of JEE Distribution. This industrial distributor operates from premises with a shop front in South West London. They have recently decided that they may as well use the shop to sell to hobbyists, since it is there, and stocked with a range of 4000 different items. JEE are also "putting a finger in the wind" to test the mail order market.

We wish these companies well, perhaps the recession will result in an overall gain for our hobby.

THEIR DUTY

There is one area where the Government could help "at a stroke" the UK and the working population. A duty change would encourage manufacture in the UK rather than in Taiwan or Hong Kong. The required change is to either lower import duty on electronic components or impose a similar duty on imported manufactured electronic items.

Take the humble Sinclair computer; some of the chips are made in the UK, but many are imported, duty paid, from abroad.

The cost of assembly on each computer is very low in comparison with its final selling price and there is therefore little to be gained by manufacturing in Taiwan, as far as this cost is concerned. However, add this small saving to the additional saving on import duty when a ready made unit is shipped in, and you can see one of the reasons why foreign manufacture is attractive.

(We should also be aware that the more items made in each Taiwan factory the bigger their buying power and therefore the lower the component costs; this can lead to a snowball effect). So come on Maggie why not sort that one out soon so Uncle Clive stays with the UK?

D. W. B. Tilleard
SECRETARY
01-261 6676

Experiment Manager

Letters and 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 PE. All letters requiring a reply should be accompanied by a stamped, self addressed envelope, or addressed envelope and international reply coupons, and each letter should relate to one published project only.

Components and p.c.b.s are usually available from advertisers; where we anticipate 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 £1 each including inland/Overseas p&p. Please state month and year of issue required.

Binders
Binders for PE are available from the same address as back numbers at £4-60 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 £13-00 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.

Practical Electronics February 1983
MOTOROLA'S MOTORCAR

Motorola's Director of Strategic Marketing has forecast that the automotive semiconductor market will treble by 1987. Setting this against a somewhat gloomier outlook for other market segments has led to the setting up of the Milton Keynes Strategic Automotive Group.

Here, the focal point of an effort to evolve the microelectronics to revolutionise the motorcar is - the Motorcar! This is a stripped out hatchback from which half a kilometre of conventional wire has been removed, and replaced with mere 65 metres of wire and 10 metres of fibre optic cable. The Motorcar has many electronic systems installed which, it is claimed, will become standard over the next decade. The purpose of Motorola's Milton Keynes facility is not to sell black box systems, but to act as a chip source and data base for companies who wish to take their technology to the market place.

For example, the Motorcar's ignition design has given birth to a specialised 6805 microcomputer called the MC6805S2, and this will interface to the engine by way of a two chip ignition system currently being developed in Geneva. Single wire control systems around the vehicle have necessitated the development of a TMOS power switch with integral CMOS decoder.

The Vehicle Condition Monitor gathers information on fluid levels and temperatures etc. All timings, including those of the windscreen wipers and indicators, are set up by the Central Timer Unit. Each piece of electrical apparatus around the car is addressed via the bus. Being referred to as outstations, each load will report its status back to the processing unit.

Even repeatability of creature comfort is catered for by the fibre-optic multiplex Seat unit which controls and memorises the driver's seat position. The Driver Information system provides normal dashboard and trip computer readout, plus warning messages from the vehicle's condition monitors.

A TO D CONVERTER,E117 RIGHT, WHERE'S ME 'AMMER?

48K LYNX

A new microcomputer from a British manufacturer is now in the shops. The 48K Lynx from Computers has a wide range of facilities and is ultimately expandable to 192K. All the professional High Street buyers give it the thumbs up, and are favouring it against its more expensive counterparts. Features include high resolution colour graphics and add on memory to 96K, 128K or right up to 192K. Although Computers are launching a full range of peripherals specially designed for the Lynx, this does not exclude connecting to other manufacturers' equipment, as there is an RS232 port and RGB + sync and composite video sockets. The standard Lynx comes with a fast and comprehensive Basic which was specially written to make the most of the Z80A microprocessor. Good for the beginner and the experienced operator alike this new computer offers great value at £225 inc. VAT.

DIMMING DESK

M.J.L. Systems Ltd have announced a range of dimming desks and power packs, utilising digital control. For both fixed and portable installations, the new systems combine versatility with lower costs. Bringing professional power dimming within the reach of those previously excluded by prohibitive costs, these desks should be a welcome change to lower budget buyers. Currently available are desks with between 6 and 18 channels (12 channel pictured). Ranging from £55 to £260 (exc. VAT) this equipment or free information is available from M.J.L. Systems Ltd., 45 Worthley Road, W. Croydon, Surrey. (01 689 4138).
RS Move

Our good friends R.S. Components, the well known electromechanical distributors, are planning a big move for 1984. They will be moving the majority of their existing operations to one massive new HQ complex at Weldon, near Corby in Northamptonshire. This mammoth task has been brought about by company expansion and a need for future growth. A large amount of the 1000 employees will also be making the move, nevertheless some will not, and of course this will be good news for the people of the Corby area who have had few job opportunities in recent years.

CABLETIME

The blackness, oh the echoing blackness
In the labyrinth beneath the street
Where dank and dripping walls perspire
By rats with pattering feet
A robot from a cavern will come
Its servo's, Satan's choir
And it shall be armed with superglue
And one hundred miles of wire

Nonsense rhyme, but true! If the viability study of the water industry and the UEI high technology group yields positive results, Britain may be spared the judder of the pneumatic drill when laying in those television cables. For beneath our feet, the decaying Victorian sewers, a network of pipes reaching 99 per cent of Britain's homes, could provide the answer. A cheaper answer. A quieter answer to the problem of cabling the new television networks. The ingenious cabling system has been devised by the water industry's Water Research Centre, in co-participation with UEI (United Engineering Industries). The three companies active within the UEI are: Link Electronics, Micro Consultants and Quantel.

Cabletime is the joint venture's company name, and its aim is to prove by trials that television conduits could be superglued to the ceilings of sewers by small robots. Bearing in mind recent media glimpses of overseas cable television, let us hope that we have no cause to look upon this mode of delivery as appropriate to the programme material.

IBA Guide

The annual publication and guide to independent broadcasting from the IBA is now on the stands. Entitled 'Television and Radio 1983', it gives lots of in depth information about all aspects of broadcasting, from breakfast television to independent local radio. Sport, art, religion, drama and science are among the main topics covered, and this handbook gives a good insight into the industry. Priced at £3.50 it is available from all leading booksellers.

ANALOGUE SIGNAL ANALYSER

An Analogue Signal Display and Analysis System which effectively provides the facilities of a large screen storage oscilloscope through the use of microcomputer technology has been produced by GSL. The system has a two channel input and can accept frequencies up to the high audio range.

Seen as having application in a wide range of fields such as research and education where its realistic price and great versatility gives it immediate advantages over the alternatives, the display of the GSL system can be provided in either time or frequency domains, i.e. with either time or frequency along the X axis.

A fixed number of screens of data can be retained in memory and these can be recalled for subsequent comparison. A printer is available to allow a hard copy of any display produced. The printer prints from the left to allow continuous records to be formed from a number of screens of data. The resolution of the printer is matched to that of the computer.

The system uses a BBC/Acorn model B microcomputer with an analogue to digital interface unit connected to the computer via its 1MHz bus.

The computer features high resolution graphics, the display has a resolution of 1 in 250 on the Y axis and 1 in 500 across the X axis. In the time domain 100 sample values are taken per channel per plot, this is reduced to 50 when in the frequency domain which is analysed via a fourier transformation. This analysis can be performed on either channel. Up to five frequency domain plots can be held in memory for comparison with the current plot.

A colour version of the system is priced at £1407.60 a black and white version at £1206.35 and the Analogue Signal Analyser at £263.00 (all prices include VAT). GSL, 2 North Way, Andover, Hants (0264) 58744.

CAR COMPUTER

The PE Car Computer (published in December 81, and January 82 issues) has a special mode of operation which can be used to measure the acceleration performance of the car. An article on using this feature to tune the car for best performance and economy, and to evaluate the effect of various fuel saving devices, is now available from the PE editorial office. Six graphs are included which show the effect of adjustments, and of a couple of 'bolt on goodies'; one of which produces improved acceleration time and mpg.

To receive the article, send a large self-addressed envelope carrying a 22p stamp to the PE editorial office (address on page 17) with a request for the 'PE Computer Dynamic Car Tuning' article.
VHD Video Disc Postponed

In a recent joint statement from Thorn EMI and JVC the "uncertain economic and market environment" was blamed for the indefinite suspension of the VHD video disc launch.

This news which will enable Philips and other licensees of the optical video disc technology the opportunity to establish the LaserVision system as the accepted format for disc players, will also hopefully mean that the conflicts experienced with the three incompatible video cassette formats will be avoided.

It would also appear that the future of the audio digital system (ADS) developed by JVC is to be reconsidered. The company has signed a technology cross licensing agreement with Philips to manufacture their compact disc digital audio system which has rapidly become the accepted standard for audio digital replay.

Despite the reasons given by JVC and Thorn EMI for postponing their launch, Philips are continuing to heavily promote LaserVision with this year's advertising budget being in excess of £3 million and although the penetration into the UK market has been slow, Jimmy Dunkley, Philips UK Audio and LaserVision director, recently commented that the long term prospects for the system were encouraging and a progressive upturn in sales is expected.

SONY STEREO VIDEO

The video boom continues to gather momentum in the UK, with the introduction of yet another quality machine from Sony. Planned for the top end of the market the C9 is a stereo, Beta-format recorder.

A front loading slimline, and fully rackable system such as this will certainly stimulate both hardware and software manufacturers alike to further explore the stereo video market. Already the main distributors of pre-recorded video cassettes are producing their titles in stereo wherever possible, suggesting 1983 will be another big year for video in the UK. The C9 will be compatible with the F1 system offering portability to those with a more creative outlook. Sony believe that once consumers have experienced stereo video they will be 'dissatisfied' with anything less, 'a bold statement', but if it turns out to be true then it will certainly put pressure on the broadcasting companies to provide stereo transmission sooner than their (mid eighties) predictions.

Tuning is automatic, and the C9's nine-event, two-week timer is set by a simple logic-controlled sequence of button pushes.

Warning circuitry is incorporated which is activated in the event of, for example, someone endeavouring to set the time to record two over-lapping programmes. Also built-in is a battery which will protect timer programming in the event of short interruptions to the power supply.

The C9 is fitted with a real-time tape counter and tape-remaining indicator. These features, coupled with dramatically improved automatic programme search and a "go-to-zero" facility make the tasks of planning and locating recordings particularly easy to perform.

A full-feature infra-red remote control is standard equipment with the C9, which is also fitted with a powered camera socket and the facility to playback or record PCM encoded tapes.

The C9 retails at around £699.
A solar powered aeroplane capable of carrying payloads of up to 100lbs of cameras and equipment, has been developed by Lockheed Missiles and Space, under a NASA contract. Christened the 'Solar High Altitude Powered Platform' it is said to be capable of reaching heights of between 60,000 and 80,000 feet. Powered by its solar cells which drive a large propeller and refuel batteries for night flying, it will be able to maintain these altitudes for months at a time. The solar cells cover the whole of the top surface of the wing. They provide enough power to take the 2000lb plane to 70,000 feet in less than four hours. Prospective applications include military surveillance and agricultural monitoring.

If ideas presently being discussed by the Government at the Industry Department come to fruition, then Mr. Kenneth Baker, the Information Technology Minister, could announce a £12 million spending spree on 50 new IT centres; some to be situated out of the main city areas. It is hoped they will bring training opportunities to more than 1000 young unemployed. Sites for the new centres (ITECS) have not yet been decided. Local organisations including banks, councils and private companies are co-sponsoring the scheme with the Industry Department, in which the trainees will learn such skills as programming, operating and electronics. In the lower population areas, smaller centres (SUBITECS) may be used, whereas existing ITECS have been in the worst affected unemployment areas.

Good news for hobbyists in all areas. The already well established company JEE Distribution, have opened their doors to the public, and indeed are also entering into the mail order business. Offering a range of over 4000 component and hardware items at competitive prices, the range includes everything from discrete components to instrument cases. The shop will be open during office hours, and on Saturdays between 10am and 4pm. A short catalogue is available from, and callers welcome at 43 Strathville Road, London, SW18 4QX. (01-870 0075).

POINTS ARISING...

STYLOCHORD (Dec. '82)
For those constructors who have been experiencing difficulty in obtaining the Top Octave Generator i.e. S50240 for this project, the device is manufactured by and available from, AMI Microsystems Ltd., 108a Commercial Road, Swindon, Wiltshire SN1 5PL. Tel: 0793 37862. It is also available as MOSTEX device MK50240.

COMBO AMPLIFIER (Sept. '82)
In Fig. 2.7, the pin-outs of TR4 and TR5 (2SC1775s) were shown incorrectly. The illustration below shows the correct orientation, and how these transistors should be pre-formed to suit the Combo p.c.b.
Those Hitachi devices are available from Hart Electronic Kits Ltd., Penylan Mill, Oswestry, Shropshire. Tel: 0691 2884.

Countdown...

Please check dates before setting out, as we cannot guarantee the accuracy of the information presented below. Note: some exhibitions may be trade only. If you are organising any electrical/electronics, radio or scientific event, big or small, we shall be glad to include it here. Address details to Mike Abbott.

Local Networks Mar. 8–10. Royal Lancaster Hotel, London. O
Laboratory Edinburgh Mar. 16–17. Assembly Rooms, George St. E
Brighton Electronics March. T
Compec Wales Mar. 22–24. Cardiff University. Z1

Laboratory Manchester Mar. 23–24. New Century Hall, Corporation St. E
International Materials Handling April 19–26. Earl's Court. I
International Packaging Exhibition April 25–29. NEC B/ham. I
Biotech May 4–6. Wembley. O
Defence Components Expo May 10–12. Metropole, Brighton. I

A7 Institute Of Acoustics f 031 225 2143
A8 Holographic Exhibitions f 01-836 6423
E Evan Steadman f 0799 22612
F2 Ponfret & District Am. Rad. Soc. f 0977 791071
I Industrial Trade Fairs f 021 705 6707
K Douglas Temple Studios f 0202 20533
L1 World Trade Cntr., Europe Ho., London E1
N Institute Electrical & Electronic Engineers Online f 09274 28211
Q Exhibitions For Industry f 08833 4371
T Trident f 0822 4671
V1 Jack Toonill, Ipswich Radio Club
Z BETA Exhibitions f 01-405 6233
Z1 IPC Exhibitions f 01-643 8040
BATTERY to MAINS
INVERTER


THE keen DIY motorist who has a garage which is separate from the house or, even worse, which is in a separate block altogether, will be only too familiar with the frustrations of working without mains electricity. What is often described as "conveniently nearby" in estate agents' particulars, all too often turns out to be alarmingly expensive in terms of the length of mains extension lead required. Sometimes, however, even a temporary extension lead is not a practical proposition because of an intervening road or footpath.

A popular solution to this problem is to use tools, lamps and accessories which have been specifically designed to operate from a standard 12 volt battery supply. This unfortunately greatly limits the choice available, and involves maintaining a range of equipment which may only be used for working on the car.

An alternative approach is to provide a substitute mains supply, usually from either a petrol driven generator or from a 12 volt-to-mains inverter. Generators require a significant capital investment and, unless required for sustained use, are usually hired when required. Rotary electromechanical inverters are often used from 24/28 volt supplies, but are not usually cost effective for DIY applications. This article describes an electronic 12 volt-to-mains inverter for loads of up to 50 watts, using only standard stock components. The use of the inverter as an automatic standby mains supply (e.g. for central heating pump power during power interruptions) is also described.

DESIGN CONSIDERATIONS

When contemplating the design of an electronic d.c.-to-mains inverter, one of the first considerations is inevitably the nature of the load(s) to be supplied. Typical loads for the DIY motorist fall mainly into one of three categories; loads of below approximately 50 to 100 watts (inspection lamps, soldering irons, diagnostic test equipment, etc.), loads of around 250 to 500 watts (electric drills, power tools, etc.), and those of the full 3 kW type (electric fires, arc welders, etc.).

Assuming that an electrical efficiency of around 75 to 80% may be expected from an electronic inverter, the load categories above represent demand currents from a standard car battery (nominal voltage=13.2 volts) of approximately 5 to 10 amps, 25 to 50 amps, and 300 amps, respectively. By contrast, the storage capacity of a car battery is typically somewhere in the range 40 to 60 ampere-hours, depending on size and discharge rate.

The required battery load current immediately rules out the possibility of using an electronic inverter with a standard car battery for loads of around 3 kW. This is the type of application which really requires a petrol or diesel generator (unless, of course, money or batteries are no object!). The 250 to 500 watt class of load is practical, but really only in situations where the load is to be supplied for only a relatively short period of time; otherwise the battery will become significantly depleted and the inverter performance will suffer. Detailed consideration of the cost and availability of suitable mains transformers and other components usually lead to the conclusion that this is a possible, but far from ideal application for an electronic inverter.

The 50 to 100 watt load range is where the concept of the electronic inverter really comes into its own. Suitable components are available ex-stock at reasonable cost, and the load imposed on a car battery is moderate enough to allow continuous operation for a number of hours. This type of inverter is also ideal for providing an automatic standby supply during periods when there is the possibility of the domestic mains supply being interrupted. A car battery may be kept permanently connected to a float charging circuit, and then be automatically switched over to the inverter supply connections when the mains is interrupted. Typically, the inverter could supply a lighting circuit and a central heating pump/controller, providing some basic amenities until power is restored; there is, after all, nothing more frustrating than having a gas central heating system rendered useless by lack of power for the pump. When the mains supply is restored, the battery charge is replenished by the float charging circuit, all without user intervention.

CIRCUIT DESCRIPTION

The circuit for the basic inverter unit is shown in full in Fig. 1. An low-power CMOS timebase i.c. is used to provide the fundamental 50Hz timing signal. This arrangement ensures frequency stability, and the use of an integrated circuit helps to minimise the overall component count. IC1 incorporates an on-chip high frequency oscillator, permitting direct connection to an external crystal, XL1. The internal divider chain has a division ratio of $2^{14}$, and when used in conjunction with a
3.2768 MHz crystal, produces complementary 50Hz outputs. The outputs are CMOS and low power Schottky TTL compatible. In applications where frequency accuracy is important, C1 may be replaced by a 5-5 to 65 pF trimmer capacitor.

The outputs from the timebase i.c. are buffered by TR1 and TR2, which are arranged as emitter followers providing current gain, but almost unity voltage gain. Diodes D2 and D3 provide protection against induced high voltage spikes. The outputs from the buffers drive two high gain power Darlington devices, TR3 and TR4. These are very rugged devices which have a gain of approximately 750 at 6 amps, and can each dissipate up to 150 watts! They are internally protected against spikes, and can be used simply as very high gain transistors, with the proviso that their collector-emitter saturation voltage is higher than a single transistor (approximately 2V at a collector current of 6 amps). TR3 and TR4 come in standard TO3 packages which are also conveniently mounted on standard heatsinks, or simply on a diecast box.

The transformer, T1, is arranged back-to-front in that the mains winding is now effectively the secondary. The two 12 volt secondary windings are fed with complementary waveforms, with the supply centre-tapped. On the secondary side, C5 removes the high frequency output components. Reverse polarity supply protection is provided by FS1/D4, and d.c. supply indication by D1.

CONSTRUCTIONAL DETAILS
A printed circuit board is used to mount most of the low current components in the inverter. A copper foil pattern for this board is shown in Fig. 2, with the corresponding component layout shown in Fig. 3. The actual layout, however, is not of critical importance, and a small piece of Veroboard approximately 60mm x 90mm may be used instead of the p.c.b.
### COMPONENTS

**Resistors**
- R1, R5, R6: 1k (3 off)
- R2: 10M
- R3, R4: 4k7 (2 off)
- R7: 220k
All resistors ±5% carbon

**Capacitors**
- C1: 68p ceramics or polystyrene
- C2: 47p ceramic or polystyrene
- C3: 10n polyester
- C4: 100µ 16V elect
- C5: 470n polyester 250V a.c. minimum working voltage

**Semiconductors**
- D1: red l.e.d.
- D2, D3: 1N4148 (2 off)
- D4: 1N4001
- TR1, TR2: BC108 or similar (2 off)
- TR3, TR4: 2N6059 or similar npn power Darlington (2 off)
- IC1: M70681

**Miscellaneous**
- T1: 2 x 0-12V at 2 amps
- SK1: 4mm screw terminal red
- SK2: 4mm screw terminal black
- SK3: Switched 13A mains outlet

When mounting the components on the board, particular care should be taken to ensure the correct orientation of the polarised components, particularly the semiconductors. It is advisable to use a heatshunt, such as a pair of long-nosed pliers, when soldering the crystal in place to avoid overheating the quartz element. After soldering, the crystal should be fixed to the board to prevent damage by vibration; a piece of double-sided tape is ideal for this purpose. IC1 may be mounted in a socket if preferred, and terminal pins are recommended for all interconnection wiring points.

The next step is to mount the remaining components in the diecast box. It is suggested that the cutout for the mains socket be made first, but the socket should not be mounted at this stage. The cutout dimensions will depend on the type of socket used; if hard use is to be expected, a socket with a metal faceplate is strongly recommended. The mains transformer should then be securely mounted adjacent to the cutout for the mains socket, and the necessary wire links fitted. The filter components, C5 and R7, should be mounted directly on the terminals of the mains winding.

The output transistors, TR3 and TR4, should be mounted with insulating kits on the long side of the case. The use of heatsinks for these devices is advantageous if sustained full-load operation is anticipated; they serve as much to dissipate the heat generated by the transformer as by the transistors themselves. The remaining components should be mounted on the end of the case adjacent to the mains outlet, taking care to leave adequate clearance around components at mains potential. The p.c.b. should be mounted opposite the output transistors, and spaced from the case with pillars.

The final step is to install the interconnection wiring and the mains socket. All wiring should be capable of carrying the appropriate currents; the +12 volt supply should be capable of carrying in excess of 5 amps. It is suggested that the wires from the transformer to the mains socket should be terminated in 4 mm plugs; these can then be secured in the terminals of the socket with the screw fixings supplied. The socket may then be mounted on the top of the case. Details of the interconnection wiring as shown in Fig 4. All components should be securely mounted, and special care should be taken to ensure adequate insulation and clearance for all components carrying mains potentials.

![Fig. 4. Wiring diagram](image-url)
TESTING AND PERFORMANCE
Testing of the mains inverter requires a car battery, or a mains power supply rated at 13.2 volts and capable of supplying at least 5 amps. In addition, a meter able to measure up to 250 volts a.c. and up to 5 amps d.c. will be required. Before starting any tests, it is essential that the correct fuses are fitted in FS1 and FS2, and the meter should be inserted in the d.c. supply line.

Connect the d.c. supply and measure the current with no load connected to the mains outlet. With a supply potential of 13.2 volts, the current should be approximately 1 amp; the mains transformer may also be heard to buzz quietly due to the square wave drive signal. If D1 is not illuminated, and no supply current is being drawn, it is likely that FS1 has blown due to a short circuit or wiring error. Before replacing FS1, the cause of the error should be determined. If no fault is evident after a careful check, it is possible that the timebase is not functioning correctly. This may be checked by disconnecting the 12 volt supply from the centre-tap of the transformer, replacing FS1 and seeing if D1 remains illuminated; if so, the fault is probably lack of 50Hz drive to the output transistors. Another possible source of problem is with the wiring of the mains transformer. The labelling of the low-voltage windings should be very carefully checked against that shown in Fig 1; the windings are polarised, and this is significant in this application. When the supply conditions are correct, the mains output may then be measured. Using a standard moving coil multimeter, the no-load output will show approximately 240 volts a.c.; the actual r.m.s. value will be somewhat higher due to the non-sinusoidal waveform.

The final test is to connect a known load to the inverter; a 40 watt light bulb provides a very convenient load. When the lamp is turned on, the current should rise to between 3 and 4 amps, but the mains output voltage will be seen to fall to approximately 210 volts as indicated on the meter.

The performance of the inverter is shown in detail in Fig 5. The graphs indicate how the load voltage falls steadily as the load increases, whereas the overall efficiency shows a peak of around 83% at approximately 33 watts. The shapes of the curves are significantly affected by the no-load input current and the performance of the magnetic core of the transformer. Improvement in the no-load current (i.e. a reduction) would raise the low-power efficiency, while a higher saturation current for the transformer would improve the high-power performance.

AUTOMATIC STANDBY SUPPLY
There are many situations where even a brief interruption in the mains supply cannot be tolerated. The mains inverter described here can be modified to provide automatic changeover between the public supply and an inverter-derived supply in the event of a mains failure. The battery used to provide the inverter supply is kept on float charge when not in use, i.e. when the public supply is available.

The modified output stage for the inverter is shown in Fig 6. When the public supply is present, the relay drives the transformer in the conventional fashion. The mains input from SK4 is routed straight out to SK3 and to the mains side of T1. The low voltage output from the transformer is full-wave rectified by D5 and D6, and R8 sets the float charge rate for the battery connected across SK1 and SK2. In the event of a public supply failure, the relay 'drops out', and assumes the state shown in Fig 6. This is then identical to the circuit shown in Fig 1, and the output is SK3 is inverter-derived, while the rest of the mains circuit attached to SK4 is isolated by RLA.

CIRCUIT VARIATIONS
The efficiency of the inverter will be improved if a larger transformer (100VA or even 200VA) is used. This will require no circuit change as such, but may require the use of a larger diecast box. To take advantage of the larger transformer to obtain a higher maximum output power, it will be necessary to also change TR3, TR4, FS1, FS2 for components rated at the appropriately increased current. For a 100 watt inverter, a 100 VA transformer will require FS1 and FS2 to be changed to 10 or 15 amps, and 500 mA, respectively. The existing devices may be retained for TR3 and TR4 since they have an absolute maximum rating of 12 amps, but for a more rugged unit, substitution by MJ4035 devices is recommended. Heatsinks will be required!
In the cut-throat world of consumer electronics, one of the questions designers apparently ponder over is “Will anyone notice if we save money by chopping this out?” in the domestic TV set, one of the first casualties seems to be the sound quality. Small speakers and no tone controls are common and all too often, the TV companies do their best to transmit the highest quality sound. Given this background, a compact and independent TV tuner that connects direct to your Hi-Fi is a must for quality reproduction.

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AMERICAN ANXIETY ABOUT MILITARY SPACE CONTROL

Two defence relay satellites were launched at the end of October 1982 by the US Air Force using the Titan 34D with an inertial stage. This was the first successful launch with the new system. The satellites DSCS-2 and DSCS-3 are engineered by the General Electric Company. The full title is Defence Satellite Communication System. These first launches are the initial part of a 13 unit series.

The early read-out data indicated that the launch was more accurate than had been predicted. The perigee was 22,751 nautical miles. This was some 17 nautical miles lower than the planned orbit. The inclination angle was 0.007 deg, and the drift rate was 0.06 deg. The launch plan was designed for an orbital injection of the inertial upper stage into a parking orbit of 100 x 82 nautical miles. A two-stage burn then moved the satellites into the synchronous orbit.

The technical details of the launch are as follows:

— The solid fuel rocket motors, from United Technologies Corporation, were jettisoned at about 125 seconds after the first burn. As it turned out the solid fuel rockets burned for one second less than planned and this was compensated by a two second burn at the core ignition stage.

— Stage two some 120 seconds later and the stage one was separated.

— The shroud was then jettisoned and the stage two shut down.

— The first satellite was ejected into the transfer orbit. The second satellite was injected into the transfer orbit some 6 hours later.

The DSCS-3 has a design lifetime of 10 years. It has three aerials and is Sun orientated. One of the aerials has 61-beam receive facilities and two 19-beam transmitting units. The systems are electronically steered and the elements are radiation hardened.

The satellites use travelling-wave tube amplifiers and incorporates six super-high frequency channels. Two of these work with a 40W output and four with a 10W output. The bandwidths available are between 50 and 85MHz. Reception is available both in super-high frequency and ultra-high frequency. Transmission is in ultra-high frequency.

The payloads are designed to provide a world-wide super-high frequency military communications system for secure strategic and tactical voice and data transmissions. The relay facilities will be used for army command and control, defence communications and ground mobile communications. The system will also be available to the National Command Authority, the White House Communications Agency and the Diplomatic Telecommunications Service.

WAR AND SPACE

Once again it seems that SPACEWATCH cannot ignore the aggressive side of the opening up of more and more efficient use of space. Just as real advances in peaceful and useful applications of manufacturing advantages and health improvement offered by developing techniques have been proven, we have to accept that now large sums will be available for the principal benefit of armed forces. Most of us reluctantly accepted that when new frontiers stared us in the face the 'out' of peaceful development would be small. At least there would be something for things that mattered. It is a great tribute that the shoestring projects managed to produce the inspiration that has more than satisfied the defence and defence projects. It must be understood that there is, however, no support from the writer for the sentiments or activities of the misguided groups who carry banners and generally make themselves a nuisance.

However, escalation does in fact seem to increase in about equal levels and therefore the condition of 'Mexican Stand-Off' remains. The world may therefore go about its business, ingenuity playing its usual part.

The Russian situation has changed, but to what extent is not known. It is known that the former premier regarded the Shuttle as a military vehicle and Russia has already made an attempt to copy it. Other countries would no doubt hope to do the same. It is certain that it will cost in the region of $1 billion and Impe in considerable demand for the next 20 years. Only benefit to the peoples of the Earth can result from the peaceful use of space.

The success of the Russian space stations is to be admired and it has always been the majority view that space stations, space platforms and shuttle-like systems represent the majority view that space stations, space platforms and shuttle-like systems represent the most economical use of men, materials and fuel. President Reagan, it seems, is set on a formal military recognition and the Air Force already has a Space Command. Perhaps a little closer examination of the situation might be worth while. The international situation of common understanding and operation in Antarctica has shown that co-operation works well. After all, this is Man in the collective adventure for the elements. That the Soviet Union's activities in space have always been regarded as being controlled by an armed state and that this is now part of the normal thinking, that everything in Russia is under military control. No real exception has been taken to this, rather perhaps it has been seen by those engaged in the space field as. 'Of course they can do things, they have all the resources available to them'. The space programmes in the West have undeniably been largely orientated to the areas of greater fiscal magnitude. It was recognised that up till now private enterprise could not foot the bill when the actually monetary returns were low. The benefits have been, from the civilian view, in the spin-off advantages. If military push is to be the order of things in the USA then civilian spin-off and employment will be boosted.

SATELLITES AS SPIES IN SPACE

The Soviet Union and the United States are the acknowledged leaders in this area of Space. However, others are catching up. India, China and France have made quite substantial progress in this area already. Financial delays may make the late 1980's a final operational period. However, France does already have an operational military satellite system called SAMRO. This is based on the Earth mapping SPOT. There was a postponement of further work on fiscal grounds. There is every possibility that this position might be eased soon.

The Soviet Union has a record for the release of photographic satellites, the rate being of the order of 35 launches a year. This is somewhat deceiving statement since compared with a lifetime of two to three years for a US satellite the Soviet version seems to 'burn up' in as short a period as 50 days. The Soviet satellites usually go singly into space, whereas the US may pack them as passengers on other major launch missions. Reconnaissance satellites could be called the ears of space because generally they are listening to activities which result from military activities.

Information also comes from listening to transfer calls in telephone networks and the transfer of computer data from one system to another. Almost any radio or telephone link can be tapped. A great tightening exercise is at work and no doubt as the slots become more crowded there will have to be pruning. There has been for some time now intense research into the propagation in those channels thought to be useless. Now that all other avenues are being fully used, a potential for all Impe in considerable demand for the next 20 years. Only benefit to the peoples of the Earth can result from the peaceful use of space.

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We let the Robot in for half price—he claimed to be only a year old!

**EHF Review...**

More than 60 exhibitors took part in the first Electronic Hobbies Fair filling over 90 stands in the splendid new venue of Alexandra Pavilion. The successful event, which attracted media attention from newspapers, radio and t.v., will be repeated from October 27 to 30 1983 so make a date now.

The photographs on these pages set the scene and are "worth 1000 words". Exhibitors are already rebooking stands for next year so the Fair will go from strength to strength. As we said before "the best event ever for the hobbyist in this country".

The exhibitors list read like a Who's Who in the electronic hobby business, from Absonglen, Allweld, Ambit and Armon through Babani, BICC Vero, Bi-Pak, Chromasonics, Clef, Electrovalue, EMOS, EE, GSC, JPR, Kansas City, Lightsoild, Maplin, Marco, Midwich, PE, PW, Radio Shack, Roadrunner, Service Trading, Shesto, Sparkrite and Velleman to Westlake and Wireless 'World; to mention just a few.

Many special attractions were mounted by organisations like the Army, RSGB, Holographic Developments, EOCS, BAEC, BBC and BVS. The display of radio controlled models, courtesy of Model Land, and the robots by Advance Robotics proved highly entertaining and continually drew large crowds. Numerous visitors watched the news according to Russia via the Luxor satellite t.v. system, just how many understood Russian is another matter!

The "bargain sales" area was always well attended and amateur radio operators talked mobile visitors in and chatted with operators around the world. Kids and creative computing abounded and one kind gentleman from Chordgate wrote a short program that turned our Micrograsp robot into a "padded cell and straight jacket" case.

We enjoyed it all, we hope you did, or will next year!

Waiting to get in. The Luxor satellite dish can be seen on the right.
1. Microsynth and, a future project, Percussion Microsynth on our stand.

2. The ITV camera watching the robots, 'watching the camera!'

3. The IPC Magazines rotunda formed a centrepiece for the special attraction area. Radio controlled models in the foreground.

4. Battery vehicles of all shapes and size.

5. Members of the Electronic Organ Constructors Society exercise their vocal chords—thankfully the organ was in tune!

6. The "bargain sales" area was always well attended.
THE early microprocessors often attracted comments along the lines of, "A solution in search of a problem". In the time since its introduction, however, the microprocessor has become an accepted and important design component, almost to the point of becoming the electronic equivalent of the all-curing medical aspirin. The micro has been hailed as a shining example of what the "White Heat of Technology" has to offer; the answer to our design problems for the foreseeable future.

The reality of the situation, needless to say, lies somewhere between these two extremes. The microprocessor has a great deal to offer in terms of speed, performance, flexibility and cost-effectiveness when applied to the solution of a wide range of problems. However, it is this very versatility which raises one of the greatest problems for many potential users. The question is when and how to make use of the micro's vast potential. The aim of this short series, therefore, is to try and bridge the gap between the undoubted technological brilliance of the microprocessor, on the one hand, and the practical aspects of how to use it, on the other.

MICROS FOR REAL APPLICATIONS

The world of the micro is a well-ordered one; the signals which circulate are glitch-free, the loads are all properly matched, the connections short, and the levels are purely digital. The designers have gone to considerable lengths to ensure that everything behaves in a predictable fashion. The essence of the microprocessor is its predictability; it is basically a finite state machine. Once programmed, its behaviour in given situations can be predicted with some certainty, and its performance will be repeatable.

It is essential that the environment in which a micro is expected to work is carefully specified if the control program is to perform correctly under operational conditions. A popular approach to the problem, and one of the subjects of this series, is to condition all signals before they reach the micro. This ensures that unexpected or unwanted effects are eliminated, or at least that their consequences are minimised. In this way, the requirement to be able to predict the total range of inputs (which is almost impossible in any real system) is eliminated, and instead the possible inputs are limited to a manageable range. From this starting point, it is then a much more straightforward problem to produce some robust control software.

The other aspect of microprocessors in real applications involves their control of peripheral hardware, particularly that which was not necessarily designed specifically for use with a micro. In some cases the interface can easily be implemented using one of the standard ranges of interface i.c.s, e.g. a serial link can be implemented with a standard UART device. The majority of real control loads, however, have not necessarily been designed with microprocessor control in mind. The requirement then is to provide the appropriate conversion between the control signals produced by the micro, and those required by the peripheral hardware. This may involve some simple signal manipulation, e.g. level shifting or power amplification. Alternatively, the conversion may involve matching the speed of the control system to the speed of the peripheral system, e.g. a micro can change the state of a lamp in a few microseconds, but the lamp takes milliseconds to respond, and the human operator must be allowed at least 20 milliseconds before any change begins to register.

This series will describe some of the more commonly used signal conditioning and peripheral control techniques. On the whole, the examples given will be directly applicable to the hardware used in the PE Microcontroller, but the techniques themselves will be applicable to a much wider range of micro-based applications. The choice of techniques to be used in a particular system will necessarily depend on the nature of the particular application. The intention here is to encourage the use of the microprocessor in ways which move away from technological abstraction, and out "Into the Real World".

The article this month will concentrate on systems which
involve purely digital control, i.e. where a line can take only one of two states. Next month the topic of analogue signals will be covered.

PERIPHERAL LINE DRIVING
The usual method of driving peripheral hardware under microprocessor control involves some sort of adaptor between the CPU and the peripheral. This adaptor acts as a filter for the peripheral, and it separates out those CPU instructions and commands which are relevant to its operation. An example of such a peripheral adaptor is the 6821 PIA, designed primarily for the 6800 microprocessor family, which provides two independent sets of eight peripheral I/O lines. The PIA also has a considerable amount of control logic which simplifies the CPU's task in controlling any peripheral hardware. Similar adaptors, with a wide range of different functions, are available for almost every family of microprocessor. Indeed, it is now common for the selection of a micro for a particular job to be influenced as much by the available range of interface adaptors as by the capabilities of the CPU itself.

The simplest type of interface is the situation where the peripheral hardware presents a buffered digital interface to the outside world. In such cases, it is simply a matter of connecting the peripheral directly to the adaptor, and then configuring the interface under software control to satisfy the peripheral's requirements. A simple example of such an arrangement is the connection of an 8-bit digital-to-analogue converter (DAC) to one of the ports of a 6821 PIA; this example will be described, with applications, next month.

There will be many cases, however, where the peripheral hardware presents a load which exceeds the drive capability of the peripheral adaptor. In such cases the modification to the interface is only a matter of increasing the logic drive capability of the adaptor. The easiest way of achieving an increase in the fanout (which in the case of the 6821 PIA is two standard LS TTL loads) is to introduce additional logic gates, configured as buffers, between the adaptor and the peripheral. These buffers may be formed of any convenient gates, and will typically increase the fanout to around 10 to 20. For buffering groups of eight peripheral lines, a range of i.c.s is available which will each handle eight lines. Table 1 shows a random selection of LS TTL devices which are available, and there are other ranges of devices containing 4, 6, and 8 gates per package. It will be noted that the devices listed have tri-state (high, low and high-impedance) outputs; this allows the simple construction of bus-connected interfaces without the need for complex switching logic. For peripheral applications requiring bi-directional lines, bus transceivers are available; these are effectively a driver and a receiver in parallel, with direction switching logic. In general, driving logic circuitry is usually simply a matter of direct connection to the interface adaptor, or the inclusion of appropriate buffers in the interface.

The final category of digital load to be considered includes applications where the load operates on levels in excess of the standard logic levels, and often requires significantly increased drive capability. Typical examples include 12/24V relay coils, filament lamps, and gas discharge displays.

<table>
<thead>
<tr>
<th>DEVICE NUMBER</th>
<th>FUNCTION</th>
<th>OUTPUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>74LS240</td>
<td>Octal inverter buffer</td>
<td>3-S</td>
</tr>
<tr>
<td>74LS241</td>
<td>Octal buffer</td>
<td>3-S</td>
</tr>
<tr>
<td>74LS244</td>
<td>Octal buffer</td>
<td>3-S</td>
</tr>
<tr>
<td>74LS245</td>
<td>Octal transceiver</td>
<td>3-S</td>
</tr>
<tr>
<td>74LS363</td>
<td>Octal transparent latch</td>
<td>3-S MOS-compatible</td>
</tr>
<tr>
<td>74LS364</td>
<td>Octal D-type flip-flop</td>
<td>3-S MOS-compatible</td>
</tr>
<tr>
<td>74LS373</td>
<td>Octal transparent latch</td>
<td>3-S</td>
</tr>
<tr>
<td>74LS374</td>
<td>Octal D-type flip-flop</td>
<td>3-S</td>
</tr>
</tbody>
</table>

Table 1. Selection of byte-wide peripheral output i.c.s
The simplest interface to a load is to include a switching transistor, or VMOS FET power transistor, between the peripheral adaptor and the load. Fig. 1 shows some examples of this technique for driving an I.e.d. indicator and a relay, respectively. This approach is ideally suited to simple interfaces, especially where the requirements of each peripheral I/O line are different. For large numbers of lines, especially with similar drive requirements, however, the cost and component count begins to escalate, and integrated circuit drivers become appropriate.

The cheapest peripheral driver (under 20p per package of six drivers!) is to be found in the 7400 series of open collector buffers. These are suited to sinking currents of 16 to 48mA, depending on collector voltage, and brief details of the characteristics of commonly available devices are shown in Table 2. An application circuit using a 7416 is shown in Fig. 2.

The selection of an integrated peripheral driver for a non-logic type of load can be a daunting task when looking through the huge range of devices which is now available. A driver for a particular application, however, can usually be identified by considering the following factors in relation to the load to be driven:

(1) The type of input signals to be provided (TTL, CMOS, etc).
(2) Whether the output requires current source, sink, or both.
(3) The load supply voltage.
(4) The logic function of the driver (buffer, inverter/buffer, AND, etc).
(5) Whether transient protection (for inductive loads etc) is required.

If selection from this list of criteria still leaves a wide field of choice, details of packaging (e.g. number of drivers per device) and cost/availability will usually narrow down the choice to a suitable device.

The PE Microcontroller contains an example of an integrated peripheral driver. The user PIA outputs were originally intended to drive 12 volt solenoids connected between the output line and OV. The drivers selected were of type UDN2981A; these are high-voltage, high-current source drivers which are TTL, DTL, PMOS or CMOS compatible, with 500mA output source capability which is protected against transients. Each output is switched on by an active high input level, and the output stages (shown in the circuit of Fig. 3) will each sustain a maximum off voltage of +50V. The maximum output current for a single driver is 500mA, or 120mA continuously for all drivers in operation at once.

**Table 2. Characteristics of some 74 Series Open-Collector Buffers**

<table>
<thead>
<tr>
<th></th>
<th>7407</th>
<th>7417</th>
<th>7426</th>
<th>7438</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-level output voltage max</td>
<td>30</td>
<td>15</td>
<td>15</td>
<td>5.5</td>
</tr>
<tr>
<td>Low-level output current max</td>
<td>-40</td>
<td>-40</td>
<td>-16</td>
<td>-48</td>
</tr>
<tr>
<td>High-level output current max</td>
<td>250</td>
<td>250</td>
<td>1000</td>
<td>250</td>
</tr>
<tr>
<td>Low-level output voltage max</td>
<td>0.7</td>
<td>0.7</td>
<td>0.4</td>
<td>0.4</td>
</tr>
</tbody>
</table>

- **7406** Hex inverter buffers/drivers
- **7407** Hex buffers/drivers
- **7416** Hex inverter buffers/drivers
- **7417** Hex buffers/drivers
- **7426** Quad 2-I/P NAND buffers
- **7433** Quad 2-I/P NOR buffers
- **7438** Quad 2-I/P NAND buffers

**CONTACT BOUNCE**

Switches and similar electromechanical devices are used in many control applications for a wide variety of purposes. There are, however, many occasions when they do not behave quite as would be expected. Consider, for example, the use of a microswitch in a gate turnstile where a count of the number of admissions is required for comparison with the gate receipts (also calculated by the same microprocessor). This would seem to be an ideal situation for an interrupt-driven counter routine, with the turnstile causing an interrupt each time a customer enters, and the interrupt service routine incrementing the total count by one.
delay with long time constants. This circuit will
Schmitt type of gate is recommended to avoid switching os-
controverdebounce delay of hardware debounce circuitry. A circuit
the alternative to software debouncing, therefore, is to use
both switch bounce and noise spikes.

The problem in practice is that the switch is not perfect,
and when the contacts are closed they tend to bounce
mechanically. The number of bounces, and the interval be-
tween them, will vary between types of switch, and even be-
tween samples of the same type. The result of this difference
between the theoretical switch and a real switch is that the
total count value may, depending on the switch and the
length of time to execute the interrupt service routine, be in
error by any amount between 0 and 500%. Even worse, the
performance will not be predictable.

There are a number of possible solutions to this problem.
The first is to use a better switch; this will not necessarily
solve the problem, and could involve a significant increase in
cost. A better solution is to keep the switch, which was
probably chosen for a combination of physical considera-
tions, and acknowledge the fact that switch bounce will oc-
cur. A way of doing this is to make the interrupt service
routine, which in the example is triggered by the high-to-low
edge, ignore further interrupts for a period longer than the
bounce period. This duration will typically be in the range
0.1 to 10 milliseconds. Achieving the ‘ignore’ period in-
volves keeping the switch interrupt masked out (done
automatically on entry to the service routine on most
microprocessors, so really only a matter of not re-enabling
interrupts), and including a software delay of appropriate
length.

Such software delay routines typically choose a period of
20 milliseconds to be on the safe side. A suitable delay
routine for the PE Microcontroller would be as follows (the
time is calculated from the individual instruction timings and
the number of times round the loop):

Op Codes
KDLY: LDX #08EO  CE 08 E0
DLY: DEX 09
BNE DLY 26 FD
(RTS) 39

This may be implemented as a subroutine, or as in-line
code (in which case the RTS should be omitted). After the
delay has finished, it is a good idea to look again at the
switch line if possible (via a PIA I/O line is the easiest way)
to check that the signal is still there; this will avoid
responding to spurious spikes on the lines. If the total count
is incremented only after the delay and re-check, the final
system should be relatively immune from the problems of
both switch bounce and noise spikes.

Software debounce is not always possible in a system due
to the amount of CPU time required to implement the delay
routine, especially if noise spikes are a frequent occurrence.
The alternative to software debouncing, therefore, is to use
hardware debounce circuitry. A circuit for providing a
debounce delay of 1ms is shown in Fig. 5. The use of a
Schmitt type of gate is recommended to avoid switching os-
cillations on delays with long time constants. This circuit will
have the same effect on short duration noise spikes, and will
thus reduce the incidence of ‘false alarm’ interrupts. The
value of $R_b$ used in the circuit should take account of the sink
current required (1.6mA for standard TTL gates) for a logic
low; with standard TTL the maximum value recognised as a
‘low’ is 0.8V, making the upper limit on $R_b$ around 470Ω.

In general it is recommended that some form of debounc-
ing is used with all switches in control applications. This will
usually also have the added benefit that the system will be
more immune to the effects of transient spikes; a feature
which is always enhanced by the use of active-low control
signals. As a final point, it should be remembered that the
debounce circuit shown in Fig. 5 must be charged up at
power-up, and the initialisation sequence must allow time
for this to be completed before recognising any interrupts.

**KEYBOARDS**

A keyboard is a common component in any microprocessor application which involves any sort of user interaction. Its normal function is to transfer commands from the user to the resident control program to initiate the re-
quired action. Typical keyboards range from simple collec-
tions of function keys, right up to a full typewriter-style
layout with additional function keypads.

Keyboards represent particularly good examples of the
hardware/software tradeoffs which must be considered
when configuring a system. They range from simple arrays of
switches on the one hand, to fully decoded keyboards with
multiple-key rollover protection and a data available strobe
signal on the other. The simple type of keyboard minimises
the amount of additional hardware required, but represents a
higher software overhead on the system, i.e. more CPU time
must be spent in detecting and identifying keystrokes. Fully
decoded keyboards represent the smallest system software
overhead, but they are more expensive in terms of the ad-
ditional hardware required; this penalty is, however, con-
 tinuously being eroded by the increasing availability of
custom keyboard i.c.s and low cost key arrays. In the ma-
 jority of control applications, where a full QWERTY
typewriter type of keyboard is rarely necessary, the trend is
still to make use of relatively simple hardware; usually a sin-
gle array of switches, with possibly some additional logic to
minimise the software overhead. A typical compromise be-
 tween simplicity and full decoding is shown in the keyboard
for the PE Microcontroller: here the keyboard is an array of
switches, but the keyboard software is simplified by the ad-
dition of a line decoder, IC23.

In order to make use of a keyboard, of whatever type,
there are a number of requirements which must be met by
the control system (i.e. by the combination of the hardware
and the software). First of all the system must detect that a
key has in fact been depressed. The key must then be iden-
tified from the implied user command; a
propriate action in response to the implied user command; a
function often performed by a module called a command
processor.

**KEYBOARD CONFIGURATIONS**

A standard 16-key hexadecimal keypad is the keyboard
used as an example in the discussion which follows. There
are essentially two ways in which the 16 keys may be arranged, and these are shown in Fig. 6. Most larger or smaller keyboard switch arrays are simple variations on these two schemes. The standard and matrix arrangements may each be made up from a collection of individual switches, or the keyboard layout may be available as a stock component.

Fig. 6a. Standard key layout for 16 keys

Fig. 6b. Matrix key layout for 16 keys

The matrix scheme has the advantages of fewer interconnections, less wiring, and only half the number of peripheral I/O lines. It does, however, require a more complex software driver for the keyboard. The standard array, on the other hand, has a very simple decoding scheme, and a non-matrix number of keys may easily be handled. It does, however, use more peripheral lines (and consequently more wiring), but these lines need only be configured as inputs. The scheme chosen will inevitably be a compromise influenced by the overall specification for the system, and the availability of appropriate switch arrays.

The actual detection of a key depression is usually performed in one of two ways. Both techniques may be used for either type of keyboard, and one example of each will be given by way of illustration. The first method involves software polling of the keyboard. A modified version of this method is used in conjunction with a matrix keyboard in the PE Microcontroller. Basically, the control software is required to look regularly (typically more than 20 times per second) at the keyboard to see if a key has been depressed. Fig. 7 shows how a standard keyboard could be connected to a 6821 PIA; all peripheral lines would be set up as inputs, and would float 'high' in the absence of a key depression. Polling the keyboard in this case, therefore, amounts to the following sequence: read the ORA and ORB registers, invert the values, and test for a non-zero value to detect a key depression. If no key is depressed, the control routine can either perform some other task which may require service, or start the polling sequence again; the sequence used in the PE Microcontroller is shown in the last issue. The subsequent action taken in the event of a key depression is discussed later.

Software polling of the keyboard is simple and requires the minimum of additional hardware. It does, however, require the control program to be continually looking at the keyboard to determine whether or not a key has been depressed. The interval between polls can be used to perform any necessary processing to respond to a keyboard command, but the time taken to implement this can vary, thus producing varying intervals between polls; this should not be a problem unless a significant amount of processing (say, more than 200 msec) is performed. The technique does have the advantage that the keyboard is automatically 'locked-out' whenever a previous entry is being processed.

The alternative to software polling is to use an interrupt-driven approach. This requires some additional hardware which will generate a logic signal whenever a key is depressed. This can then be used to drive the user interrupt request line on the processor. Thus an interrupt will be generated whenever a key is depressed, and the control program will be freed of the requirement to constantly scan the keyboard. Fig. 8 shows how a matrix keyboard could be arranged to generate an interrupt whenever a key is

Fig. 7. Simple key array configured for software polling.

Fig. 8. Matrix key array configured for generating interrupts.
Identifying a key for the standard keyboard shown in Fig. 7 is quite a simple problem. First, the PIA ORA is read into, say, rA and then inverted; rA will then have a bit set to ‘1’ for each key depressed. If rA is tested and found to be non-zero, then the key pressed is in the range ‘0’ to ‘7’. The key may then be identified by performing a logic shift right and testing the carry bit until it is set; the number of shift operations should be counted, and will give a result in the range 1 to 8. If the inverted value read from ORA was zero, then the key depressed must be in the range ‘8’ to ‘F’. To identify this key, read ORB, invert it, test for a non-zero value (if the inverted values of ORA and ORB are both zero, then no key has been depressed), and the shift-and-test-carry should be repeated. In this case, however, the count of the number of shifts should start at 8, rather than zero. The shift count when a bit is found will be in the range 9 to 10 (hex), and will correspond to the keys ‘8’ to ‘F’, respectively. The number of shift operations will indicate the identity of the first key found, or will be zero if no key is found, and will thus be a number in the range 00 to 10 (hex).

Converting from the key identity, in terms of number of shift operations, into an internal key code is a straightforward operation for a standard keyboard. The simplest way is to use a look-up table. The table is a list of key codes organised so that the first code corresponds to ‘no key found’, the second to ‘0’, the third to ‘1’, etc. The appropriate key code is then found by setting the index register to point to the start of the table, and using the shift count as an offset into this table. Thus, for example, a count of 7 indicates that the key pressed was the ‘6’, and that its code will be found at table start + 7. The conversion routine will, then pick up the code and return it as the identity of the key to the command processing routine.

Identifying key depressions for the matrix keyboard shown in Fig. 8 must be done with user interrupts disabled (which happens automatically when an interrupt service routine is entered after a key depression), otherwise the identification process itself may generate further, unwanted, interrupts.

The basic principle for identifying the key depressed is to select each output line (PB0 to PB7) in turn, and see if any key on this line (e.g. ‘0’, ‘4’, ‘8’ or ‘C’ on PB0) has been pressed. At the start of the routine, as mentioned earlier, all output lines will be set low. Reading the input lines from PB4 to PB7 should show that the top four bits of ORB are not all high if a key is depressed; this should be the first step in the key identification. Assuming that at least one of the input lines are low, the next step is to identify which key is down; no keys down means that the interrupt was either spurious, or for some other peripheral, and the keyboard routine should be exited.

Each of the output lines is selected in turn until one of the input lines goes low. Remembering that the circuit uses an active low logic, this selection is done by output of FE, FD, FB and F7 to ORB in turn until the value read back from ORB has a value other than F in the top four bits. If the key depressed was ‘A’, the value output to the bottom four bits to locate the key would have to be B, and the value in the top four bits read back from the PIA would be also B. The situation at this point is that we have an output value of FE, FD, FB or FD, at which a key depression was detected, and an input value corresponding to the key depression. Only the four least significant bits of the output value, and the four most significant bits of the input value are of interest. First of all, however, the input value must be checked to remove any multiple-key values, otherwise the code conversion routine will fail. The best way to do this is to perform a bit test on each of the top four bits of the input value in turn, stopping at the first bit set to zero, and forcing all of the rest high (with an OR instruction). When this has been done, a composite key code can be formed, with the 4 least significant bits of the output value in the least significant half of the composite, and the 4 most significant bits of the input value in the upper half of the composite.

The conversion of the composite key code to the internal key code used by the rest of the software is best performed using a look-up table again. A typical table, for the circuit in Fig. 8 and the same codes used for the standard keyboard, would contain the following values in consecutive locations:

| EE, 00 | ED, 01 | EB, 02 | E7, 03 | DE, 04 | DD, 05 | DB, 06 | D7, 07 | BE, 08 | BD, 09 | BB, 0A | B7, 0B | BE, 0C | 7D, 0D | 7B, 0E | 77, 0F |

This table contains pairs of values; each pair is the composite key code, followed by the internal key code. The conversion is performed by first setting the index register to point to the start of the table. The composite code is then compared with the contents of the location indicated by the index register. If it is equal, the contents of the location pointed to by the index register plus one are loaded into the key code store, and the conversion routine exited. Otherwise, the index register is incremented by TWO, and the process repeated until either a match is obtained, or the end of the table (checked separately) is reached.

This table-based conversion technique is by no means the only way to convert from a key position related value to an internal representation. Other techniques may be used which will be more efficient with particular hardware configurations. The table-driven method is, however, applicable...
to all conversion problems, and it represents the most flexible and easily modified technique.

KEY DEBOUNCING

The problem of switch bounce applies to keyboards as much as to individual switches. The techniques for handling the problem are broadly similar. Hardware de bumping, however, is usually applied to complete keyboards, rather than to individual keys, and is therefore only usually found on completely decoded keyboards. In control applications, therefore, where fully decoded keyboards are the exception rather than the rule, software de bumping is most commonly employed.

The method of applying software de bumping to a keyboard is usually embodied in the keyboard driver routine. The principle is to perform the key identification process twice, separated by typically 20 milliseconds, and then compare the results. Only if the result is the same on the two iterations is a valid code passed on to the command processor, otherwise the results of the two passes through the identification routine are ignored. The 20 millisecond delay is most easily implemented as a software delay loop; typically 2000 times round a short loop will give the required delay.

NEXT MONTH: The next part of the into the Real World series will concentrate on the problems of handling analogue signals. Practical applications will be given for digital-to-analogue and analogue-to-digital conversion interfaces using low-cost conversion components.

Future issues will continue with the discussion of problems with using micros in the real world. Opto-isolators, glitch removal, pulse stretching and multiplexed display driving will be among the topics covered.

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MODEM CHIP

Sending microcomputer data over short distances is easy, thanks to RS232 or current-loop standards and the easy availability of UARTS and PIAs which do all the hard work for you. But what if you want to exchange PAC-MAN programs with your granny in Edinburgh? Or access a bigger computer in Dallas, Texas? Short of laying your own cable (not recommended!) there is only one solution, and that is to use the telephone network.

Don’t try connecting RS232 data to your telephone, though, because a) it won’t work, and b) you will end up with a mushroom cloud over your UART! The trouble is, RS232 signals need d.c. links with logic states represented by positive and negative voltages. The phone system, however, is essentially an a.c. system with the only d.c. voltages being provided and controlled by your local exchange.

To send data on the telephone system it must appear to be similar to speech, and one way of achieving this is to code the ones and zeros as different audio tones within the audio bandwidth of the network. This technique is in wide use, but unfortunately it requires the use of a modem (modulator/demodulator) at each end of the link, and old age pensions being what they are, granny probably couldn’t afford one.

Modems have, however, become cheaper lately, especially the acoustic coupled variety which uses the standard telephone microphone and earpiece to couple into the network, but the cost of the necessary oscillators filters and detectors with all those inductors, capacitors, and OP-AMPS is still preventing most of the home computer fraternity from indulging.

But never fear! Your fearless columnist, friend of all PAC-MAN playing grannies, has news of a new device which should bring the cost of modems tumbling! The Am 7910 single chip modem subsystem from Advanced Micro Devices sweeps away the need for all those old-fashioned inductors and capacitors and replaces them with nice modern digital circuits. Hook the RS232 signals from your micro to one set of pins, add a few discrete components, wire up to your acoustic-coupler and hey presto! The world is your oyster.

Inside the Am 7910’s 28 pin package is an amazing selection of goodies. On the transmit side, it takes the RS232 digits and uses them to control a digital sine wave synthesiser which after filtering drives a digital to analogue converter (DAC) and a post analogue filter before being fed out to the telephone coupler as a Frequency Shift Keyed (FSK) tone sequence. On the receive side, the tones from the coupler are analogue prefiltred, digitised in an ADC and then separated by means of a digital filter before demodulation and RS232 output.

In addition to those basic features, the Am 7910 also has amazing flexibility. The world is a real “tower of Babel” as far as modem frequencies and data rates are concerned, but the Am 7910 can be switched to handle nine different modem standards, which would not have been possible for the older analogue system. The remote data collection, the Am 7910 even has an automatic-answer capability so you could dial up your home from a call box using an acoustic coupler and get back data on all those exciting household parameters like the gas meter reading or the oven temperature. Beats string and tin cans, doesn’t it?

EASY AS A.G.C.

Many audio systems face the problem of wildly fluctuating input levels, and a Canadian firm called Linear Technology Incorporated has just come up with a neat little Automatic Gain Control (AGC) circuit to help solve it. Usable in hearing aids, telephone systems, CB transceivers, and portable tape recorders, their new LC502 device can live in an 8 pin mini d.i.p. or a tiny flat-pack and will operate on supplies of between 1 and 10 volts thanks to a built in full wave rectifier.

Providing up to 70dB of gain control range, the LC502 tries to keep its output signal level at a constant 20 millivolts r.m.s. regardless of variations in the input signal amplitude due to speaker position or loudness. The user can set any nominal gain for the circuit of between ~6dB and +64dB by means of an external full wave detector with the LC502 will adjust its gain automatically down to the ~6dB limit as the input signal level increases. Inside the chip there is an inverting operational amplifier with an electronically variable resistance in its feedback path, and a full wave detector with a smoothing circuit. As the input signal level increases, the d.c. output voltage from the detector also increases and this is used to control the variable feedback resistance which in turn reduces the gain of the circuit.

For obvious reasons, two important parameters of any AGC system are the attack and release times. The LC502 settles to within 2dB of final value within one millisecond after a 25dB input step, and release time can be adjusted to between 25 and 500 milliseconds. The noise performance, whilst not of hi-fi standard, is perfectly adequate for the sort of applications in which the LC502 will be used.

An added bonus is that the input circuitry of the device is designed for direct connection to an f.o.t. buffered electret microphone.

MICRO MONSTER

A short while ago I covered the new DEC “PDP11-on-a-chip” T-11 microprocessor which is now becoming available. I was more than impressed by that device, but now DEC have done it again by announcing a new device coded the Micro/J-11 which can actually outperform the most powerful of all their existing PDP 11s, the 11/70. Now, the 11/70 is a big expensive machine, and the prospect of someone putting the CPU of such a monster into a single 60 pin package has never really occurred to me. If I pass on a few of its salient features you will see what I mean!

The J-11 contains two sets of six 16 bit general purpose registers plus six 64 bit floating point arithmetic registers plus three stack pointers and several special. It runs on a 20MHz clock and can do a 16 bit register addition in 200 nanoseconds or a 16 bit multiply in 4.4 microseconds. An on-chip memory management unit gives 22 bit addressing to cover 4 megabytes of memory at 128K bytes per page, and the internal data bus is 32 bits wide for a really zizzling performance. This amazing device even runs its own diagnostic programs when power is applied, and reports its state of health to the system interface!

There’s lots more, but we haven’t got the space. As a parting shot I will just mention that despite all that raw power the J-11 consumes only 1 watt from a 5 volt supply which is less than many 8 bit devices!

To take advantage of such a monster, it will be necessary to add buckets of memory and plenty of disk storage, but no doubt before long we will all have one in our electric toaster and think nothing of it. Ah well, that’s progress!

AVAILABILITY

Devices featured in Semiconductor Update should, under normal circumstances, be available from good component retailers, but bear in mind that retailers will often not receive stocks of a device until some time after it has been featured in Update.
team of Racal people, all 12,500 of them who believe in Britain and in themselves, the finest team in the world. He was saying this when Racal had a couple of thousand people and has been saying it ever since, and with absolute sincerity.

Harrison, like Jones, is also keenly aware of added value (i.e. high productivity) but employs an oblique approach. He stresses, with justifiable pride, that exports per UK head of his employees has reached £21,000, more than three times the average for the whole of Britain's manufacturing industry.

I can add a figure or two of my own. In the last ten years Racal's world-wide turnover has multiplied by a factor of 30, while the number of Racal people has grown only by a factor of six. This tells us something about Racal, something about technological advance and something about general unemployment.

**PEOPLE**

Sir Ernest's belief in people is well-founded, but I think he is being too modest. My own observation is that management style as well as competence is the key to success.

I remember as a keen one-time motorcyclist my reverence for the BMW machine and the consequent shock of learning that they were assembled not, as I had imagined, by skilled German craftsmen but by a largely ex-patriate Turkish workforce. The machines nevertheless, remained immaculate.

And why, one wonders, has Japanese discipline and dedication to the work ethic been not only accepted but even welcomed in industrial South Wales by a workforce which hitherto has not been known for acquiescence in new patterns of work.

I commented on this phenomenon a couple of years ago but had over-looked further developments. Some 6,000 people are now employed by eight Japanese companies in South Wales and all appear to be prospering. The companies all have single-union agreements which largely eliminate squabbles over who does what. Compare this with factories with a dozen unions, a multiplicity of shop stewards and constant friction over demarcation. In the one case unity of purpose, in the other potential chaos.

**JAPANESE STYLE**

True that at least some of the Japanese-style management prefer to recruit shop-floor operatives straight from school, uncontaminated by bad practices. The difficulty of finding and keeping such recruits accepting a high standard of discipline and total involvement, and reports suggest that this leads to contentment rather than the reverse. Staff turnover, always a problem in a largely female electronic assembly shop, has declined since the pioneer companies came into the area six years or so ago, setting standards for work practices which then appeared to be difficult to enforce. The Japanese invasion, one is tempted to say revolution, in South Wales is good for the area, good for the people and no doubt good for the Japanese.

What about Racal people? The Decca electronics interests bought by Racal were doing badly at the time. Today they are again successful, and yet the workforce is composed of substantially, if not entirely, the same people as before.

Of course people and their individual qualities are important at all levels of employment but without leadership and direction their abilities and talents remain undeveloped, even willingness to work undermined.

In industry, the saying that there are no bad troops, only bad officers. Could it not be that General Sir Ernest Harrison is an inspired leader of his Racal Regiments in attacking world markets? That his shock troops down to the lowest ranks have the confidence in themselves only because of their own confidence and trust in a leadership that has never let them down?

**OUTLOOK**

1982 proved a dramatic year at home and overseas. Now in the first weeks of a new year it is even more difficult to project the future. We have yet to get the feel of a new regime in the Kremlin. With so many countries on the brink of bankruptcy it seems unlikely that the world recession will improve, if ever. Wars and rumours of war continue, both economic and military. Political warfare too, with a hard fought election at home in prospect.

The electronics industry is still good news. Even television broadcasting, with all its triviality, has brought benefits. Channel 4 resulted in millions of pounds of new equipment which still runs into this year with extensions to the transmitter network. Breakfast TV will also bring in revenue from hardware, maintenance and re-equipment.

**PROSPECTS**

On the ground we have the start-up of the Mercury data network, the prospect of cable TV and or cellular mobile radio. In the air the US space shuttle has opened up new possibilities in deployment of communications, scientific and defence satellites.

The home computer market has taken off to the extent that I read somewhere that one clever young man in the business could be worth £100 million by the end of the year. Equally, he might lose it. And apparently Gatwick No 2 Terminal will generate a lot of extra telecommunications business.

Companies like Cable & Wireless, GEC, Plessey, Racal, Ferranti and the aerospace companies will all have record turnovers, record profits and hopefully an increase in people employed. The news is not all bad, opportunities are there to be seized. One might say there are no bad times, only bad businesses.

If this is not true how does one account for the entrepreneurs who become millionaires last year in the hard grip of recession. Dick Skipworth of Memec, said now to be worth £10 million at the age of 44, or Alan Sugar running Amstrad in "consumer electronics", almost universally regarded by others as a disaster area. Or the founders of Micro Consultants up in the million bracket and the founders of Continental Microwave who have nearly reached the magic million. It's not only the big companies who make money. The little 'uns can do very nicely, too.
The use of side lights or dipped headlights during twilight conditions is now considered mandatory and can be instrumental in reducing both the frequency and severity of road accidents. Unfortunately many drivers often do not recognise the onset of twilight conditions soon enough; their eyes become gradually accustomed to the progressive reduction in ambient light level. The point at which the lights are eventually switched on is then too late; being simply too dark for safe driving without lights.

The unit described provides the driver with both audible and visual warnings of inadequate ambient light level. The threshold is adjustable over a fairly wide range and the alarm action is quite positive. The unit automatically resets when the light level returns to a safe level. The device uses readily available low cost components and can be easily and quickly fitted to any vehicle.

CIRCUIT DESCRIPTION
The light sensitive transducer, IC1, produces an output of +5V when illuminated and 0V when in darkness. The switching threshold of the device is made adjustable by means of VR1 and its supply voltage is regulated with the aid of a simple shunt Zener diode, D1. The output of IC1 is inverted by means of TR1 and then applied to the reset input of a 555 timer, IC2, which is connected in an astable configuration.

The astable provides an output at approximately 1Hz and this is applied to the I.e.d., D2, via an appropriate series resistor, R7. The low frequency square wave output is also connected to a second 555 astable, IC3. This stage operates at approximately 12kHz and its output is taken via coupling capacitor, C5, to a miniature loudspeaker.

The unit is protected against inadvertent reverse connection of the supply by means of D3. C1 and C6 provide decoupling of the supply voltage rail.

Provides audible and visual warning of an inadequate light level
CONSTRUCTION

The components are assembled on a small piece of 0.1 in matrix Veroboard measuring approximately 70mm x 43mm. as shown in Fig. 2. Terminal pins should be employed for interconnection of the circuit board with the case mounted components.

When assembly is complete, the top side of the board should be examined for correct placement and orientation of components whilst the underside should be inspected for dry joints and solder bridges between tracks. Breaks in the tracks should be made using either a proprietary spot face cutter or with the aid of a small sharp drill.

The circuit board should be mounted in the base of the plastic case using two small stand-off pillars. Interconnections from the board to the case mounted components are made using short lengths of insulated wire.

The transducer used for the alarm output of the alarm can be a conventional loudspeaker, and earpiece, or even a standard telephone insert. The nominal impedance of such a unit can be anywhere in the range 8 ohm to 10 kilohm. Most small transistor radio loudspeakers will produce more than ample volume and the value of the coupling capacitor, C5, may be altered to increase or decrease the sound level accordingly.

The light activated switch i.c. is most conveniently mounted on a separate small piece of Veroboard which may be secured to the upper surface of the case by means of a single nut, bolt and stand-off pillar. The four interconnections to the i.c. are best made using a short length of four-way ribbon cable. To improve the external appearance of the finished unit, the light activated switch i.c. may be fitted with a standard l.e.d. clip and, furthermore, it is recommended that the device be recessed (by means of an appropriate length of stand-off pillar) so that its upper surface is flush with the surface of the l.e.d. bezel. Such an arrangement not only offers a measure of protection for the i.c. but also restricts the angle over which incident light is received.

INSTALLATION AND ADJUSTMENT

Adjustment of the twilight indicator is best carried out with the unit fitted to the vehicle. Suitable locations for the alarm module include the rear parcel shelf and the front dashboard. The unit should be positioned so that the light sensitive transducer is positioned upwards facing the windscreen or rear window. The acceptance angle of the transducer is fairly wide and can, if desired, be narrowed by means of a short extension tube bonded to the mounting clip. Such a tube should, of course, be sprayed matt black.

The threshold control, VR1, should be adjusted so that the alarm operates at the onset of twilight. The alarm may be cancelled, if desired, by interrupting the supply using a single pole single throw miniature toggle switch. Automatic cancellation of the alarm when the side lights are on can be achieved simply by wiring a 10 kilohm resistor from the side light circuit to the base of TR1.
NO NOISE

Sanyo, of Osaka city in Japan, has filed a European patent application 0 056 464 on a circuit for removing pulsive noise interference from a radio signal.

Fig. 1 shows the basic idea. FM detector 11 outputs a stereo composite signal to delay circuit 31 and gate control 33. The delayed composite signal is applied to one input of a subtracting circuit 37 via emitter-follower buffer circuit 41. Capacitor 43 bridges to the other input of circuit 35 via another buffer. The subtracted output goes to stereo demodulator 15.

The delayed composite signal also goes to pilot tone extractor 45 which produces a reference signal for a conventional phase lock loop 47, which produces signals at 19kHz and 38kHz. A cancel signal is derived at 65 and fed back to the subtract circuit. Gate 67 is controlled by circuit 33 which has a high pass filter 69, noise detector 71 and shaper 73. When there is no pulsive noise or interference in the composite signal, gate control circuit 33 produces no pulse and gate 67 conducts. So the cancel signal from circuit 65 goes via gate 67 to one input of subtractor 35, while the other input receives the delayed composite. When there is pulsive noise on the composite it is detected at 71 and gate 67 switched. So the composite and pulsive noise is applied to both inputs of subtract circuit 37. The pulsive noise is removed and the stereo pilot signal cancelled. The lengthy patent gives a detailed breakdown of a convoluted series of events which brings this about.

It's worth noting in passing that while in Japan recently, visiting JVC, I heard the demonstration of a very new prototype pulsive noise suppressor. This removes interference spikes from an audio waveform and disguises their removal by replacing missing parts of the waveform by extrapolation. No details were available, but it seems likely that the technique used is a spin-off from error concealment in digital audio reproduction, where too many bits are missing for error correction to be possible. The JVC circuit, which works on any audio signal (whether from radio, gramophone or tape recorder) points the way to the future. Circuits like that described in the Sanyo patent are suitable only for FM stereo radio use.

HEADPHONE WARNING

Michael Pears of Leamington Spa, Warwickshire has filed a British patent application 2 093 242 on a warning system which tells anyone wearing headphones when the telephone or doorbell is ringing. The headphones plug into the hi-fi via the auxiliary device, and the microphones are put near the doorbell and telephone.

Fig. 1 shows how the microphones 5, 6 trip the circuit and switch relay Ra to control the headphones. When there is no signal from microphones 5 & 6 transistor T2 is switched off, via resistors R1, R2. The collector voltage of T2 is too low to switch NOR gate G1.

When either or both of the microphones picks up a sound signal, T2 receives a signal via capacitor C2. This switches it at a rate determined by the frequency of the audio input from the microphone. While T2 is momentarily non-conductive, its collector voltage rises to switch gate G1. Gate G2 now has signals at its inputs and switches T1 to operate relay R2. Gates G1, G2 latch on with feedback and the headphones are disconnected from the hi-fi, and switched to receive the sound from the microphones. So the listener suddenly stops hearing music and hears the door or telephone bell instead. Re-set button 10 puts the system back to normal for music listening.

There is also a modified time sensitive circuit in which the ringing current is rectified and stored in a capacitor until a threshold value has been built up. In this way brief false alarm sounds cannot trigger the system.
**Microdoctor**

Is an alternative to AUTOMATIC TEST EQUIPMENT which can be very expensive. MICRODOCTOR is perfectly adequate for diagnosing faults in microprocessor boards or computers in the REPAIR SHOP or on the PRODUCTION LINE. Reports are PRINTED on the integral thermal printer. Tests supported are CHECKSUM, RANTEST, WAIT, READ, WRITE, ID READ, ID WRITE, DUMP IN HEX, DUMP IN ASCII, TEST DATA LINES (for shorts between data, address and rails). SEARCH (for two specified bytes), MAP (print a memory map of ROM, RAM, ID and EMPTY SPACE). Supports both multiplexed and non-multiplexed address/data. Standard software will also DISASSEMBLE in Z80 mnemonics – other disassemblers cost extra. Programs for board-testing can be written in MINUTES – and retained for MONTHS even if the power is switched off (CMOS RAM is backed up with rechargeable battery). Capacity is 15 different programs of 12 tests each. Included are two PROBE CONFIGURATION CARDS (one Z80, other uncommitted). PROBE with 24 inch cable and 40-pin DIL plug – and POWER SUPPLY. Extras available are 6502 disassembler retrofit. Clipeover PROBE (only needed if .P is soldered -in) £35.

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---

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£169 + VAT

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**Dataman Designs**

LOMBARD HOUSE, CORNWALL ROAD, DORCHESTER, DORSET DT1 1RX. Telephone: Dorchester (0305) 68066 Telex 418442 DATAMAN

Prepaid orders normally shipped by return. Prices include Post and Packing. Postage in UK £1.00, Europe £3.00, Rest of World £5.00. VAT should be added at current rates.
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These rugged general purpose meters feature colour coded scales, fuse and diode protection and a choice of 20 or 30 kΩ/V sensitivity. Supplied with test leads and a strong rigid carrying case.

**BRIEF SPECIFICATION**

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<tr>
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<th>AMM 201</th>
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<tr>
<td>No. of ranges</td>
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<td>60mV–300V</td>
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<td>10–1000V</td>
<td>6–1200V</td>
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<td>a.c.</td>
<td>50µA–250mA</td>
<td>30µA/600mA</td>
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<td>Current ranges d.c.</td>
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<td>20Ω–2MΩ</td>
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<td>Resistance ranges (full scale)</td>
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<td>-20 to +31</td>
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<td>dB ranges</td>
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To: ANDERS Electronics Ltd. (PE Meter Offer), 48–56 Bayham Place, London NW1 OEU. Tel: 01-387 9092.

Please send me

| AMM 201 at £15.95 each |
| AMM 301 at £19.95 each |

I enclose PO/Cheque No. Value

Name
Address

Please allow 28 days for delivery

OFFER CLOSES FRIDAY, MARCH 25, 1983

Name
Address

To: ANDERS Electronics Ltd. (PE Meter Offer), 48–56 Bayham Place, London NW1 OEU. Tel: 01-387 9092
Many lower-cost car radio receivers fail to provide satisfactory reception of weaker signals. Whilst this may be of little concern to the motorist who wishes to listen mainly to the BBC Radio Four transmission on long wave and perhaps also one or two local stations, those who are a little more adventurous in their listening habits will derive considerable benefit from enhanced receiver performance.

Many of the problems associated with poor receiver sensitivity can be readily overcome by providing the receiver with a larger input signal. This will considerably improve reception; not only is the signal "louder and clearer" but the effects of ignition interference and miscellaneous noise generated by the engine can be greatly reduced.

The radio Booster described not only provides some 10dB, or so, of additional signal gain, but also improves the efficiency of the aerial matching. The unit offers two separate inputs; one for low and mid-frequencies (100kHz to 3MHz) and one for high and very high-frequencies (3MHz to 120MHz). These inputs exhibit appropriate impedances for matching typical car aerials intended for MW/LW and VHF reception respectively. The result is a properly matched wideband preamplifier system which will be more than adequate for the reception of all but the weakest signals.

The unit is simple to construct, uses only one integrated circuit and one field effect transistor, and requires no alignment or internal modification to the existing receiver.

CIRCUIT DESCRIPTION

The complete circuit diagram of the radio Booster is shown in Fig. 1. The LF/MF aerial is connected to the high impedance input at SK1. Silicon switching diodes, D1 and D2, provide input protection for TR1 which operates as a source follower in order to buffer the relatively low input impedance of IC1. The HF/VHF aerial is connected to the low impedance input at SK2. Simple frequency compensation is provided by L1, C3 and R3. This network improves stability and assists with the duplexing of the LF/MF and HF/VHF inputs.

IC1 is a fixed gain broadband RF amplifier. This device provides a nominal voltage gain of 10 with an upper frequency 3dB point of typically 140 MHz. Ferrite bead, L2, and capacitor, C5, provide efficient supply decoupling at VHF whilst C11 and C7 decouple the supply at other frequencies. A simple shunt Zener stabiliser, D3, regulates the supply at approximately 6V. The π network provided by L3, C8 and C9 reduces supply-borne ignition and electrical noise to a minimum whilst C10 reduces generator whine. Reverse supply protection is provided by D5 and the presence of the supply is indicated by led. D4.

CONSTRUCTION

The radio Booster is built using a single-sided p.c.b., the copper foil layout of which is shown in Fig. 2. The layout is quite critical, particularly if good VHF performance is to be maintained, and thus no other form of construction should be attempted.

IC1 should preferably not be fitted with a holder and all other components should be fitted with the minimum lead length. Components are most conveniently fitted in the following order; terminal pins, resistors, capacitors, inductors, diodes, transistor, and integrated circuit. Care should be taken to ensure correct polarity of the electrolytic capacitors, diodes, transistor, and integrated circuit. The p.c.b. component layout is shown in Fig. 3.
Once complete, both sides of the p.c.b. should be carefully checked. The foil side should be examined for dry joints and solder bridges between tracks. The component side should be checked for correct placement and orientation of components. The p.c.b. should then be mounted into the diecast case using four short stand-off pillars. Note that, to minimise stray pick-up of electrical noise, the use of a screened metal case is absolutely essential.

Wiring from the p.c.b. to the case-mounted components should follow the layout shown in Fig. 4. Note that the OV connection is made at three separate points, each being a solder tag secured by one of the two retaining nuts of each input socket. Care should be taken to ensure that the polarity of the l.e.d. D4, is correctly observed. A standard 5-pin 180° DIN socket is used for power input; the positive connection being taken to pin 1 whilst the negative connection is taken to pin 3. Constructors may, of course, substitute a different power connector, or pin convention, to suit their own preference.

INITIAL TESTS AND INSTALLATION

Connect the output socket, SK3, to the aerial input of the car receiver using a length of either 75 ohm or 50 ohm coaxial cable terminated with suitable connectors. The length of this cable is not critical.

The radio Booster should, ideally, be located as close to the aerial as is practicable, however, this arrangement may be difficult to realise particularly if the aerial is roof mounted. In any event, the feeder run from the aerial to the Booster should not exceed about 2 metres in length and must be routed well away from any vehicle component which produces a significant amount of electrical noise (eg; wiper motors). The cable used for this run should be the feeder which was originally supplied with the aerial, suitably cut short. It should not be 50 ohm or 75 ohm cable.

Connect a VHF rod aerial to SK2 using a short length of 50 ohm or 75 ohm cable. If only one aerial is to be used for the reception of both LW/MW and VHF, this should be connected to SK2 and not SK1. If VHF reception is not required, the MW/LW aerial should be connected to SK1 and SK2 should be left disconnected. The use of an appropriate base-loaded antenna is recommended for short wave listening in the HF broadcast and amateur bands. Such an aerial should be connected to SK2 via an appropriate length of 50 ohm cable. If an aerial tuning unit is to be employed, this should be connected between the HF aerial and SK2, taking care to observe adequate screening and earth connections.

Connect SK4 to the vehicle's 12V power source using any convenient length of cable and connecting point. The cable should be routed well away from the aerials and vehicle ignition system. Check that D4 is illuminated. If this is not the case, check the polarity of the supply connections, D5, and the l.e.d. itself. The voltage developed across D3 may also be checked and this should be approximately 6V.

Tune the receiver across the desired band and note the improvement in signal strength. Note that, unless the receiver has a signal strength indicator, little effect will be noticed on signals which are already strong enough to actuate the receiver's automatic gain control system. Weaker signals, which may not have been audible before, should be greatly improved. A quick check can be made by reverting back to the original aerial system without the radio Booster connected in circuit. If ignition interference is a problem, the diecast case of the Booster should be earthed to the chassis of the vehicle. The earth connection at the aerial end of the input cable should also be checked.
**COMPONENTS**

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Capacitors</th>
<th>Miscellaneous</th>
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<tbody>
<tr>
<td>R1 330k</td>
<td>C1 22p</td>
<td>SK1 Standard Belling Lee coaxial socket</td>
</tr>
<tr>
<td>R2 2.2k</td>
<td>C2 47n</td>
<td>SK2 Standard Belling Lee coaxial socket</td>
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<tr>
<td>R3 270</td>
<td>C3 100p</td>
<td>SK3 Standard Belling Lee coaxial socket</td>
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<tr>
<td>R4 100</td>
<td>C4 47n</td>
<td>SKF 3- or 5-pin 180° DIN socket</td>
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<tr>
<td>R5 220</td>
<td>C5 1n ceramic</td>
<td>p.c.b.</td>
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<tr>
<td>R6 1k</td>
<td>C6 47n</td>
<td>Stand-off pillars (4 off)</td>
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<tr>
<td></td>
<td>C7 470n polyester</td>
<td>Diecast case</td>
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<td></td>
<td>C8 100n polyester</td>
<td>Terminal pins</td>
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<td></td>
<td>C9 100n polyester</td>
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<td></td>
<td>C10 100µ 16V p.c. mounting electrolytic</td>
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<td>C11 1n ceramic</td>
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All resistors are 1/2W 5% carbon

**Inductors**

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<tr>
<td>L1 10µH</td>
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<td>L2 Ferrite bead</td>
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<td>L3 1m</td>
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Components and p.c.b. are available from Howard Associates, 59 Oatlands Avenue, Waybridge, Surrey, KT13 9SU.

**WANTED**

- circuit diagram with installation notes on Leak Varislope 2 stereo preamplifier. H. G. Wilkinson, Lyndene, Greengill, Aspatria, Carlisle, CAS 2RA.
- MULTIMETER for radio/t.v. v.g.c. £12. 01 554 2913 evenings. Shanti, 536 East Ave, Ifford, Basingstoke, Hants GU14 OAH.  
- DISCO, complete console with light show, mics, mixer box many extras £300 or offer. Farnborough 543641. Mr. R. M. Schoenewolf, 5 St. Christophers Road, Cove, Farnborough, Hants GU14 OAH.
- HEATHKIT 5 inch scope plus manual and X1, X10, probe hardly used, working but needs slight attention £50. Buyer collects. R. Yates, 124 High Road, North Weald, Essex. Tel: 037 882 3303.
- LOUDSPEAKERS, Baker 12 inch Wharfadle, 8 inch Tweeter 3 inch Goodmans Axion 10 inch including crossover. All 150£ £12. Tel: 01 368 3931. A. R. De Groot, 33 Albemarle Road, Barnet, Herts.
- KEITHLEY 600B Electrometer, hardly used. Offers or swap CB rig, video. R. G. Rush, 4 The Bury, Shillington, Hitchin, Herts SG5 3PB.
- TRITON computer 36K RAM 8K BASIC cased motherboard professional cassette 1200 baud, Teletype and v.d.u. £400. o.n.o. Y. Pirgali, 316 Reigate Road, Downham, Bromley, Kent BR1 5JN. 68B 5299 after 6 p.m.
- WANTED electric typewriter golfball or daisy wheel usable as printer send description, photo. price to: R. Arnold 19 Ave de Senarcens, CH 1293 Bellevue, Switzerland.
- SINCLAIR SC110 scope x 1 £10 probe, mains adaptor. Nicads, manual, case. Pristine, £100. Tel: 0553 86 618. Mr. S. V. Windebank, 36 Springvale, Gayton, Kings Lynn, Norfolk PE32 1QZ.
- SWAP/SELL: ZX81 any condition. Tel: Cork 021 51/6/1 computer grade p.s.u. Four 1.5A modules.  
- SV6A computer grade p.s.u. Four 1.5A modules. All conceivable features £20 o.n.o. Will split. Tel: 0553 86618. S. V. Windebank, 36 Springvale, Gayton, Kings Lynn, Norfolk PE32 1QZ.

**BAZAAR**

**PRINTER** Creed 7B 240V with opto signal interface keyboard and cover. Working with diagrams £28.00 M. J. Wilsher, 144 Bedford Road, Hitchin. Tel: 0426 33209.
- EPROMS two 64K, both new and unused, £9. Ring 041 332 3841. P. Thompson, 228 West Princes Street, Glasgow G4 9DL.
- CASIO FX502P £35 and FX501 P £30 or near.
- CASIO FX502P £35 and FX501 P £30 or near.
- ACORN atom 12K ROM 12K RAM. Two utility programs +L.7 monitor £35. G. Baines, 20 Sugden Court, Dunstable, Beds. Tel: 0582 600913.
- CASIO FX502P £35 and FX501 P £30 or near.
- CASIO FX502P £35 and FX501 P £30 or near.

**Resistors**

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<td>C3 100p</td>
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</tr>
<tr>
<td>C4 47n</td>
<td></td>
</tr>
<tr>
<td>C5 1n ceramic</td>
<td></td>
</tr>
<tr>
<td>C6 47n</td>
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<td>C7 470n polyester</td>
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<tr>
<td>C8 100n polyester</td>
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</tr>
<tr>
<td>C9 100n polyester</td>
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</tr>
<tr>
<td>C10 100µ 16V p.c. mounting electrolytic</td>
<td></td>
</tr>
<tr>
<td>C11 1n ceramic</td>
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**Inductors**

<p>| | |</p>
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<tbody>
<tr>
<td>L1 10µH</td>
<td></td>
</tr>
<tr>
<td>L2 Ferrite bead</td>
<td></td>
</tr>
<tr>
<td>L3 1m</td>
<td></td>
</tr>
</tbody>
</table>

**Miscellaneous**

- SK1 Standard Belling Lee coaxial socket
- SK2 Standard Belling Lee coaxial socket
- SK3 Standard Belling Lee coaxial socket
- SKF 3- or 5-pin 180° DIN socket
- p.c.b.
- Stand-off pillars (4 off)
- Diecast case
- Terminal pins

**COMPONENTS**

- Resistors
- Capacitors
- Semiconductors
- Miscellaneous

**Fig. 4 (above)** Internal wiring diagram of the printed circuit board to the external sockets

**Fig. 5 (right)** Interconnecting diagram for MW/LW and HF/VHF aerials. If only one aerial is to be used for MW/LW and VHF this should be connected to SK2
THIS is the first single-page data sheet in a series for users of the PE Microcontroller. The aim is to provide some more detailed information on the operation of the DISBUG monitor to assist the development of user control programs. Where appropriate, more detailed data on the hardware will also be included.

DISBUG RAM LOCATIONS
The memory locations at the top of the RAM region are reserved for use by DISBUG. Locations 03A0 up to 03FF are used by the monitor program to record the current status of the monitor, to hold the addresses of various service routines, to record the results of various monitor routines, and for a variety of ‘housekeeping’ purposes. An understanding of the routines in DISBUG requires a knowledge of the structure of this RAM region, which is shown below. The mnemonic names are also shown to simplify reference to locations in future data sheets. It should be noted that some of the values are stored in two bytes of memory, e.g. PF1SRA.

<table>
<thead>
<tr>
<th>DISPLAY</th>
<th>STATDIS</th>
<th>03FF</th>
<th>Status code/prompt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>03FE</td>
<td>MS address digit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>03FD</td>
<td>Address digit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>03FC</td>
<td>Address digit</td>
<td></td>
</tr>
<tr>
<td>ADDDIS</td>
<td>03FB</td>
<td>LS address digit</td>
<td></td>
</tr>
<tr>
<td>SEPODIS</td>
<td>03FA</td>
<td>Separator character</td>
<td></td>
</tr>
<tr>
<td>DATADIS</td>
<td>03F9</td>
<td>MS data digit</td>
<td></td>
</tr>
</tbody>
</table>

KEYBOARD
The Microcontroller keyboard is scanned by a subroutine called KEYBOARD, which also includes a 20 millisecond debounce routine. The routine assumes that the keyboard PIA has been correctly set up by the DISBUG initialisation routine (which is executed automatically at power-up), and it uses a maximum of four bytes of stack space. The scan routine is called by ‘JSR KEYBOARD’, which is coded as BD F8 2C. There are no entry parameters, but the routine corrupts all registers except SP. On exit, r8 will contain a reply code of: ‘01’=valid key found; ‘00’=no key found; ‘FF’=uncertain result (differing results from the two key scans). The location (key address in the matrix in an internal code) of the first key found depressed in the first scan will be found in rA; this will only be valid for a reply code of ‘01’. The KEYADD store will be equal to the contents of rA, and KEYFLAG will be set to ‘FF’ if a key was found on the first scan, or to ‘00’ if no key was found on the first scan.

KEYBOARD SCAN ROUTINE
The address in the key matrix produced by the KEYBOARD routine is converted into the appropriate DISBUG key code by a subroutine called KEYCODE. This will normally only be called if the reply code from KEYBOARD was ‘01’; the routine will, however, correctly handle a reply code of ‘00’. The conversion routine is called by ‘JSR KEYCODE’, which is coded as BD F8 77, and the maximum stack usage to be allowed for is 2 bytes. On entry to the routine, rA should contain the key address from the KEYBOARD routine, and r8 should contain a ‘00’ or ‘01’ reply code from KEYBOARD. The KEYCODE routine corrupts all registers except SP, and on return the key code is contained in rA, and also in RAM location KEYCD. The table below shows the correspondence between keys, key addresses and key codes to be expected in DISBUG, and should allow readers to use these routines in their own control programs. (M.T. & D.W.)

<table>
<thead>
<tr>
<th>KEY</th>
<th>ADDRESS</th>
<th>CODE</th>
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<tr>
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<td>00</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
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<td>0E</td>
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<tr>
<td>15</td>
<td>66</td>
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<table>
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<th>CODE</th>
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<td>REGISTER</td>
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<td>02</td>
<td>PRESET</td>
</tr>
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<td>3</td>
<td>03</td>
<td>MEMORY</td>
</tr>
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<td>04</td>
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<td>PF2</td>
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<td>9</td>
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<td>NEXT</td>
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<td>FIELD</td>
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<td>14</td>
<td>0E</td>
<td>SWICSR</td>
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<table>
<thead>
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<tr>
<td>03C4</td>
<td>UMRSA</td>
<td>User monitor routine</td>
</tr>
<tr>
<td>03C3</td>
<td>CRS</td>
<td>Current register</td>
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<tr>
<td>03BF</td>
<td>VARS</td>
<td>Variable storage</td>
</tr>
<tr>
<td>03BE</td>
<td>QSTACK</td>
<td>Top of DISBUG stack</td>
</tr>
<tr>
<td>03A0</td>
<td>USTACK</td>
<td>Top of user stack</td>
</tr>
</tbody>
</table>

Key Code of FF—No key pressed
PROGRAMMABLE UNIJUNCTION TRANSISTORS

P. GATEHOUSE

In this article I shall attempt to do justice to a device which has arrived quietly amongst all the magnificent i.c.s we keep devouring. Programmable Unijunction Transistor (PUT) circuits have proved reliable and sturdy solutions to situations in which I would have placed an i.c. and I hope to convince you that a few PUTs are a useful investment.

THE DEVICE

The circuit symbol (Fig. 1) for the PUT is that of the SCR, but with the gate at the other end. Essentially that's all a PUT is; a "complementary" SCR triggered not by a pulse positive with respect to the cathode, but by a pulse negative with respect to the anode. However, unlike SCRs, the holding (valley point) current is determined by conditions at the gate. Fig. 1 shows a transistor circuit equivalent to the PUT; when \( V_G = V_A \), TR1 is biased off and no current flows through the base junction of TR2 so that stays off. As \( V_G \) becomes negative with respect to \( V_A \), a current \( (\text{later} \, I_G) \) flows through TR1's base allowing it to pass current to the base of TR2 which is negative with respect to \( V_A \). Now that TR2 is biased on it proceeds to increase the eb current of TR1 further, and the circuit conducts current from A to K until \( V_A \) is made negative with respect to \( V_G \) (this is oversimplified, as the next section will show).

PUT CIRCUIT SYMBOL

SEMICONDUCTOR STRUCTURE

TRANSISTOR EQUIVALENT

PUTs are not high-power devices. Anode currents are of the order of a hundred milliamps maximum, and the anode-cathode breakdown voltage is around \( \pm 50V \) for the devices mentioned in this article.

The only PUT widely available is the 2N6027, a general-purpose specimen, with the 2N6028 (for timer applications in particular) not unheard of. An alternative is the BRY39 silicon controlled switch which has leads connected to all four regions (Fig. 1) so you can't go wrong! Leave the cathode gate unconnected and you have a PUT.

ELECTRICAL CHARACTERISTICS

The anode voltage \( V_A \) of the PUT in Fig. 2 is plotted against the current flowing through the anode terminal, \( I_A \) in Fig. 3. This is not the usual characteristic, which is current against voltage, but for the PUT Fig. 3 is more useful.

In section NO of the curve, \( V_A < V_G \) so only a leakage current flows out of the anode: \( I_A = I_L \) (which is negative). This is of the order of 0-1mA maximum at high temperatures, and decreases to about 10nA at room temperature. Except in long-delay timer circuits it is negligible. At O, the anode and gate are equipotential so its not surprising that \( I_A = 0 \), anode-cathode leakage being all but immeasurable.

When \( V_A \) exceeds \( V_G \) by the earlier explanation, the AK circuit is thrown into conduction. The characteristic shows that the PUT still refuses to conduct until \( P \), at \( V_A \) about 0-5V greater than \( V_G \), the anode current at \( P \), \( I_P \), being a few \( \mu \)A. \( V_A \) at this peak on the graph is termed the peak point voltage, \( V_p \), and the corresponding anode current, the peak point current \( I_P \). The difference \( V_p - V_G \) is known as the offset voltage \( V_T \) and is due almost entirely to the BE voltage required to pass a current through TR1. \( V_T \) is approximately 0-5V and decreases slightly with increasing temperature. Now the programmability becomes apparent, for \( V_p \) depends on \( V_G \) which is set by the external circuitry; the voltage at which the PUT switches is under your control, or programmable.

The switching process is represented by PV on the curve, a "negative resistance" region in that \( V_A \) falls as \( I_A \) increases. No point on PV is a stable state for the negative gradient simply invites more current to flow. If this current is available, the anode current increases until the PUT is driven past \( V \) into saturation. However, if the anode current cannot remain above \( I_V \) or, as a result of the current being \( > I_V \), the anode voltage falls below \( V_V \), the PUT returns to a non-conducting state.

In Fig. 3, this condition is indicated by the load line LL' which is the relation imposed upon \( V_A \) and \( I_A \) by the anode load resistance \( R_A \) when \( V_A \), which is approximately equal to \( V_V \), is held constant as the PUT switches on: \( V_A = V_p \) and \( -I_A - I_V \) \( R_A \) simply represents the voltage drop across \( R_A \). Where this line crosses the "on" characteristic are the values of \( I_A \) and \( V_A \) when the PUT has assumed its new state. As mentioned above, if the anode current is available, \( Q \) is on \( V_S \) i.e. \( R_A \) has a LOW value; the line LL' has a shallow gradient. If \( R_A \) were so large as to prevent saturation, LL' would be steeper and \( Q \) would be on PV. When a PUT has become saturated and \( I_A \) is subsequently reduced below \( I_V \), the load line MM' indicates by the position of W the conditions after the PUT has reverted to the "off" state.

The valley point \( V \) is the "holding" current: the value of \( I_V \) is dependent upon the gate conditions and is thus programmable as is the peak point voltage. By altering the circuit conditions, the PUT can be used as a latch (driven into saturation and

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holding the “on” state) or as an oscillator (failing to hold the “on” state). This increased versatility over the UJT is also less expensive for the properties of the UJT are fairly critical; the only apparent disadvantage of the PUT is that its maximum operating frequency is about one fifth that of the UJT—the 2N6027 will not get past approximately 100kHz. The “standoff ratio” frequently encountered in UJT and PUT circuits is another word for the gate voltage $V_G : V_G = \frac{\tau}{V}$ where $\tau$ is the standoff ratio and $V$ is the supply voltage. It cannot be altered in UJTs unless you make them, but as mentioned before, you are free to select $V_G$ with PUTs.

**BASIC APPLICATIONS—RELAXATION OSCILLATOR**

This circuit is probably the most simple and reliable relaxation oscillator possible. Fig. 4 shows the general idea and the waveforms seen on a scope at the terminals. As $C$ charges through $R_4$ $V_A$ rises. When $V_A$ exceeds $V_G$ the PUT conducts from $A$ to $K$ (depending on the supply voltage you can neglect $V_T$ and discharges $C$ through $R_3$ which limits the peak discharge current during the pulse seen on $V_K$. When $C$ is discharged it is vital that $R_4$ is so large that it cannot supply the valley point current $I_v$ of around 50µA depending on $R_1$ and $R_2$. The PUT does not remain saturated if $I_A$ falls below $I_v$ and reverts to the “off” state, allowing $C$ to charge up again. At the gate, $V_G$ is set by the potential, divider $R_1$ and $R_2$ connected across the supply lines; this determines how far $C$ is allowed to charge and thus the frequency of oscillation.

In the conducting state, the PUT draws current from $V_G$ (the gate current $I_G$) through TR2 in Fig. 1 so do not reduce $R_1$ to below a few hundred ohms. The gate resistors program not only $V_G$ but also control the peak point current and valley point current.

**TIMERS**

Timer circuits are very similar to the oscillator except the time-constant $RC$ will probably be longer and $R_4$ is small enough to supply an adequate holding current. The leakage current of approximately 10nA must be taken into account when dealing with large time-constants. Once $V_A$ exceeds the PUT gate voltage by $V_T$, the PUT is saturated by the current through $R_4$ and remains off (Fig. 5).

An alternative employing only the PUT which is probably the simplest timer circuit possible is shown in Fig. 6. This demonstrates a new approach; the gate voltage is gradually reduced as a result of a charging of capacitor $C$. Here the offset voltage previously neglected is vital to the circuit, for the PUT conducts when the voltage across $C$ reaches $V_T$ i.e. about 0.5V. Low-voltage power supplies are needed for decent delay times with this circuit.

**LATCH CIRCUITS**

Latch circuits employ the PUT as an SCR triggered by an inverted pulse at the gate (Fig. 7). As soon as $V_G$ falls below $+V$ by more than about 0.5V ($V_T$ again), the PUT “fires” and with an adequate anode current remains on. The circuit is reset either by breaking the anode current circuit at $A$ or $K$, or by forcing the gate (which will now be less than $+V$ because of the gate current $I_G$) to $+V$. $R_1$ and $R_2$ will be needed depending on the exact form the trigger takes; a capacitor could even be used to get the PUT to trigger on any falling edge. Touch switches are not impossible, the PUT is sensitive enough.
WORKING CIRCUITS—PUT OSCILLATOR

A basic oscillator is shown in Fig. 8. The cathode pulse is very useful as it has a clean, sharp leading-edge and is also fairly powerful as it is the charge of C being dissipated in a much shorter time than it took to build up, TR1 inverts the pulse to provide powerful as it is the charge of C being dissipated in a much shorter time than it took to build up, TR1 inverts the pulse to provide.

Petrol 8k small keyboard BASIC S ROMS manuals, many programs as new could possibly deliver £200. Tel: Denbigh 3401. F. R. Stott, "Tywyn", School St. Henlans, Denbigh, Chwvd. ZX81 16K RAM 5/0 Port manual £56 o.n.o. Tel: 01 451 1879. Peter Rouse, 27 Christchurch Avenue, London NW6 7QP.

If TR1 is replaced by a l.e.d., R5 left out and the time-constant adjusted for the largest possible capacitor, it is safe to exceed the power rating of a l.e.d. in bright flashes. The higher the value of \( CV' \), the more energy per pulse (max. 250uJ)—but with a pulse length of around 10-100uS that’s over 1W power during a pulse).

PUT SIREN

As with UJT’s, relaxors oscillators may be coupled together so that one controls the frequency of oscillation of the other forming a siren (Fig. 9). With C2 charging gradually and the voltage at A2 rising, the charging current supplied to C1 is increased by the larger contribution made through RX and the time-constant of PUT1 decreased. This cycle repeats, with the frequency of oscillation of PUT1 rising steadily, until PUT2 discharges C2 when the a.f. output returns to the start of the climb.

OPTICAL SENSORS

The PUT is most useful in optical sensor latch configurations for detecting “flashes” of light or darkness. Sensors such as the ORP12 I.d.r. are obvious for Fig. 7.

SUPERBOARD 24K BASIC’s 4, 5, 20 screen formats, £70 software + more £275 o.n.o. Mr. A. J. Clarke, Tel: St. Allans 34566. ZX81 and 16K RAM Sinclair built (both), p.s.u. leads manual etc. £80 Tel: 01-778 4889 R. A. Norman, 101 Avenue Road, Beckenham, Kent BR3 4RX.

UK101 uncased, Wemon monitor 300/500 baud + software, cassette recorder and 12 inch b/w TV £180 o.n.o. after 5 p.m. Tel: 051 922 9565. M. Vicars, 4568 Stanley Road, Bootle, Merseyside L20 5AS.

SPT-HIGH (Langley) 19 inch cabinet rack on castors, detachable back clipons, vent panels £80 buyer collects. G. Turner, 6 Ludgate, Tring, Herts GP23 4ES. Tel: Tring 3320.

PE & HE for sale. Will swap for working computer gear HE from Aug 79 PE from April 79 to date. F. W. Webb, 17 Low Downas Road, Hettone-Hole, Tyne and Wear. Tel: Hexton 268883.

SPARKRITE Voyager car computer: boxed, unused £40. D. V. Porter, Tel: 021 747 4472.

AVO 8, casd, immaculate condition £70. 12 element high gain v.h.f./f.m. antenna £40. Tel: 03446 2174. N. R. Jonas, “White Caim”, Wellington College, Crowthorne, Berkshire.

ORGAN parts for Maplin MS51/2. Two 9-key keyboards — several boards — reverber unit £70 o.n.o. Buyer collects. G. Roberts, 25 Holmes Road, Breanpool, Derby DE7 3BT. Draycott 3819.

FX-602P Alpha programmable calculator. 512 steps. Three months old. Lots of software. Any offers? Phone after 7 p.m. Jeffrey 01 458 3025.

UK101 case 32K RAM, 22K EPROM, printer. EPROM programmer. Assembler / Dissembler / CEGMON / MON 2 EPROMS 32X48. 300/600. Software £525 o.n.o. Mr. D. G. Hubble, Edith House, Stow Road, Oxford, OX4 2HB.


Wellington College, Crowthorne, Berkshire.

Petrol 8k small keyboard BASIC S ROMS manuals, many programs as new could possibly deliver £200. Tel: Denbigh 3401. F. R. Stott, "Tywyn", School St. Henlans, Denbigh, Chwvd. ZX81 16K RAM 5/0 Port manual £56 o.n.o. Tel: 01 451 1879. Peter Rouse, 27 Christchurch Avenue, London NW6 7QP.
SUPEROBOARD 2 BK cased Wemon Monitor £190 32 x 32 Screen 300/600 baud automatic tape control numeric keypad £110. Mr. A. Morten, "Rosswood", Nursery Lane, Bargoed, Buteon, Dyserth Tel: 0298 4601.

TRANSCENT P.D. X String synthesiser very little used. Must sell £290 o.n.o. J. Bedward, 9465. 200 A.ECH 100M 75M 50M 68Kk New Welwyn C25 precision resistors 80p each offers the lot. Hill: Tel: 0665 77 354.

SUPEROBOARD Cased [Challenger 1P] BK RAM 24K E100 in good condition, sounds great, games, software £120 o.n.o. S. F. Astbury, 26 Gregory Close, Harlaston, Grantham, Lincs. NG32 LUG. Tel: 07487 3477.

PRINTER DAM Dynamics RS33 with 6 rolls paper 110 baud good condition £50. C. L. Loo, 1352 Road 35, Kepong Garden, Kuala Lumpur, Malaysia.

CREED Teleprinter and cover complete with 20mA interface driving software for £80/280 P/E. Coney, Mareham-Le-Fen, Boston, Lincs. Tel: (0655886)267.

AY-5 1230 Clock Timer Chip new £2.50. Other components surplus to requirements. Details S.A.E. G. A. Noble, 50 Griffiths Slough, Berks SL2 1HF.

For sale test equipment valves PV, PE, TV, EE, wanted manual circuit for Cossor Oscillograph Oscilloscope. Mr. N. Vassanen; 23 Tilson House, Tilson Gardens, London SW2 4LY. Tel: 01 674 2856.

KEYBOARD and gold contacts for D.I.Y. synth. or organ builder. 4 octaves £30. 061 962 6197. Mike Gardiner, 36 Victoria Drive, Sale, Cheshire, M33 2H7.


STRONG Chess Computer Murphy Encore. Many features, one month old £110-00. Tel: Northampton 715458. Mr. M. B. Pirbainch, 72 Newnham Road, Northampton.

COMPUKIT UK101 BK cased and software, two month old Will accept reasonable offer. Tel: Northampton 715458. Mr. M. B. Pirbainch, 72 Newnham Road, Northampton.

COIL winder automatic Manual Coil Winder Co. The Doncaster, E106 W. Greig, 45 Mansfield Crescent, Clarkson, Glasgow G76 7EA. Tel: 041 638 6157.


WANTED SE3A Scope Tube. J. Glover, 1 Bryony Cottages, Hambledon, Godalming, Surrey GU8 4JH. Tel: 0486 749202.

VALVES, unused assortment, details from Oxted. Details please add 15% VAT & P&P. Sale, 0-150mA at X1 range £400 o.n.o. Mrs. Pirbainich, 72 Newnham Road, Northampton.

TRITON L7.24 8AM RAM £3 basic sound gen. Eprom progr. Teletype, VDU, professional cassette. 2400 baud programme graphics all £400 o.n.o. Mrs. P. Pirgali, 361 Reigate Road, Sidmouth, Devon. Tel: 698 5399 after 6 p.m.

S.T.5 (0) 12 Gauge Station Wagon £16.50. 2 15A motor switches £1.50 each. Two £50. P. Coney, Mareham-Le-Fen, Boston, Lincs. Tel: 10658861267.

Et1 wanted Mixer 10-2, unfinished, required some components and wiring, well made woodwork and metal work £50. A. J. Kinch, 2 Hedge End. Woodstock. Oxford. OX7 1NFP. Tel: Woodstock, 811689.


UK101 BK Cased Cegmon BASIC-5 Joy stick. Used, in sound/outs software. £15. Swap W.H.Y. etc Mr. J. Bedward, 21 Withies Lane, Midsomer Norton, Avon BA3 2JE. Tel: 412 280.

COLOUR TV panels wanted for G.E.C. C2110 series line and field in particular. Patrick Doherty, 120 Montrose Park, Galway, Ireland.

Bells 24 volt 6 inch £6 each, ideal for burglar alarms, fire alarms etc. Only 24 available. M. Harries, 152 Leicester Street, Whitemoor Reans, Wolverhamton, West Midlands.

WANTED Instruction Handbook for Olivetti QL computer to buy or copy. Small fee? Paul Compton, Hadham Hall School, Little Hadham, Ware, Herts.

TANDERG 3514X 4 track tape deck, 7" mint (genuinely unused). S-on-5 £90 o.n.o. (ex change Jupiter Acer) Tel: 07605-402 (Norfolk).

ET1 Master Mixer 10-2, unfinished, required some components and wiring, well made woodwork and metal work £50. A. J. Kinch, 2 Hedge End. Woodstock. Oxford. OX7 1NFP. Tel: Woodstock, 811689.


TELEPRINTER in acoustic case with p.s.u. computer interface information available £35.00. Tel: Malmesbury (0292) 701 614.

WANTED Teleequipment D66 Circuit diagram original or photostat and technical books radio by G. N. Patchett. Urgent: Tel: 01-422 2802 Daytime.

ELEKTROR high com. set of completed circuit boards inc. chips, modules, unused £45. Charles Bowden, 7 Parc Eglos, Helston, Cornwall TR13 8UP.

COLOUR TV panels wanted for G.E.C. C2110 series line and field in particular. Patrick Doherty, 120 Montrose Park, Galway, Ireland.


UK101 BK Cased Cegmon BASIC-5 Joy stick. Used, in sound/outs software. £15. Swap W.H.Y. etc Mr. J. Bedward, 21 Withies Lane, Midsomer Norton, Avon BA3 2JE. Tel: 412 280.

COLOUR TV panels wanted for G.E.C. C2110 series line and field in particular. Patrick Doherty, 120 Montrose Park, Galway, Ireland.

Bells 24 volt 6 inch £6 each, ideal for burglar alarms, fire alarms etc. Only 24 available. M. Harries, 152 Leicester Street, Whitemoor Reans, Wolverhamton, West Midlands.

WANTED Instruction Handbook for Olivetti QL computer to buy or copy. Small fee? Paul Compton, Hadham Hall School, Little Hadham, Ware, Herts.

TANDERG 3514X 4 track tape deck, 7" mint (genuinely unused). S-on-5 £90 o.n.o. (ex change Jupiter Acer) Tel: 07605-402 (Norfolk).

ET1 Master Mixer 10-2, unfinished, required some components and wiring, well made woodwork and metal work £50. A. J. Kinch, 2 Hedge End. Woodstock. Oxford. OX7 1NFP. Tel: Woodstock, 811689.


UK101 BK Cased Cegmon BASIC-5 Joy stick. Used, in sound/outs software. £15. Swap W.H.Y. etc Mr. J. Bedward, 21 Withies Lane, Midsomer Norton, Avon BA3 2JE. Tel: 412 280.
**SHORT-CUT TO 'SHORT' DETECTION**

**MODERN** printed circuit boards with plated-through holes are often soldered very quickly in a production-like situation using a wave soldering technique—i.e. from below.

The constructor working with the board the other way up has to take great care to avoid an excess of solder running into a plated hole, since if the component is a DIL socket, a solder bridge may form out of sight, under the socket, on the other side of the board. If the board is for an expansion memory or is the memory section on a single-board computer, it is possible that such a short circuit could be under one of many sockets and if the fault is sought by systematic removal of those, Murphy’s law will ensure that it is lurking beneath the last socket to be removed! Convinced of this fundamental truth and finding myself in the situation described above I devised the following method to locate the fault.

1. Determine which two adjacent lines are shorting with the aid of a multimeter, after have removed all the chips from the board.
2. Trace the two lines throughout the board.
3. Apply a low voltage to one of the two lines and a return path via a suitable load from the other line.
4. The voltage and load should be chosen so that the printed circuit tracks are not overloaded but carrying a current which is a significant proportion of their design maximum.
5. Use the microvolt measurement facility of a sensitive scope or similar device having a high input impedance to test for voltage drops along these two tracks e.g. in the circuit shown testing between A and B or G and H will show no voltage drop, but C to D, J to K, D to E, K to L, E to F and L to M will all show small detectable drops in voltage which indicates that the bridge is between sections CB and JH of the two tracks.

**CASSETTE TAPE TIMER**

**WHEN** recording material on audio cassette it is useful to have an indication of the approaching end of tape.

The circuit shown gives an audible warning some 1.5, 2, 5 and 10 minutes before the end of a C30, C60, C90 and C120 respectively.

The ZN1034 timer triggers at switch on and pin 3 goes high. After the chosen delay this pin goes low turning on the audible warning device.

**David J. Giles,**
**Edinburgh.**
LOW COST MULTIPLE BARGRAPH DRIVER

This circuit was designed to combat the essentially high price for the construction of multiple bargraph displays as used in real time Spectrum Analysers etc. The diagram shows the essential parts for a single bar and may be easily extended to as many stages as required.

The heart of the circuit is IC3, a 4028 BCD to decimal decoder, fed by a binary decade counter, IC4. This counter is driven at 200Hz by a simple CMOS clock, IC6. The diagram shows a ten I.e.d. bar, and if higher bars are to be driven, then a higher clock frequency is required to stop visible flickering. The outputs of the counter also drive a simple digital to analogue converter. The binary output is buffered by IC7, the power for which is derived from a simple regulator built around IC8, to provide a consistent display free from supply induced level shifts. IC7 is a 4050, and this was chosen because it can cope with inputs above its supply voltage.

This buffered signal is passed to a simple DAC, known as a R/2R ladder formed by the 150k and 75k resistors. The resulting analogue voltage is connected to the inverting input of IC2, the non inverting input of which is connected to the input signal to be measured via a peak detecting circuit formed around IC1. The input level is variable via the 47k preset in IC1's feedback loop. The output of the comparator IC2 goes to enable the cathodes of all the I.e.d.s in that particular bar. Thus the circuit works as follows.

The counter IC4 starts at 0000 and so pin 3 of the decoder IC3 is high thus enabling the I.e.d.(s) on that line. As all the counter's outputs are low the DAC's output will also be low, i.e. 0V. If the input signal is above 0V then the output of the comparator IC2 will be high and enable the I.e.d. column so that the bottom one will light. Then the counter advances to 0001.

The second I.e.d. is enabled by IC3 and a voltage about half a volt above 0V appears at the comparator. Again if the input level exceeds this the DAC's output then the I.e.d. column is not enabled and nothing lights. As all this occurs at high speed, the effect is a steady bar of light, its height being proportional to the input level, the I.e.d.s having 0.5V increments.

If more than one column of I.e.d.s is required, then you only need to duplicate IC1, IC2, TR1 and I.e.d.s, as the counter, decoder, TR2 to TR11, and the DAC are common to all channels.

The simple circuit shown will however suffer from a varying of I.e.d. brightness, depending on the number lit, if the basic circuit is extended beyond one or two bars. This effect may be counteracted by using an AND gate for each I.e.d. as shown in the second diagram. Although more expensive, it does solve the problem of brightness variation and still works out cheaper than a driver using several LM3914 bargraph driver i.c.s.

G. Durant, Selby.
This month's ULTIMUM daughter board is a Universal PROM programmer designed to allow you to program the 2K, 4K and 8K range of single-rail EPROMS. It complements the RAM/ROM card which will take the 2K or 4K EPROMS (2716, 2732/2532) as well as providing the capability to program the 28 pin 2764. With this, and next month's card (a ROM emulator), most of the facilities required to develop microprocessor systems become available.

**FEATURES**

Several facilities are incorporated to make the PROM programmer reliable and safe to use. A 24 pin header has been provided to allow you to change from one PROM type to another without having to alter messy links. A current limited 5 volt supply is available to prevent damage to your PROMS in the event that they are inserted upside down. All the necessary switching is provided on the programming lines to make verifying etc. straightforward. To keep the software to an absolute minimum, hardware is included to provide the 50 msec pulse needed for correct programming, with software monitoring capability. All the decoding is provided to make sure that the PROM programmer uses the minimum address space.

**CIRCUIT DESCRIPTION**

The heart of the PROM programmer is an 8255 parallel interface (I.C.1). This provides 24 lines of input/output in the form of three, eight bit ports. The 8255 is addressed by a decoding system which ensures that only 16 bits of address space are used. The 8255 may be mapped to any 16 byte boundary throughout the processor's 64K address space. This decoding is achieved with IC's 4, 5, 6 and 7. IC’s 5, 6, and 7 are magnitude comparators (74LS85) which are 'ANDed' together to select the 8255 when the processor address corresponds to the value set up on switches 1 to 12. By linking the link 1 to ASO (see Fig. 1) it is also possible to de-select the board altogether leaving more space for memory when the programmer is not in use. The 8255 CS line also feeds back to the enable line on the motherboard. This decoding arrangement allows you to put the PROM Programmer into any slot without changing links. IC3 (Fig. 1) is a static sensitive device and should be inserted last. This is not a very dense board, but one should always check for solder blobs and shorts before applying power.

**ASSEMBLY**

Start with the i.c. sockets, then the discrete components. Take care to distinguish between the two transistors, and note their orientation. Refer to the component layout (Fig. 4.2). IC8 is a three pin package which doesn't appreciate being inserted backwards.

Insert all i.c.'s (IC2 and the header will be inserted later). IC1 is a static sensitive device and should be inserted last. This is not a very dense board, but one should always check for solder blobs and shorts before applying power.

**SETTING UP**

Table 1 shows how to set up the various links. Choose where the programmer will sit in memory and set switches 1 to 12 according to this table. Link 1 should be set to ASO if you wish to de-select the board from the 8255 on the motherboard. For initial testing, it is simplest to wire this to the 5 volt line.

**TESTING**

The 8255 should be tested for operation on each of its lines. A simple program (Table 4.2) in BASIC can be used to do this. Check that lines A0-A7, B0-B7, C0-C3 pulse from 1 to 0 with a high impedance voltmeter or the simple 'logic probe of Fig. 4.3. Do not insert a PROM into socket IC2 while doing this or it will be damaged. The outputs of IC3 (pin 5 and 13) can be tested with the same program. A short 'blip' on your meter (or 'logic probe') will indicate satisfactory...
Fig. 4.1. Circuit diagram of ULTIMUM's Universal PROM Programmer

HALF-MEGABIT EPROMs WELCOME!

operation. The latch (IC9) can be tested by latching data with the line C1 which should be pulsed high then held low, checking that the data on eight outputs (see Fig. 4.1) are correct. This done, the setting up is complete.

WIRING FOR PROM TYPES

Table 4.3 gives the various header options for IC10. Table 3(a) shows the lines connected to this header. Each PROM type requires a different header. The connections in Table 4.3 make use of the current limited supply.

The correct sequence for programming any PROM is as follows:

With the power off . . .
1) Choose and insert the appropriate header for IC10.
2) Power up the board, without the PROM inserted.
   This allows the 8255 and monostable to settle to their safe state.
3) Insert the PROM and program.
4) Remove the PROM.
5) Power down.

Follow this sequence, or you will run a slight risk of mis-programming one or more locations.
Fig. 4.2. Component layout. Copyright Watford Electronics

Compatibility range:
Acorn Atom
Apple II
Atari
BBC
Commodore PET
Dragon 32
Jupiter Ace
Oric I
RML 380Z
Spectrum
Superboard
Superbrain
S100 Bus machines
UK101
Video Genie
ZX81

Daughter card range:
Ram card
Rom/Battery backup Ram card
EPROM programmer card
Romulator card
Floppy disc controller card
Printer and general port card
Analogue I/O card
Sound card
Speech card
Terminal card
Processor card
Prototyping card

Table 4.1. The link options

<table>
<thead>
<tr>
<th>Link</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LK1</td>
<td>IC4 to +5V (default position)</td>
</tr>
<tr>
<td></td>
<td>Permanently mapped in</td>
</tr>
<tr>
<td></td>
<td>to A50</td>
</tr>
<tr>
<td></td>
<td>May be dynamically mapped</td>
</tr>
<tr>
<td>LK2</td>
<td>IC4a to IC5 (default position)</td>
</tr>
<tr>
<td></td>
<td>Memory map option</td>
</tr>
<tr>
<td></td>
<td>to +5V</td>
</tr>
<tr>
<td></td>
<td>I/O option</td>
</tr>
<tr>
<td>LK3 &amp; LK4</td>
<td>Default position</td>
</tr>
<tr>
<td></td>
<td>Alternative = I/O option</td>
</tr>
</tbody>
</table>

The switches set the required position in memory, in binary. For example, S2 set and all others open would give 4000 hex (16384 decimal).

Fig. 4.3 (right). A simple logic probe circuit
COMPONENTS...

Resistors
R1  8k2
R2  1k
R3  300k 1%
R4  56
R5  47k
R6, R9  10k (2 off)
R7, R8  2k2 (2 off)
R10  22k
R11  4k7
R12  3k3
All resistors 1/2W 6% unless otherwise specified

Capacitors
C1  15n
C2  1n
C3  470n 5%
C4, C5, C7  100n (3 off)
C6  2n2
C8  100u/16V
C9-C16  100n disc ceramic (8 off)

Transistors and Diodes
D1, D2  OA91 (2 off)
TR1, TR3  BC214L (2 off)
TR2  BC184L

Integrated Circuits
IC1  8255
IC2  PROM to be programmed
IC3  74LS123
IC4  74LS13
IC5-IC7  74LS85 (3 off)
IC8  78L05
IC9  74LS363
IC10, IC11  8x4k7 s.i.l. resistor pack (2 off)

Miscellaneous
SK 1 24-pin socket for header
24/28 pin s.i.l. socket for PROM
D.i.l. switches 8 x s.p.s.t. (2 off)
Printed circuit board WE03 PRG
PL1 2 x 32 'A+C' DIN Euro Plug (Right-angled pins)
24 pin d.i.l. personality header
14 pin d.i.l. socket
16 pin d.i.l. socket (4 off)
20 pin d.i.l. socket
40 pin d.i.l. socket

Constructors' Note
Kits for all parts of the ULTIMUM system are (or will be) available from Watford Electronics, 33 Cardiff Road, Watford, Herts WD1 8ED. Send SAE for price list of boards now available.

10  P = programming port address
20  POKE P + 3, 136
30  POKE P, 85:POKE P + 1, 85:POKE P + 2, 85
40  POKE, 85:POKE P + 1, 170:POKE P + 2, 170
50  GOTO 30

Table 4.2. 8255 check program in BASIC

<table>
<thead>
<tr>
<th>Vpp TIE</th>
<th>GND</th>
<th>2564 (Texas)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+5V</td>
<td>+5V</td>
<td>GND</td>
</tr>
<tr>
<td>2716</td>
<td>2732</td>
<td>2532</td>
</tr>
</tbody>
</table>

Table 4.3. Header options for IC10

<table>
<thead>
<tr>
<th>OE</th>
<th>PGM</th>
<th>PGM/CS</th>
<th>OE</th>
<th>PGM</th>
<th>PGM/CS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low for read.</td>
<td>Hold low for read.</td>
<td>Low for read.</td>
<td>Hold low for read.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AO-A7  O/P  DO-D7  A/A-A7
B0-B7  O/P  A8-A15  Vpp Sw
(B0)-(B7) O/P  C0  O/P  mono fire
C1  O/P  C1  O/P  latch fire
C2  O/P  C2  O/P  Vpp Sw
C3  O/P  C3  O/P  OE
C4  I/P  C4  I/P  uncommitted
C5  I/P  C5  I/P  uncommitted
C6  I/P  C6  I/P  Vcc sense
C7  I/P  C7  I/P  PGM sense

Table 4.3(a). Header connections

Vpp TIE  1  24  +5
pin 18  2  23  +5 Lim.
20  3  22  GND
21  4  21  Vpp
24  5  20  OE
25  6  19  Q7
26  7  18  O6
27  8  17  A13
28  9  16  A12
50  10  15  A11
C4  11  14  PGM
PGM/CS  12  13  PGM

NOTE: For machines like Superbrain, where the whole of the address space is taken up by RAM, by changing Links 2-4 the Programmer becomes an I/O mapped device.
Table 4.4. Simple program for 2732 PROMs

<table>
<thead>
<tr>
<th>Line</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1FN &gt; 4095 THEN 300</td>
<td>finished?</td>
</tr>
<tr>
<td>20</td>
<td>IF L &lt; 256 THEN 110</td>
<td>increment low address</td>
</tr>
<tr>
<td>30</td>
<td>Q = RAM start</td>
<td>programming power off</td>
</tr>
<tr>
<td>40</td>
<td>IF ((A&lt; 128) AND (A &gt; 63)); bit 6 set, chip in backwards</td>
<td>programming power on</td>
</tr>
<tr>
<td>50</td>
<td>IF R &gt; 191 THEN 300</td>
<td>increment high address</td>
</tr>
<tr>
<td>60</td>
<td>POKE P, 0; POKE P + I, 0</td>
<td>initialization</td>
</tr>
<tr>
<td>70</td>
<td>N = N + 1</td>
<td>increment count</td>
</tr>
<tr>
<td>80</td>
<td>L = L + 1</td>
<td>increment low address</td>
</tr>
<tr>
<td>90</td>
<td>A - PEEK (P + 2); read port C</td>
<td>programming power off</td>
</tr>
<tr>
<td>100</td>
<td>POKE P + 3, 136</td>
<td>counters; addr high &amp; low, data locations</td>
</tr>
<tr>
<td>110</td>
<td>POKE P, 0; POKE P + I, 0</td>
<td>initialization</td>
</tr>
<tr>
<td>120</td>
<td>POKE P + 3, 2</td>
<td>initialise high address</td>
</tr>
<tr>
<td>125</td>
<td>IF PEEM (P + 3) &gt; 127</td>
<td>finish program</td>
</tr>
<tr>
<td>130</td>
<td>POKE P + 3, 0</td>
<td>programming power off</td>
</tr>
</tbody>
</table>

PROGRAMMING PROMS

The programs to program PROMs can be of many levels of sophistication. Table 4.4 is a simple program for 2732 PROMs (the most commonly used), which illustrates the general principle. You could design programs to cater for all PROMs (possibly menu driven) checking for correct insertion, and making sure they are blank before programming. The board is supplied with data on the 8255, so that more sophisticated programs may be produced.
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Practical Electronics February 1983
## DISK DRIVE AND INTERFACE KITS

<table>
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<tr>
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<td>10.00</td>
</tr>
<tr>
<td>90MB</td>
<td>10.60</td>
</tr>
</tbody>
</table>

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KONOSUKE Matsushita was born in 1894 in a small village 35 miles south of Osaka, the commercial capital of Japan. The English translation of his name is "Lucky man under the pine tree" and indeed he spent his childhood under a matsu (Japanese pine).

He was apprenticed to a bicycle merchant in Osaka at the age of ten, bicycles being an exotic rarity in Japan at the time. After seeing a tramcar for the first time, he was convinced that the electric industry had a bright future and in 1910 joined the Osaka Electric Light Company.

By 1918 he had become the youngest inspector on the payroll and decided to set up in business on his own. With his wife and brother in law, he manufactured a device he had patented: this was an Edison screw, adaptor designed to fit a light socket.

Matsushita built his first office and factory in 1922, extended his sales operations and had by now 50 employees. Bicycle lamps, heaters and radios were among the products made in the decade that followed.

Matsushita Electric Industrial Co. came into being in 1935 with a capital of 10M Yen and nine subsidiary companies. The group's products were mainly domestic appliances, including experimental TV receivers made in 1938.

Seeing the conditions prevailing in post-war Japan, the company's founder set himself the task of re-vitalising his country: his slogan was "P.H.P."—Peace and Happiness through Prosperity. In 1951 Konosuke Matsushita visited the USA and Europe and on his return urged all employees to work together to build the company on international lines.

An exchange of technical expertise was arranged with Philips of the Netherlands in 1952, and Matsushita Electronics Corporation was established to produce a wide range of electronic components. These included semiconductors and electronic tubes.

PANASONIC

The concern continued to expand and in 1959 opened its first overseasventure, Matsushita Electric Corporation of America, which sold its products under the brand name of Panasonic. 1961 saw the first overseas manufacturing concern established—the National Thai Company.

Ten years later, Matsushita Electric stock was offered on Wall Street and wasstantly oversubscribed; six further leading markets were listing its stock two years later.

By 1961 Konosuke Matsushita left the company's Chair in 1973. He had certainly lived up to his name as "The Lucky Man. . ." but also proved himself as both a patriot and hard-working man of vision. Outside Japan he will best be remembered by the thousands of products with brand names of National, Panasonic, Quasar and Technics.

With an excellent reputation for sound reproduction equipment and as a component manufacturer—especially of complex integrated circuits—entry into the electronic music field was almost a natural progression.

In 1980, he attended the launching of a new series of organs, when the trade was introduced to the "U" organs, and told that Technics' engineers had been back to the drawing board and had completely redesigned the range of instruments. Among the new features at that time was the Program Chord Computer, a "first" for Technics, which allowed the SX-U60 to be programmed to remember 100 chords of eight basic types.

Technics have continued to update the series, the latest model being an improvement on the SX-U90, namely the SX-U90P.

SX-U90P

This de luxe instrument has a space-age appearance, its console being finished in silver-grey and mounted on columns. It is priced at £5999.99 (in case you can't afford £6000) and, although described as portable, is supplied with a pair of silver-grey extension speaker cabinets and was probably designed for professional use.

For practicing, two 10W speakers are built in to each side of the console: these are indispensable in judging expression when using remote cabinets. Two 4-octave manuals and their control buttons and tabs are housed between the monitor's speakers. Under the metallic hodding of the console, Belo are 13 pedals and the expression control.

The various buttons and tabs are colour coded and many of them illuminated. Although I do not favour consoles that look like a pin-ball machine, I must admit that the complexity of modern instruments is such that the performer needs all the help the manufacturer can offer in finding things quickly, especially when reading music at the same time. The controls are fitted above the upper manual and on the cheeks, and laid out logically.

The Orchestra Conductor section has 12 illuminated buttons which allow the player to select various departments: these are Tab Voices, Orchestral Presets, Percussion, Solo Synth., Organ, String Ensemble and Vocal Ensemble which, apart from Orchestral Presets, are available on both manuals.

Tab Voices cover the organ tones. These include the complete range of Flutes (equivalent to those in drawbar organs), Brass, Oboe and String on the Upper Manual, whilst the Lower Manual has Flutes 8', 4', 2' and 1' with Diapason, Horn, Cello and String. Pedal Tabs include those for Bass Guitar and String Bass.

Two types of synthesizer are employed. Upper Orchestral presets allow polyphonic playing, where there are eight effects to choose between. Solo Synthesizer presets allow single note melodies on either manual and there are some odd effects here, such as Cosmic Fuzz, or Whistle and Synthie Chopper!

FEATURES

One of the outstanding features of the SX-U90P is the Rhythm Unit. It has a stereo output and can also be programmed to suit the user. Its information is based on pulse coded modulation and it produces the recorded sounds of actual instruments and is thus considerably lifelike. In non-programmed mode there is a choice between 12 patterns, each with a variation and it will produce intros. and fill-ins. It can be made to trigger an accompaniment of piano, banjo or guitar.

Percussion can be applied to the Upper Manual at 5-1/3', 4', 2-2/3' and 2' pitches and there are also Upper/Lower Percussive Presets—Piano, Harpsicord, Vibraphone etc. Harmonic Couplers can be used from either manual and there is also the intriguing Upper Click control: this applies the very same effect that many engineers have burned midnight oil trying to eliminate and was largely responsible for the original success of the Hammond with jazz organists!

Celeste may be applied selectively to sections of the organ and the Voice Setting Computer allows the player to store four favourite voice combinations in memory for six weeks if the instrument is unused.

Although probably best suited to club or studio work, Technics have not forgotten the beginner's aids. Auto Play Chord (one-finger, fingered and memory) and Program Chord Computer still are featured, the latter remembering two 50-chord programs within which can be edited if mistakes occur. Walking Bass can be applied to the pedals and Arpeggios played on Harp or Strings.

In all, the SX-U90P is an exciting and complex instrument which should be seen to be appreciated as it is impossible to cover all its many features here.

The silicon chip has been a boon to Matsushita and its contemporaries—and if we still had to rely on valves the organ would need a complete room to house what the SX-U90P encompasses!
UK01 SINGLE KEY BASIC

The UK02 Monitor ROM is a vast improvement over the original UK01 ROM but it leaves the computer still lacking the ability to produce complete BASIC words by pressing just one or two keys. A short program to remedy this is given below and can be used with either monitor by changing the first line of the program to the appropriate input routine address ($FFBA for UK01, $FBAC for UK02). Unfortunately when used with the UK02 Monitor, the Editor is completely disabled when the program is running, but this may be overcome as follows—

1) Enter the program using the mic monitor.
   2) Reset, enter Cold Start and then type in the following BASIC lines:

   1) POKE 536,64: POKE 537,2:END
   2) POKE 536,172: POKE 537,251:END

To activate the Single Key Basic, type RUN. Before calling the Editor type RUN 2 and then edit in the normal way, after which RUN may be used to return to Single Key Basic. Reset W can be used instead of RUN 2 although this will of course clear the screen. The POKEs given in line 1 above are also used to activate the program when used with the UK01 monitor.

BASIC words are called by using CTRL plus another key as listed below. It was considered unnecessary to include words of three letters or less as it is almost as fast to type these out in full. However these are presented for completeness along with other infrequently used words together with the OFFSET and may be included if required by adding them to the table.

With regard to the Table, pressing CTRL and another key gives the ASCII value of the key plus $80. Thus the required value for the KEYBD column in the Table can be easily calculated, e.g. CTRL 4 gives $34 x CD – F4 (Hex). The following keys cannot be used; M, SPACE, SHIFT, (also E and L for UK02 Monitor). It is essential to end the Table with a 00 Byte.

Once the Machine Code has been entered, a BASIC loader may be produced using the mic to BASIC converter given in P.E. July 1981.

PROGRAM LISTING

<table>
<thead>
<tr>
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POKE 122,nn: POKE nn*256,nn:NEw

WORKSPACE MOVE

Sir—You may be interested in the following for Microprompt.

In Compukit 101 or Superboard BASIC, the ability to reserve a block of RAM for machine-code routines by giving a number in response to MEMORY SIZE? or POKEing 133 and 134 is useful if the routines are written to reside at the top of RAM. It is, however, often desirable to use a machine-code program at the same time as BASIC, which resides in low memory. For example, an extended monitor (mine runs from 0280 to 0D50). It is possible by means of a couple of POKEs to move BASIC’s workspace from 0300 to XX00—wherever you want it.

To move it to another place, the command is:

POKE 122,nn: POKE nn*256,nn:NEw

having put nn into decimal. The POKE 122 changes the main base pointer. The second POKE is essential to prevent BASIC crashing. The “new” command changes all BASIC’s vectors to the appropriate new positions. So to reserve memory up to 0FF hex, giving free space from 0222 to 0FF hex, use:

POKE 122,16: POKE 16*256,0: NEw

Once set, reset has no effect on the vectors, so the memory stays in the new configuration until BASIC is Cold-started again. Michael Punnett, Swanley, Kent.

UPDATE!

Sir—The program “Text String Search” published in PE Oct. ’82 Microprompt was originally written by myself for the Symmon monitor. Since then, Newman has become the standard and because of different usage of zero page and low memory, the program as published will not function properly with this monitor. Points to note for conversion are:

1. The first free byte in Newman is $0228 and not $0222 and the program needs relocating to this new start address.

2. References to $E9 to $E5 must be changed to other zero page locations. Some of the later bytes from the input buffer ($13 to $5A) can probably be used instead.

3. References to other zero page bytes and Basic routines $A000 onwards still apply and do not need changing.

L. J. Dolman, Norwich.

NOTE: Many of the three letter words require brackets which the single key basic program will not supply, the exception being SPC.

Peter Beckett
Blackpool.

TABLE KEYBD OFF

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OTHER BASIC WORDS WITH OFFSET VALUE

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TABLE KEYBD

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OTHER BASIC WORDS WITH OFFSET VALUE

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PIXEL GRAPHICS

Sir—With a desire to improve the graphics capability of the UK 101 I set out to design a system that was cheap, simple, and gave higher resolution.

I decided not to use any more than the 1K of video RAM already on the UK 101. This limited the resolution to 64 x 96, 32 x 192, 128 x 48 or some other such combination. The system I intended to use was one where each point is represented by a bit in the video memory.

However there are two methods of performing this. One is a true method, whilst the other only appears to perform the function.

The second method is to "switch off" the main character generator and "switch on" an alternative character generator. In this second character generator an alternative character set is held with the characters arranged in such a way so that it appears that each bit represents a point. Using this method a second character generator must be programmed as well as having the auxiliary chips (i.e. address decoding etc.) and despite the ever decreasing price of 2716 EPROM's, this is still a costly process.

The first method is both cheaper and information from the RAM is used directly, giving a resolution of 60 rows by 96 columns with one line of text at the bottom. This can be used for scores for games etc.

Having this line of text is why the resolution is slightly lowered.

As shown in Fig. 2, what was a character position is now eight pixel positions with bit 0 representing the top left hand point etc. A one in this bit position will produce a white square in this location. By means of the machine code subroutines given, each point in the 60 by 96 array of points may be set, reset or examined.

The circuit itself is quite simple and can be divided into three separate parts. Firstly the address decoding 1's and 0's are decoded using NAND and NOR gates with the result that the output of the 4-input NAND gate is low only if address 61823 (F17F Hex) is present on the address bus. The four AND gates decode the top four address lines so that the character generator is switched back on if the bottom line of the VDU RAM is accessed.

The second part of the circuit is simply a hold-follow latch constructed so that if the lower input to 7402a is 0, then the data on DO is held in the latch and produced on the output. This is Often with the data from the VDU address decoding and so turns the Character Generator on (requires a one to turn it on) if either the latch has been latched to one or the bottom line of the VDU is being displayed. The pixel logic is automatically turned off when the Character Generator is on and vice versa.

The pixel logic itself is very simple. IC7 is a dual 1 of 4 data selector. Depending on C9 and C10 (which normally are address inputs to the CHR GEN) either VD0 and VD4 or VD1 and VD5 or VD2 and VD6 etc. are produced on the outputs. This in effect divides the normal character position into 8 blocks as required. IC2 is isolate IC1 from the Shift Register inputs and prevents the Shift Register inputs being connected to each other as would otherwise happen.

C. M. Taggart, St. Albans

Warford Electronics' new 4K monitor WEMON uses the top 4K of memory (including address F17F). Those who have this ROM should use the alternative address coding shown in Fig. 1.

To turn the pixel graphics on: POKE 61823,1 (or POKE 58239,1 when 4K monitor is present).

To turn the pixel graphics off: POKE 61823,0 (or POKE 58239,0 when 4K monitor is present).

Since the first address in the screen memory that can be seen on the TV varies with the version of UK 101, the routines work as follows:

Horizontal position of pixel point is POKE'd into address 226.

Vertical position of pixel point is POKE'd into address 227.

X=USR(X) should then be performed.

To set a pixel point on the screen: POKE X=USR(X) should then be performed.

To turn pixel point off: POKE 11.150. The pixel point's position is then cancelled out.

To reset a point, i.e. make it black, this routine should be used with POKE 11.158 in stead of POKE 11.150.

To find out whether a point is black or white POKE 11.158 should be used address 228 will be zero if the point is black and non-zero if it is white. When the routines have been loaded 8082 should be answered to MEMORY SIZE?

All these addresses are for an 8K UK 101. For a 4K machine the routines should be put into memory from OF96 to OFFF. The set, reset, and examine routines have been loaded 8082 should be answered to MEMORY SIZE?

C. M. Taggart, St. Albans

E.g. to set point 64.31:

POKE 61823,1 to turn the pixels on.

POKE 11.15:POKE 12.31 to use set routine.

POKE 226.64:POKE 227.31:X=USR(X)

The pixel's position is specified and this point is set i.e. made white.

To reset a point, i.e. make it black, this routine should be used with POKE 11.158 in stead of POKE 11.150.

To find out whether a point is black or white POKE 11.158 should be used address 228 will be zero if the point is black and non-zero if it is white. When the routines have been loaded 8082 should be answered to MEMORY SIZE?

Fig. 2. Each original character position is divided into its eight pixel points

A Hex dump of the machine code sub-routines which may be called from either machine code or BASIC using X=USR(X).

IF96 20 B0 1F 11 E2 91 E2 60

IF9E 20 B0 1F 49 FF 31 E2 91
COMPRESS
Sir—Using a BASIC program to produce DATA statements for the storage of machine code, for example, will result in DATA statements containing a large number of spaces. Consequently there will be a wastage of precious memory and the time to load the program from tape is considerably increased. This COMPRESS program will remove these spaces (spaces between quotes are unaffected).

The program takes up 157 bytes and is stored in the free space above the BASIC storage area. The program contains no Monitor subroutine calls and is therefore compatible with all Compukit monitors.

To use the program: load and run it, then CLEAR. CLEAR is necessary to reset all the program pointers.

You will be surprised at the amount of space wasted in what may look like a compact program!

Noel Caffrey, Dublin.

BASIC LISTING
5 REM COMPRESS
6 REM NOEL CAFFREY JAN 1982
10 FORI=552TO709:READD:POKEI,D:NEXT
1200 DATA169,3,133,26,133,124,169,1,133,25,133
1201 DATA123,165,123,133,22,165,124,133,23,160,0
1202 DATA177,208,18,200,177,25,20,18,145,123
1203 DATA136,145,123,162,2,32,187,2,76,0,0
1204 DATA162,2,32,176,2,32,187,2,160,0,177
1205 DATA25,145,123,200,177,25,145,123,32,176,2
1206 DATA32,187,2,162,1,160,0,177,25,201,32
1207 DATA240,31,201,34,208,18,145,123,32,176,2
1208 DATA32,187,2,177,25,201,34,240,4,201,0
1209 DATA208,238,201,0,240,11,145,123,32,187,2
1210 DATA32,176,2,76,133,145,123,32,176,2
1211 DATA32,187,2,165,123,145,22,165,124,200,145
1212 DATA22,76,52,2,138,24,101,25,133,25,144
1213 DATA22,76,52,2,138,24,101,123,133,123,144
1214 DATA22,76,123,96,138,24,101,123,133,123,144
1215 DATA22,76,123,96,138,24,101,123,133,123,144
1216 DATA22,76,123,96,138,24,101,123,133,123,144
1217 DATA22,76,123,96,138,24,101,123,133,123,144
1218 DATA22,76,123,96,138,24,101,123,133,123,144
1219 DATA22,76,123,96,138,24,101,123,133,123,144

ASSEMBLY LISTING
0228 A903 LDA $003
022A 851A STA $01A ;set up start addresses
022C 857C STA $07C ;and program pointers.
022E A901 LDA $081
0230 8519 STA $019
0232 857B STA $07B
0234 A57B LDA $07B ;store new start address
0236 8516 STA $016 ;for the current line.
0238 A57C LDA $07C
023A 8517 STA $017
023C A000 LDY $000 ;check for end of program.
023E B119 LDA ($19), Y
0240 D012 BNE $0254 ;increment end of program.
0242 C8 INY
0243 B119 LDA ($19), Y
0245 D00D BNE $0254
0247 917B STA ($7B), Y ;store end of program
0249 88 DEY ;mark.
024A 917B STA ($7B), Y
024C A202 LDX $020 ;increment end of program
0251 40000 JMP $0000 ;address.
0254 A202 LDX $020 ;jump to WARM START.
0256 20BB02 JSR $0280 ;increment pointers.
0259 20BB02 JSR $0288 ;store new link address.
025C A000 LDY $000 ;move to start of text.
025E B119 LDA ($19), Y
0260 917B STA ($7B), Y
0262 C8 INY
0263 B119 LDA ($19), Y
0265 917B STA ($7B), Y
0267 20BB02 JSR $0280
026A 20BB02 JSR $0288
026D A201 LDX $020
026F A000 LDY $000
0271 B119 LDA ($19), Y
0273 C920 CMP $020 ;space?
0275 F01F BEQ $0286 ;yes, then skip.
0277 C922 CMP $021 ;quotes?
0279 D012 BNE $028D ;yes, then copy to end
027B 917B STA ($7B), Y ;of line, or end of quotes.
027D 20B002 JSR $0280
0280 20B002 JSR $0288
0283 B119 LDA ($19), Y
0285 C922 CMP $022
0287 F004 BEQ $028D
0289 C900 CMP $020
028B D0EE BNE $027B
028D C900 CMP $020 ;end of line?
028F F00B BEQ $029C ;;store character.
0291 917B STA ($7B), Y
0293 20B002 JSR $0280
0296 20B002 JSR $0280
0299 4C7102 JMP $0271 ;back to start of loop.
029C 917B STA ($7B), Y ;store end of line mark.
029E 20B002 JSR $0280 ;;store new link address.
029A 917B STA ($7B), Y
02A6 9116 STA ($16), Y
02A8 A57C LDA $07C
02AA C8 INY
02AB 9116 STA ($16), Y
02AD 4C3402 JMP $0234 ;;routine to increment
02B0 8A TXA ;pointers to old program.
02B1 18 CLC
02B2 6519 ADC $01
02B4 8519 STA $01
02B6 9002 BCC $02BA
02B8 E61A INC $01A
02BA 60 RTS ;;routine to increment
02BB 8A TXA ;pointers to new program.
02BC 18 CLC
02BD 657B ADC $01B
02BF 857B STA $07B
02C1 9002 BCC $02C5
02C3 E67C INC $07C
02C5 60 RTS

Noel Caffrey, Dublin.
VARIABLE PHOTOGRAPHIC RESISTANCE

3-PHASE VARIABLE TRANSFORMERS

3-PHASE VARIABLE TRANSFORMERS

INDUSTRIAL STROBE KIT

SOLDATEX FLUID VALVES

MINIATURE SOLENOID FLUID VALVE

240/230V A.C. SOLENOID FLUID VALVES

RHEOSTATS

NEW POWER RHEOSTATS

NEW POWER RHEOSTATS

240/230V A.C. SYNCHRONOUS GEARED MOTORS

GEARED MOTORS

24 V. D.C. GEARED MOTOR

24 V. D.C. GEARED MOTOR

BLOWER/PUMP

BLOWER/PUMP

BLOWER/PUMP

BLOWER/PUMP

DIAPHRAGM COMPRESSOR

DIAPHRAGM COMPRESSOR

VEEDER-ROOT PRE-SSET COUNTER

VEEDER-ROOT PRE-SSET COUNTER

SANGAMO WESTERN TIME SWITCH

SANGAMO WESTERN TIME SWITCH

VENNER TIME SWITCH

VENNER TIME SWITCH
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* PCI INTELLIGENT LCD MODULES
* TOKO SWITCHES: F SERIES/R7000 SERIES
* ALPS POTentiOMETERS AND KEYSWITCHES
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VIBRATO: Robot type voice modulator with depth & rate controls
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PHONOSONICS

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IMPORTANT: Regulation - All voltages quoted are FULL LOAD. Please add Singapore figure to secondary voltage to obtain full load voltage.

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Six octave

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<td>2224</td>
<td>4 x C</td>
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**BENCH POWER SUPPLY**

See constructional article in February 82 'Practical Electronics'.

Prices inc. VAT at 15%.

Available in kit form or built up.

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Also providing information on fuel consumption and tuning.
### COMPUTER COMPONENTS

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**OTHER REGULATORS**

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**OPTO-ELECTRONICS**

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**DISPLAYS**

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