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SMITH CHART PROGRAM - CIRCUIT ANALYSIS BY COMPUTER - ANALYSER II

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VOL 26 NO 6 JUNE 1990

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PE TAKES TECHNOLOGY FURTHER - BE PART OF IT!
CD inventor Philips are adding a new three head Dolby HX Pro cassette deck, the FC870, to their acclaimed 8 series HX Pro range.

The FC870 cassette deck features a three-head design with separate hard permalloy heads for recording, playback, and tape monitoring and direct source tape comparison. Separate capstan and reel motors are included in the solenoid electronic control system which continuously monitors the audio signal and on reaching high frequency saturation point increases high frequency response by several decibels without increasing low frequency distortion. The deck has many features including quick music search (QMS), automatic music scan (index scan), record mute, blank skip and a choice of Dolby C or B. The expected price is around £249.

For more information contact Julie Harding, Mathieu Thomas Ltd, 8 Westminster Palace Gardens, London SW1P 1RL. Tel: 01-222 0833.

See How They Run

Maplin tell us they are assisting the mouse breeding cause by introducing two all new 3 button serial computer accessories, designed for use with IBM PC/XT/AT and compatible computers. At just £29.95, the newly styled 3 button serial mouse produces a serial output signal. This is connected to the serial (RS232) port of the host computer, thereby eliminating the need for an interface card or extra hardware. The mouse 'tail' is 1.5 meters long and is terminated in a 25-way D-type socket. A neat environmentally conscious feature ensures that no mouse need be homeless - a mouse bracket is available which can be attached to a convenient surface. When the mouse is not in action it can be placed in the bracket, preventing accidental damage. A good investment for only £1.28.

Also newly introduced is a 3-button serial track-ball. This is a neatly stacked track-ball which provides an alternative to a mouse when desk space is limited. It's compatible with most IBM PCs and software intended to be mouse driven. It features a pop-up menu which allows it to be used with programs that are not normally mouse driven. The price is just £9.95.

For further information contact any of Maplin's nationwide shops, or their real office at PO Box 3, Rayleigh, Essex, SS6 8LR. Tel: 0702 554161.

CATALOGUE

Greenweld's great 32-page spring supplement catalogue can hardly have been missed by readers who bought our May 90 issue, in which it was bound. For the benefit of those who, for whatever reason, missed the issue let me highlight some of the bargains in Greenweld's supplement.

The first one to catch the eye is the offer of a free soldering iron when you order over £20 of goods. It shouldn't be hard to find goods to inspire you to spend that amount. Some terrific value disco gear is featured, for example, and some excellent high power amplifiers. 12 new models of the popular Meix digital multimeters have been added, plus lots of other new test gear items as well. And if you're looking for surface mounting components, mosfets perhaps, Greenweld can help you. There are many other good offers, too. If you haven't got a copy of this latest bargain list, get one! Greenweld Electronics Ltd, 443 Millbrook Road, Southampton, SO1 6HJ. Tel: 0703 772500.

Cirkit's splendidly thick Summer 1990 constructor's catalogue has come in. It offers hundreds of versatile new products for an ever-widening range of electronics construction applications. There are 184 pages featuring more than 3000 product lines, arranged alphabetically in sections for quick and easy reference. You'll find products from batteries to test equipment and tools, meeting the requirements of users at all skill levels and with a wide variety of interests. Cirkit also offer a 'super-fast' mail order service which, they say, ensures that all orders received by 4pm are despatched the same afternoon. Of the many new products featured, the expanded digital multimeters range will be of interest, as will the other varieties of meter available, including one specially for use in automotive fault finding and servicing. Complementing the catalogue's bigger, brighter product ranges are a wide selection of books, battery chargers, inductors, crystal filters, satellite TV cables, and a very broad selection of components of interest to all readers. And you could win some rich rewards in Cirkit's latest competition. Circuit Distribution Ltd, Park Lane, Broxbourne, Herts, EN10 7NQ. Tel: 0992 444111.

STC produce a variety of catalogues of interest to the sophisticated constructor. We've received two of their latest, their 1990 Tool Book, and their 1990 Cable and Wire Book. The tool catalogue contains practically every conceivable tool of use in electronics, and the cases to keep them in as well. You'll also find test accessories and assembly aids, benches and storage equipment, PCB production materials, cable and wiring aids, tapes and adhesives, batteries and chargers. The cable and wire catalogue is virtually an encyclopaedia on the subject, containing 'ordinary' assembly wiring as used in your day-to-day project construction, plus computer cables, telephone and power cables, and high performance wires. There is also a section of wiring accessories, basically covering mains plugs and sockets, etc. STC Electronic Services, Edinburgh Way, Harlow, Essex, CM20 2DF. Tel: 0279 626777.
HI-D COLOUR PRINTER

A high-definition colour video thermal printer providing A4 copies has been introduced by Thurlby-Thandar. The CH5504 features a range of optional interfaces providing RGB, parallel, and hybrid data inputs. The printer has been designed to be simple to operate, yet offer a fully adjustable print to meet a wide range of applications which include CAD, medical, general video, and industrial requirements.

For further information contact Thurlby-Thandar Ltd, 2 Glebe Road, Huntingdon, Cambs, PE18 7DX. Tel: 0480 412451.

PCBS AND CFCS

The PCBS of which we hear in the news regarding environmental problems are not the same PCBS which you use when constructing electronic projects. The first term relates to harmful chemical products, the latter to the essential and benign components of electronic assembly, printed circuit boards. (Your Ed comments that they may be benign but he's found their use totally addictive!) Levity apart, electronic components of electronic assembly, printed circuit boards. (Your Ed comments that they may be benign but he's found their use totally addictive!)

Normally, the solder paste used in the assembly of surface mounted devices contains a rosin-based flux which, following the soldering process, needs to be washed off by CFCS solvents. Over the last three years BOC has developed a paste free of this flux, as well as a special atmosphere in which the soldering is carried out, and which allows the paste to decompose leaving the board clean. The new process is claimed by the manufacturers to help out environmental damage and costs.

PARALLEL PROCESSING TRAINING

Salford ITeC has been chosen as one of only 14 training centres in the UK to offer assistance to local businesses in a rapidly expanding area of computers, parallel processing.

Unlike conventional computers which carry out instructions one at a time, parallel processing carries out many steps simultaneously. I.e. in parallel.

Centre Director David McArthur said the ITeC had been chosen because of the positive commitment of the ITeC staff in seeking to meet a growing training need. He added that the ITeC is now equipped with specialised computer equipment, and he hoped many organisations throughout the North West would benefit, particularly in manufacturing.

Salford ITeC is an independent training company which offers computer training to young people and to the business community. It is sponsored by Ferranti International, the University of Salford, and Salford City Council. The company is an equal opportunities employer and is registered as a charity.

For more information contact Stowell Technology Centre, Holland Street, Salford, M5 2SE. Tel: 061 745 8442.

ADVERTISERS AWAKE!

Don’t let your competitors steal all the glory of PE News Page Publicity - have YOUR interesting new products highlighted here as well as theirs! Send us concise details plus a good photo and we’ll do our best to publicise them.

First come first served, and it must be interesting. It’s up to you to keep us all informed!
A product ideal for the environmentally conscious electronics constructor has been introduced by Electrolube. Believed to be the first aerosol photoresist product using an ozone-friendly propellant, the new Electrolube RP50 is a fast-drying positive resist for one-to-one reproduction of circuits, diagrams and images on metals from positive transparency masters.

Available in 75ml and 200ml aerosols, RP50 is particularly suitable for all production requirements either in the lab or at home. 1 litre and 2.5 litre bulk containers are also available for larger volume users. With a solids content of approximately 12%, RP50 aerosols have a shelf life of one year unused, and give coverage of about 2.2 sq metres (75ml) and 5 sq metres (200ml).

Easily applied, the resist is quick drying and simple to process. It gives greater resolution, flexibility and economy in use than dry film resist and pre-coated pcbs. Processed RP50’s green colour produces a high contrast image with a resolution of better than 0.1mm. A fine spraying nozzle ensures extremely thin, uniform edge-to-edge coating, with thickness entirely within the user’s control. Dried coatings are resistant to mechanical stresses and fluctuations in temperature and humidity. After applying the resist to a clean, grease dust free surface (ie the copper surface of fiberglass pcbs) the coated boards are left to dry overnight, or alternatively oven dried for 10-15 minutes at 75-80 degrees C. The design artwork is then placed on to the coating which is then exposed to an ultraviolet light source. The design pattern is then coated with undiluted photoresist on the design pattern is then exposed to the uv, on a copper background. The remaining photoresist on the design pattern is removed with undiluted photoresist developer leaving behind the printed circuit pattern ready for subsequent operations.

RP50 can also be used to achieve a wide variety of technical and artistic reproductions on various metal surfaces, for example pictures on copper plates, steel, brass, etc. Electrolube also manufacture a complementary range of etching and related chemicals to meet all production requirements.

For further information contact: Electrolube Ltd, Blakes Road, Wargrave, Berks, RG10 9AW. Tel: 0734 404031.

NEw-s

ROBUST CASING

Euronus, the robust environmental cure, has become available direct from Bopla UK Ltd. Widely used throughout the electrical and electronics industries, the Euronus range is available in four different materials, diecast aluminium, polycarbonate, ABS and glass-filled polyester. These cover a wide range of sizes. The diecast aluminium range offers excellent screening properties.

REVOLUTIONARY CATE

The computerisation of train enquiry offices has reached its half-century, with the 50th installation now in use at Cardiff.

Complex journeys can be planned in seconds using the Computer Assisted Timetable Enquiry system (CATE), developed by British Rail Research.

Starting and destination points are keyed in by the operator, together with any other details such as day of travel and time of departure. The system then rapidly produces a journey plan showing routes, times and changing prices for even the most complicated journey. Other useful information, such as availability of refreshments or the need for advanced reservations is also clearly shown.

"CATE has revolutionised train enquiries", said Mike Robinson, BR's Systems Development Manager. "The time taken to process each enquiry has been reduced from minutes to seconds, accuracy has increased and staff training needs have been reduced."

All BR stations are listed in the system, together with selected off-rail locations and the major European railheads of Paris, Brussels, Cologne and Amsterdam.

Development work is going on to get fares and short term train alterations into the system, and to design a self service version for customers at stations. It is also likely that a version of the system will be developed for use by travel agents and, with the advent of low-cost terminals, CATE could eventually be available in the home.

CATE is believed to be the most advanced system of its type in the world and a number of foreign transport operator have expressed interest.

DISTURBANCE ANALYSING

A n even clearer picture of the disturbances affecting mains supply is now available with the launch of the PDA101 Power Disturbance Analyser by Megger Instruments.

The PDA101 allows the choice of measuring spikes and hf noise either between phase and earth or between neutral and earth through simple switch selection.

This is a key factor in accurately profiling disturbances affecting the voltage or its frequency outside user-defined limits. The introduction of the analyser is in direct response to international market demand from such sectors as computer maintenance and system installers.

The unit monitors mains supply voltages from 90V to 260V and is capable of reporting voltage sags and surges, high or low average voltages, dropouts as short as 1.5ms, and power cuts of as long as 10 hours duration. While measuring frequency variations, it is also capable of measuring voltage spikes to a resolution of 100V and high frequency noise up to 20MHz.

Disturbance events are recorded in real time and can be printed out in English, French or German, or stored in memory. Up to 900 events can be stored for a month.

For more information contact: Megger Instruments Ltd, Archcliffe Road, Dover, Kent, CT17 9EN. Tel: 0304 202520.

Its smart appearance and outstanding specification makes it ideal for housing all types of instruments and control gear.

The polycarbonate version is virtually unbreakable in normal use and has good electrical properties. In addition it is resistant to chemical attack and temperatures ranging from -40°C to 130°C. Popular sizes are stocked with clear lids. Receieved neoprene o-ring gasket seals are standard. The ABS range withstands temperatures ranging from -40°C to 80°C and is unaffected by alkaline solutions.

Probably the quickest in the range is the glass-filled polyester housing.

Its heat, moisture and chemical resistant properties combine with good electrical insulating qualities. For further information contact Bopla Ltd, 29 Blakes Road, Aylesbury, Bucks, HP19 5RY. Tel: 0296 390939.

NON-CFC PHOTORESIST

A product ideal for the environmentally conscious electronics constructor has been introduced by Electrolube. Believed to be the first aerosol photoresist product using an ozone-friendly propellant, the new Electrolube RP50 is a fast-drying positive resist for one-to-one reproduction of circuits, diagrams and images on metals from positive transparency masters.

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The diecast aluminium range offers excellent screening properties.

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CATE is believed to be the most advanced system of its type in the world and a number of foreign transport operator have expressed interest.
POWERSFUL CLAMP-DOWN

Measuring both ac and dc current and voltage, the new SK3800 is the latest multifunction clamp meter from TMK Instruments. This handheld, yellow-cased instrument has a 3 1/2 digit liquid crystal display and can accommodate 50mm conductors. Additional features include Data Hold for retaining the reading, Peak Hold for measuring the current of transient signals, diode and continuity tests, and a dc voltage resolution of 0.1mV.

Supplied complete with a safety wrist strap, carrying case, test leads and instructions, this battery operated unit measures both alternating and direct current up to 500A. The two ranges have a basic accuracy of ±2% with overload protection to 1000A. DC voltage is in three ranges to 1000V, and ac voltage to 750V. Input impedance for both ac and dc measurements is greater than 10M ohms. Resistance measurement is to 2k ohms, with 1 ohm resolution. Measuring 230 x 70 x 36mm and weighing just 380gms, the SK3800 is fully guaranteed for 12 months and costs £115 plus vat.

For further information contact TMK Instruments, Building 3, GEC East Lane, Wembley, Middx, HA9 7PJ. Tel: 01-908 3355, and ask for Mike Dixon.

HIGH SPEED VIDEO

A video instrumentation system that can capture thousands of frames of high-speed action in the blink of an eye has been developed by Bantelle.

The system combines solid-state imaging electronics, an automatic event-detection processor, a high-volume memory, and a personal computer for ease of operation. "The camera can be programmed to monitor, automatically record, and then play back frame by frame an event that takes place in a few hundred microseconds", said Ronald Gorenflo, Manager, Battelle Institute Ltd, 15 Hanover Square, London W1 R 9AJ. Tel: 01-493 0184.

For more information contact Renate Siebrasse, Operations Manager, Bantelle Institute Ltd, 15 Hanover Square, London W1 R 9AJ. Tel: 01-493 0184.

SOLDERING STATION

The new SA500 soldering station from OK is claimed to set new quality standards for low cost soldering equipment. Its 70W ceramic heater has closed loop control to provide a temperature range adjustable from 315°C to 427°C, and led heater and power-on indication is provided. The low-leakage soldering iron has a slim profile handle and non-burn cord sleeve. A wide range of tips is available. It is supplied as a compact benchtop unit with built-in iron holder. The price is around £64.

For further information contact OK Industries UK Ltd, Barton Farm Industrial Estate, Chichester Lane, Eastleigh, Hampshire, SO5 5RR. Tel: 0703 619841.

CHIP COUNT

UPD78310 16-BIT PERFORMANCE

A new cmos single-chip microcomputer aimed at real time control applications and offering true 16-bit performance has become available from Impulse.

Manufactured by NEC, the UPD78310 is the non-less version of the UPD78312. Although designated as 8-bit devices, this family of microcomputers has a 16-bit cpu and internal bus architecture which allows it to perform true 16-bit operations, including 16 x 16 bit multiplication and 32/16 bit division. It is therefore ideal for applications with real time processing requirements or with heavy demands on arithmetic or logical operations.

The UPD78310 is compatible with the 8085 type of multiplexed bus structure, and in addition to the 256 bytes of on-chip ram, external memory of up to 64k bytes can be addressed. On-chip features include multiple 16-bit timers and counters offering a range of modes; two pulse-width modulation units; a 4-channel 8-bit analogue to digital converter and two 4-bit real time output ports suitable for stepper motor control. A total of 48 input lines are available.

The sophisticated instruction set provides 94 types of instruction on up to 317 operands. With a 12MHz crystal, instruction cycle times of 16ns are achieved, and an instruction pre-fetch queue further enhances performance. On-chip interrupt control allows up to three external, 12 internal and two non-maskable sources to be employed, with eight priority levels. Both hardware and software context switching is supported.

The UPD78310 will operate from a single 5V supply over the industrial temperature range of -40 to +85 degrees C. Applications include office automation systems, automotive and robotics as well as industrial control systems, particularly those involving motor or positioning control.

PHD 16N8-5 HIGH SPEED DECODER

Philips have announced their fastest programmable decoder. The PHD16N8-5 features a propagation delay of 5ns and uses bipolar ttl process technology. It is intended for the address decoding functions required by any of the current high-performance 32-bit architectures, such as Sun Microsystems's SPARC, Motorola's 88000 and Intel's 8600. It is also designed for use with the popular 80386, 80486 and 68000 architectures.

The new decoder is targeted for some high speed 16L8 PAL applications, where 16L8PAL devices are used for address decoding functions. This includes memory decoders, code detectors, random logic, peripheral selectors and state machine decoders.

The device's high speed capabilities (33% greater than the fastest 16L8 currently available) help scientists to achieve true zero-wait states, keeping pace with today's high-performance microprocessors.

The PHD16N8-5 will be beneficial to systems regardless of cpu speed since it allows designers to design-in more accessible and less expensive run, thus helping to reduce total system costs. It is the first in a new family of high-speed decoders from Philips, based on a streamlined version of their 75ns PAL architecture. This new architecture offers designers higher performance products with a proven process technology which eliminates risks and simplifies product qualification.

BIST25A AND BFG25AX RF TRANSISTORS

Two new low voltage, low current rf transistors from Philips are ideal for the fll stages in 'pagers', and feature low noise and high gain up to 1GHz.

The BIST25A is an npn device in the SOT-23 outline, and uses second generation rf techniques to achieve a gain of 5dB and a noise figure of 2dB when measured at 1GHz. The BFG25AX is an npn transistor in a plastic SOT-143 surface mounting package with four tabs. It also uses second generation techniques to provide a gain of 22dB and a noise figure of 2dB at 1GHz.

MANUFACTURER'S ADDRESSES

Impulse Electronics, Hammond House, Catherham, Surrey, CR3 6XG. Tel: 0883 46433.

Philips Components Ltd, Millward House, Torrington Place, London WC1 E 7HD. Tel: 01-580 6633.
Did you ever wonder how radio and tv commercials get from the production houses where they are made, and which are mainly in London, out to the tv and radio studios dotted round the country? Sometimes both radio and tv adverts, for instance for Today newspaper, go on air within hours of being made, because they centre on a topical news story.

And how do radio news items, like interviews, get distributed to local radio stations round the country, for local editing? If a Scottish MP talks in London about housing in Edinburgh, London radio stations will not be interested, but Scottish stations will.

Commercial tv stations round the UK get their advertisements sent by British Telecom's landline and microwave links twice a week, on Thursday afternoon and Saturday. If a topical advert misses these slots, it has to be sent by dispatch rider or courier. Until September 1989, commercial radio stations got their adverts on tape (either dat cassette or continuous loop cartridge) by rail, road or air freight. It was a painfully slow and clumsy operation.

In America, over 4000 radio stations have for many years been getting their material by satellite link. They also get syndicated music programmes, like pop concert recordings, by satellite. For the last 18 months a similar system has been operating in Britain. Satellite Media Services is run by ex-BBC and Coventry Cable tv man John Ross-Barnard.

The SMS nerve centre is at Euston in London, near Capital Radio. Advertising agencies, recording studios and news services deliver programme material and commercials to the centre, either on tape or down a high quality telephone line. SMS then collates the material and sends it down another line to British Telecom's satellite uplink station in Docklands. The signals go up to the Intelsat satellite, and from in a 2 MBit/s data stream down to any radio station in the United Kingdom or Eire equipped with an SMS downlink dish and receiver. Currently there are 52 downlinks, serving over 100 stations. The receiver equipment is made by Scientific Atlanta.

The 2 MBit/s stream contains two 768 kbit/s stereo pairs; 15kHz bandwidth with 15 bit linear coding. This is reduced down to 11 bits, with one bit added for parity to give 12 bit code. There are also two half-bandwidth sound channels for speech, two 32 kbit/s data channels, and a remote control channel which can trigger up to 128 commands at the downlinks around the country.

Every radio station is equipped with a bank of dat recorders modified to respond to the remote control commands coming down from the satellite. Header words let the commands individually address selected downlink stations.

So from the Euston office, SMS can pick any of the 52 banks of dat recorders dotted around the country, switch them to record, transmit a programme or commercial, and then switch the machine off again. In this way any programme material delivered to Euston can be squirted to any radio station within a matter of minutes, irrespective of whether there is anyone on duty at the radio station. Provided there is a blank tape in the machine, it will record whatever is beamed down from the satellite, while dat machines in other stations remain dormant.

Some of the dat recorders are Sony DTC-1000 models, connected by RS-232 serial computer line to a control box built by British company ASC of Aldermaston.

The next step will be to use digital compression, probably the system developed at Belfast University and adopted by British professional audio company SSL, to reduce the word length from 12 bits to 4 bits. This will let SMS cram more programme material into the 2 MBit stream.

INTERACTIVE

John Ross-Barnard has always been known in the industry as a forward thinker. Already he is thinking forward on the next development for SMS. As radio stations round the country install more and more automated equipment (many stations now play music from banks of CDs stored in juke boxes under touch screen computer control) J.R-B wants to make the SMS system interactive. This would let radio stations transmit their "traffic" information by satellite back to a central logging station.

Traffic information is the key to survival of commercial radio stations. Advertising breaks

MUSIC LOGGING

There is room in the bit stream on a cd or dat music recording for copyright information. So it is relatively easy to automate the logging of all music played. If SMS can provide an uplink in each radio station, this information could be beamed out of the station in real time, or at the end of every day. This would speed up payments all round.

Technically there are no real obstacles. All it needs is an agreed digital protocol so that all stations are uplinking their traffic and copyright information in the same or compatible form. But legally, there is a major obstacle. The uplink becomes a communications service and under the current duopoly arrangement only British Telecom and Mercury can run a full telecommunications service in Britain. The first crack in the law came with the grant of six Specialised Satellite Service licences, e.g. to British Satellite Broadcasting's subsidiary Datavision and firms serving betting shops. But these only permit the broadcast of business data or programming one way, from one point to many. The DTI has said it will look at two-way licences when it reviews the telecommunications duopoly in November.

There is a lot more to it than that. The remote control triggers must "tickle" the dat machines through a complex series of operations, to ensure that an incoming signal does not over-write existing material. The tape is remotely fast wound to the end and then searched for a safe blank space. The codes have to cope with any length of tape. A computer countdown system at Euston switches on warning lights ahead of each transmission, so that if anyone is using one of the dat machines, they can quit in time for the next transmission.

The dat recorders are Sony DTC-1000 models, connected by RS-232 serial computer line to a control box built by British company ASC of Aldermaston.

The next step will be to use digital compression, probably the system developed at Belfast University and adopted by British professional audio company SSL, to reduce the word length from 12 bits to 4 bits. This will let SMS cram more programme material into the 2 MBit stream.
The National Consumer Council has published a lengthy paper which examines the European Community's anti-dumping regulations from a consumer viewpoint, focussing on the measures that have been used in the consumer electronics sector, and at what cost.

The paper relates details of a number of anti-dumping cases in the EC involving imports of consumer electronic goods, mainly from the Far East. Apparently, in all these cases, the interests of injured producers have been of greater concern than those of consumers, even though the measures taken have resulted in consumers being forced to pay higher prices.

Estimates are put forward in the paper concerning some price increases resulting from duties imposed by the EC on cheap foreign imports. For example, in order to protect EC manufacturers from what they see as unfair competition, consumers have to pay, on average, around £13 more for a cd player, £20 more for a video recorder, £74 more for a computer printer, £31 more for an electronic typewriter, and over £181 more for a photocopier. These measures probably cost UK consumers over £274 million a year in higher prices. EC consumers as a whole probably pay around £1170 million more for their goods. This is the equivalent of five per cent of the total Community spending on consumer electronic goods.

These estimates only relate to immediate costs and do not take into account the long-term effects. Protection could encourage inefficiency in the domestic industry, resulting in higher costs, which lead to yet higher prices. There is also the deterrent effect which the mere threat of anti-dumping measures has on trade. It is possible, too, that exporters to the EC might raise their prices in anticipation of duties being imposed. This effect could be even greater than the actual price rise resulting from the imposition of anti-dumping duties.

The justification for imposing such burdens on consumers is queried in the paper. It is argued that the competition posed by Far Eastern exports is not necessarily unfair. In none of the cases examined could it be demonstrated that Far Eastern exporters were dumping their products at below their domestic costs of production. EC manufacturers tend to argue that if their sales fall this must be because of unfair low pricing by competitors outside the EC. Japanese manufacturers, however, argue that their market share is increasing because their products are superior in quality and performance. The Japanese also criticise EC producers for bad investment decisions and for failing to update their technology.

Reduced consumer choice is another possible result of import restrictions. This can occur if domestic manufacturers cannot produce enough to fill the gap left by low-price imports. In some cases, EC producers had already abandoned the cheaper end of the market by the time anti-dumping measures were imposed. Additionally, it is possible that foreign producers who specialise in cheap, mass-produced goods may move up-market to avoid duties. The effect could be to increase competition in other market areas, the opposite of what may be required for the domestic industry to survive.

Of several recommendations made in the report, one in particular stands out, that before duties are imposed on cheap imports from outside the community, the cost to consumers should be calculated and weighed against the benefit to the Community industry. The report comments that there has never been a case where the EC has ruled out duties on the grounds that they would harm consumers.

It's about time that it did.

THE EDITOR
### TTL & CMS 4000 SERIES

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<th>Package</th>
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### CMOS 4000 SERIES

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<td>DIP-16</td>
<td>3.3 V</td>
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In last month's Intelligent LCD Modules article we examined in detail the nature of the Sanyo LCM570 display module. We saw that it contains an 80 symbol memory and a liquid crystal screen on which sixteen symbols can be displayed simultaneously in a two-line format. We further saw that the module's internal character generator ram contains 160 pre-programmed symbols consisting of alpha characters in upper and lower case, punctuation marks, mathematical symbols, plus a selection of Kana and Greek characters. (Last month the wrong symbols for theta, omega and zeta were shown in Fig.3, but the correct ones were shown in the dot matrix table of Fig.1.) Additionally, information on how to create your own library of eight symbols was given.

We went on to discuss how a message or pattern of up to 80 characters in length could be programmed into the module's display memory and how that pattern could be shifted and modified by the simple use of control codes. It was shown how these codes could be sent either as 8-bit or 4-bit blocks.

**SMARTER LCD MESSAGE MAKING**

**MESSAGE FROM CONTROL**

This month I shall describe a control circuit which can be used as a dual-purpose board for experimenting with the numerous attributes of the lcd module and for actively displaying messages or patterns in practical situations. The board can be controlled either directly from a computer parallel port or via an eprom, or both. An example of a computer program, written in Basic, is also shown, in which the main control modes are illustrated as practical examples.

The lcd module has 11 control lines, eight for carrying data (D0-D7), and three for mode selection (RS, RW and E). By putting the module into 4-bit control mode, four of the data lines (D0-D3) are not used. This means that we really only need to use seven output lines from a computer, eprom, or eprom. However, as you will see in a moment, I have used nine computer lines to control the board, allowing other functions to be controlled as well as the module. The computer lines used are the normal eight data lines, D0-D7, plus the ATN line. The latter is used to control the read/write mode functions of the board.

As you will probably have surmised from last month's article, you can in fact control the led module directly from the computer without the need for any interfacing electronics. The purpose of the circuit is to allow you to use an eprom or eprom as the main lcd controller, and to program it either in an ordinary eprom programmer, or directly from a computer. Once the eprom has been programmed, the computer link becomes unnecessary and the message maker board becomes totally self-contained, complete with its own control clock, the rate of which can be varied from a panel-mounted potentiometer.

**THE CIRCUIT**

The circuit has been designed so that computer lines DA0-DA3 control the led lines D4-D7. DA4 controls the led read/write (RW) operation, DA5 controls the led RS mode select pin. DA6 and DA7 are used to control two 'wait-a-bit' delay times to give pauses and variety to the rate at which messages vary on the screen. The same two lines also control the reset function which returns an address counter to the start of its cycle. As previously mentioned, the ATN line controls the eprom read/write line, and it simultaneously steps the address counter.

The complete circuit is shown in Fig.1. It consists of a control oscillator (IC7a/b), an address counter (IC1), the eprom (IC2), a computer interface buffer (IC3), and the led module. Additionally, there are two function-control gates (IC5 and IC6), a delay-state counter (IC4), and a second oscillator driving an inverter to generate the negative voltage required by the led module.

**NEGATIVE GENERATOR**

IC7e and IC7d are configured as an oscillator running at about 400Hz, as set by the values of R13 and C2. The output is buffered by IC7e which drives the inverter circuit consisting C3, D1, D2 and C4, the latter smoothing and storing the resulting negative voltage. The led screen contrast depends on the negative voltage presented to the module's pin 3. VR2 is used to set this voltage, and it may be a preset pot as shown, or a panel pot for manual control to suit ambient light conditions. As mentioned last month, the screen contrast will also depend on which line and font mode is selected.

**CLOCK AND COUNTER**

When under direct eprom control, the rate at which the message is shifted and displayed is controlled by the oscillator around IC7a/b. The basic rate is set by C1, but is manually controllable from the panel by VR1. Taken via the gates in IC5 and IC6 (more on which in a moment) the oscillator output provides the clock pulses for the address counter IC1.
and also the trigger pulse controlling the LCD module’s ‘E’ line.

The counter’s output lines sequentially control the addresses of the EEPROM IC2. Each time the LCD ‘E’ line is triggered, the module responds to the data presented to it from the EEPROM data output lines.

### DELAY COUNTER

The duration between address counter pulses can be varied by switching a delay counter in and out of circuit. The counter is IC4 and is clocked by the oscillator IC7a/b. The Q7 and Q4 outputs of IC4 are taken to the gate IC5, as are the full-rate clock pulses. The choice of which clock rate is selected is controlled by the status of EEPROM lines D6 and D7, which control the A/B multiplex lines of IC5. The gate passes the full-rate clock to its Y output when D6 and D7 are either both high, or both low. With D7 high and D6 low, clock Q4 (medium delay) is passed through. With D7 low and D6 high, clock Q7 (longest delay) is passed through.

### COUNTER RESET

The counter IC1 can be reset by a suitable control code from the EEPROM. This enables messages shorter than the full EEPROM length (2048 address locations) to be looped repeatedly, resetting to the start at the selected moment. If a reset code is not given the counter will cycle repeatedly through all 2048 addresses. In order to reset the counter EEPROM lines D6 and D7 both need to be set high. The X output of IC5 is then opened to...
the high level present on input X3, which resets the counter. Immediately the counter is reset, D6 and D7 cease to be high (providing you’ve programmed the data properly!) and so IC5 shuts off the reset level allowing the counter to restart.

The counter can be manually reset at any time by S1. This must be done prior to each time you wish to program the eeprom directly from a computer.

**READ/WRITE GATE**

A second set of gates, within IC6, controls the signal routing required for eeprom or computer control running.

When under eeprom control, S2 switches the gates in IC6 so that the clock pulses via ICs are routed to the counter IC1. The gate simultaneously holds the eeprom in read mode (WE high, OE low), and the interface buffer IC3 closed to the computer lines. When switched to the opposite mode, S2 opens the gates in IC6 to allow IC3 to open to the computer lines, and for the eeprom lines WE and OE to be put under control from computer line ATN. The clock pulses via IC5 are simultaneously shut out. In this mode the LCD module is entirely under computer control. It is also in this mode that the eeprom is directly programmed by the computer.

**POWER SUPPLY**

The board and module need to be powered by a stabilised +5V supply, at around 60mA. This can come from an existing 5V psu or from a 9V supply via IC8 and adding capacitor C7 as in Fig. 5. The other ics and the LCD module must NOT be powered directly by voltages greater than 5V.

**COMPUTER PROGRAM**

The illustrative program in Fig. 3 has been written in Basic, and apart from making minor changes in the dialect, plus changing five control numbers, it can be run on any computer having an 8-bit parallel input/output port, such as a Centronics or User port.

The control numbers you are likely to have to change to suit your own computer are those in line 100, relating to DRT, OUT, DN, UP, and AT. DRT is the data direction register which sets whether the port is to be configured as an input or an output. OUT is the register to which you write in order to send data out through the port. AT is the register which controls the ATN (attention) line. DN is the code which sets the ATN line low, and UP is the code which sets it high. Check your computer manual for the relevant codes and substitute them for the numbers given in line 100.

For example, with the standard BBC computer the codes are: DRT = &FE62, OUT = &FE60, DN = 14, UP = 206, AT = &FE6C.

For the Commodore 64: DRT = 59459, OUT = 8F.

---

PRACTICAL ELECTRONICS JUNE 1990
Fig 3. Experimental software listing.
sets them all off. In line 280 the display is cleared using code 00000010. The entry mode is set in line 290 by code 00000110, which you will see from last month’s article sets the DD ram to increment by one each time it is written to. It also sets the cursor to shift right by one place (if activated) and for the screen display to remain unshifted.

Next, in line 300, the Return Home mode is called using code 00000100, resetting the DD ram address to zero and returning the cursor and screen to their primary positions.

That completes the initialisation routine, following which we can start sending data and shift commands to the display. Any of the above codes can be changed from those shown to suit your particularly needs, and full details of the alternatives were given last month. However, with the Message Maker circuit, it is essential to send the commands in lines 240 and 250 following switch-on in order to put the module into 4-bit mode.

**DISPLAY EXAMPLES**

The remainder of the program shows a selection of example codes and data which can be sent to the module to illustrate the principle functions which it can perform. You will notice that in some cases I have chosen to bypass the binary to decimal conversion routine, for example by quoting the decimal number directly (as implied by J in lines 370 and 440), and by using the computer’s Ascii conversion facility to take a message written in English and send the correct data codes to the module (eg line 570). Note that your computer must have the same interpretation of Ascii codes as the module, otherwise you will have to insert a code conversion routine.

There are several examples, too, of shifting the display, both by sending the shift code directly (line 480), or by modifying the shift function primary command (line 610).

**SYMBOLISING**

An example of programming-in your own symbols is shown in the routine from lines 740 to 880. The matrix data, as discussed last month, is held in the data statements at lines 750 to 820. The data in line 820 produces the £ sign which becomes the symbol referred to in line 600. Try changing the data codes in lines 750 to 820 and see what results you get.

You will find several examples of the use of the delayed clock setting in which lines 220 and 230 are called.

**RESET, STOP AND ONWARDS**

The address counter reset code is the final command of the main program, and is the F = 192 call in line 940. Once 192 has been ORed into the eeprom, the counter will be reset to zero when that code is recognised by IC5. This means that you must avoid allowing that code to be entered into eeprom address zero. If you do, the counter can never be stepped forward and the display module will give every impression of being inactive. The eeprom must be allowed to at least complete its initialisation routine before reset is called.

The program has a STOP call in line 940. This is because the eeprom capacity is too small to take all the previous commands plus those from line 1000 onwards. If you want to examine what lines 1000 to 1160 do, remove the eeprom and just run the unit under computer control, deleting the STOP command. (The program contains a counter, variable S, which keeps track of the number of commands sent to the circuit.)

**COMPONENTS**

**RESISTORS**
- R1-R9 1k (9 off)
- R10, R12-R14 10k (4 off)
- R11 33k
- All 0.25W 5% carbon or better.

**CAPACITORS**
- C1, C2, C8-C10 10n polyester (5 off)
- C3, C5 1p 16V elect (2 off)
- C4 47p 16V elect
- C6 1n poly styrene
- C7 47µ 16V elect (optional, see text)

**POTENTIOMETERS**
- VR1 1M lin mono rotary
- VR2 100k preset

**SEMICONDUCTORS**
- D1, D2 1N4148 (2 off)
- IC1 4040
- IC2 eeprom type 2816 (2048 x 8-bit) (see text)
- IC3 74HC245
- IC4 4024
- IC5 4052
- IC6 4053
- IC7 4069
- IC8 7805 (optional, see text)

**SWITCHES**
- S1 min push-make
- S2 spdt min toggle

**MISCELLANEOUS**
- LCD display module LCM570 or RS 585-006, box 180 x 120 x 40mm, printed circuit board, pcb supports (4 off), 14-pin dil ic socket (2 off), 16-pin dil ic socket (3 off), 20 pin dil ic socket, 24-pin dil ic socket, 3.5mm jack socket, knob.

**EXPERIMENTING**

The aim of the program is first to show you what can be achieved with the lcd module, and then for you to re-write or modify it in order to achieve other displays and modes of control. As long as you first set the module into 4-bit mode, you can play with the codes as much as you want. For much experimenting it is not necessary to have the eeprom in circuit, and you can just control the module from the computer. When you have achieved a particular result, then you can insert the eeprom and transfer data to it. Once the data is stored, then the computer can be disconnected and the message maker used on its own to cycle through and display the message or pattern routine. Another option available if you do not have a computer which can be coupled to the unit is to program an (e)eprom using an (e)eprom programmer (of which PE has published several examples recently), and then to insert the (e)eprom into the unit. (Note that only eeproms can be directly programmed while in the Message Maker.)

**Fig 4. Pin connections for the LCM 570.**

**Fig 5. Power supply (see text)**
COMMUNICATIONS PROJECT

Other modules having different display formats but identical command control codes are:

<table>
<thead>
<tr>
<th>CHAR x LINES BACK LIT</th>
<th>CODE</th>
</tr>
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<tr>
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<td>16 x 2</td>
<td>EL 585-028</td>
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<tr>
<td>24 x 2</td>
<td>EL 585-034</td>
</tr>
<tr>
<td>40 x 2</td>
<td>EL 585-040</td>
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<td>LED 585-113</td>
</tr>
<tr>
<td>40 x 2</td>
<td>LED 585-129</td>
</tr>
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</table>

Do not use the other modules with the Message Maker without first consulting data sheet 9811. Note the difference in the RS VO drive for some modules, as in Fig. 7. The optional backlight inverter for module 585-056 is coded 585-078, but the other EL modules can all use the 585-062 inverter. The led backlit modules do not need an inverter.

MORSE DECODER

Next month I shall describe another project which makes use of the same LCM570 lcd module. The project will be a semi-intelligent morse code decoder which automatically decodes and displays morse messages received via a radio, or cassette recording, or computer, or direct from a morse key. The project will also illustrate other techniques by which the led module can be initialised and controlled.

Fig 7. Equivalent schematic diagrams of V0 drive for RS code numbers indicated. The left hand circuit is the one equivalently used in the Message Maker.

Fig 6. Control wiring details.

SIMILAR LCD MODULES

The LCM570 is available from Electromail under code number RS 585-006. The optional EL backlighting inverter (see last month) is available as code number RS 585-062.
Electronics Handbook

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It's not easy to be an expert on every aspect of electronics - but this 800 page integrated reference book will make sure you can always find that vital information. Well illustrated and detailed, it covers Digital and Analogue Electronics, Tables and Standards, Communications technology, Personal Computers, and relevant Mathematics. The author has created an environment where the reader will find answers to not only those problems directly related to Electronics, but also to those in related areas. The text includes all the major definitions, theories, facts, equations, and standards you need to use.

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by P M Grant, C F N Cowan, B Mulgrew, J H Dripps

Extensive coverage of signal processing and coding, both analogue and digital, with a distinct practical flavour. It is based on an industrial course given by the Electrical Engineering Department at Edinburgh University.

Chapters 1-4 cover basic techniques such as Laplace and z-transforms, Fourier transforms, sampling theory and time domain analysis. Chapters 5-7 cover frequency filter design - both Finite and Infinite Impulse Response types. Optimal time domain estimation techniques such as Wiener, Kalman and adaptive filters are covered in chapters 8-10. The next major section, chapters 11-13 covers spectral estimation - including material on the design of discrete and fast Fourier transforms and modern spectral analysis. This is followed in chapters 14-17 by a consideration of coding techniques, including forward error correcting codes and data reduction techniques for voice and image data transmission. Finally, chapters 18-20 cover some practical aspects of signal processing - including analogue and digital implementations and the use of matched filters in radar and communications.


Fundamentals of Microprocessor Systems

by Philip A Witting

This complete guide for designing microprocessor-based equipment considers all the hardware and software issues to be resolved during design. Theory is explained in a manner not specific to any particular processor, however two chapters are dedicated to the Motorola 6800 family of devices. These chapters are paralleled by two appendices which consider the Intel 8080/8085 family.

Microprocessors and Microsystems Review: "It is almost certainly the best of the books on microprocessor systems design currently on the market. I would strongly recommend it for all second and final-year courses in microprocessor systems design. Owing to its size, it covers all the topics likely to be found in such courses."


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LAST MONTH WE LOOKED AT CONDUCTION IN SEMICONDUCTORS. WE SAW THAT THERE ARE TWO KINDS OF SEMICONDUCTORS:

* n-type - in which the charge carriers are electrons
* p-type - in which the charge carriers are holes

Holes are really vacancies in the structure of the crystal lattice. In an electric field, electrons jump from hole to hole, which has the effect of making the holes appear to move along the semiconductor, from positive to negative. They act as positive charge carriers.

We also discovered what happens when a p-type semiconductor adjoins an n-type semiconductor - the pn junction. The features of this junction are:

* a depletion region, with no charge carriers
* one-way conduction
* an in-built cell, giving a forward voltage drop (0.6V in silicon).

These features determine the characteristics and behaviour of the simplest semiconductor device, the diode. Now we look at something a little more complicated: the transistor.

THREE LAYERS OF SEMICONDUCTOR

There are several kinds of transistor, but the type we usually refer to as a "transistor", is more accurately called an npn silicon bipolar junction transistor. Taking the description a word at a time:

* npn: it consists of three layers of semiconductor, a layer of p-type sandwiched between two layers of n-type (Fig. 1).
* silicon: the material it is based on (its substrate) is silicon.
* bipolar: conduction is by electrons and holes.
* junction: its action depends upon the features of the pn junction.
* transistors: we will explain this when we have seen how the transistor works.

Closely related types of bipolar junction transistors are pnp transistors and those with a germanium substrate.

Fig 1. Simplified structure of a transistor.

BASIC ELECTRONICS

By Owen Bishop

Part 6 - Transistors.

The current goes one way, the electrons go the other, and the holes don't move at all - they just change place. This is a PN junction.

Fig 2. Stages in making an npn silicon transistor.

Investigation 1 - currents in a transistor

You need: battery box (6V)
R1 22k
R2 180 ohms
D1 TIL209 or similar light-emitting diode
TR1 ZTX300 npn junction transistor
Testmeter, breadboard

Before we go on to discuss how a transistor works, let us see how it is made. Fig. 2 illustrates one of the techniques used. The process begins with a slice (or 'chip') of n-type silicon (a). One surface of this is oxidised to form a thin layer of silicon oxide. Silicon oxide is a non-conductor. A hole is etched in the silicon oxide, exposing the silicon beneath. In a furnace, the silicon is exposed to the vapour of an element with three electrons such as phosphorus. This forms a layer of n-type silicon (2d). We now have a 3-layer 'sandwich' and this is covered over with a layer of silicon oxide (e). Finally (f), a layer of metal (the collector) is plated on to the other surface of the substrate, and two wire contacts are made through the silicon oxide to the p-type region (the base) and the small n-type region (the emitter).

A transistor is very small, measuring a millimetre or less across. To make it easier to handle, it is enclosed in a metal or plastic case with terminal wires connected to the three regions.

USING A TRANSISTOR

A transistor has three terminal wires - which way do the currents flow? This investigation helps you find out.

Investigation 1 - currents in a transistor
Set up the circuit of Fig.3 as in Fig.4, without the wire link in position. The led is being used to indicate whether current is flowing in through the collector of the transistor. R1 is used to limit this current (if any) to a safe level that will not burn out the led.

Connect the power. Does the led light?

What really wire link to the circuit. What happens now?

Remove the wire link. What happens now?

Switch the testmeter to a low milliamp range. Connect the testmeter across the two terminals used for the wire link. What happens to the led now? The resistance of a milliammeter is very low so its effect on the circuit is almost the same as the wire link. But you can now measure the current. How much current is flowing to the base of the transistor? Is this enough to make an led lit?

How much current is flowing to the collector of the transistor? Is this enough to make an led light?

When the link is in position and the led is lit, use the testmeter to measure the voltage between the base and the emitter of the transistor.

**HOW A JUNCTION TRANSISTOR WORKS**

In Fig.5a the three regions of the transistor are shown as they appear in the circuit-diagram symbol. But this symbol does not clearly illustrate the actual arrangement of the layers. From Figs.1 and 2 we know that the transistor is a p-type layer between two n-type layers. There are two pn junctions in it. The two pn junctions are the equivalent of two diodes, connected back to back (Fig.3b).

In Investigation 1, we passed a current into the base. Obviously this current would pass through D2 of Fig.5b and out of the emitter. The base-emitter voltage was found to be a small value (less than 0.6V). This is why such devices were originally called transfer-resistors. The name has since been shortened to transistor.

**THERMAL RUNAWAY**

When we studied diodes we noted that a reverse-biased diode has a small leakage current flowing through it. This is due to the presence of minority carriers in the diode. In a transistor, the collector-base junction is a reverse-biased diode, so leakage current flows through it. The effect of variations in the base current is transferred to the collector current. This is why such devices were originally called transfer-resistors. The name has since been shortened to transistor.

**Fig. 5. The action of an npn transistor:** (a) symbol; (b) equivalent pair of diodes; (c) motion of charge carriers; (d) currents through a transistor.
Germanium transistors have a larger leakage current than silicon transistors. Thus these devices are much more prone to thermal runaway. This is one reason why silicon transistors are preferred for most applications.

One way of preventing thermal runaway is to design the external circuit so that excessive currents are impossible - by using resistors to limit current size, for example. But in some circuits we may want to have large currents so this method is not applicable. In such cases we have large currents so this method is not applicable. In such cases we use devices specially rated to withstand high currents (power diodes and power transistors). In addition we use heat sinks (Fig.6) to conduct excessive heat away from the device. A heat sink is made of copper-aluminium, both of which are good conductors of heat. Aluminium heat sinks may have a matt black anodised coating to maximise radiation of heat. Heat sinks usually have an arrangement of vanes to encourage air to flow past the sink and carry the heat away. Of course, adequate ventilation of the enclosure is essential to allow the air currents to flow. In extreme cases we use a small electric fan to force a draught past the heat sink.

**TRANSISTOR SWITCHING**

In Investigation 1 we found that the collector current flows and the led lights whenever we feed a small current to the base of the transistor. We are able to turn the led on or off by turning the base current on or off. The transistor is being used as a switch. Fig.7 is a version of the same circuit, in which the switching action is made clearer. This circuit is the basis for Module 8, Fig.21 (next month).

**Fig 7. Typical transistor switch circuit.**

The transistor switch circuit of Fig.7 has an input for supplying current to the base of the transistor. A resistor limits the current to a safer level. When $V_{IN}$ is greater than a certain value, enough current flows to the base to make a large collector current flow. This current flows through the load. The load can be any of a wide range of devices. In Investigation 1 the load was an led with its current-limiting resistor. Instead, you might have a filament lamp, a buzzer (eg last month's Module 5), or a relay (Module 7). If the load is inductive, the diode prevents the transistor from being damaged by the large reverse current generated when current to the load is abruptly cut off. This effect was explained in an earlier part.

The advantage of the transistor switch is that it is a way of using a very small current to control a device that requires a much larger current. But there are some limits on what type of device can be controlled:

* The device must be one that operates on direct current; the transistor can not switch alternating current. If you have to control an ac device, use the transistor to switch a relay which in turn switches the ac.
* It must be capable of operating on the voltage between the supply voltage and the collector voltage. The collector voltage is about 0.6V when the transistor is fully on. With a 6V supply, this means that the device must be able to operate satisfactorily on 5.4V.

The device must not pass more current than the transistor is rated to carry. A typical low-power transistor can carry 200-500mA; it will probably require a heat sink at the upper end of this range. For larger currents we use power transistors capable of carrying several amps.

Now let us look a little more closely at the switching operation.

**Investigation 2 - transistor switching**

You need: battery box (6V)
- R1, R3 4k7 (2 off)
- R2 1k
- R4 180 ohms
- R5 100 ohms
- VR1 10k potentiometer (eg Module 3)
- D1 TIL209 or similar light-emitting diode
- TR1, TR2 ZTX300 npn junction transistor
- 2 off testmeter

Set up the circuit of Fig.8, as in Fig.9. D1 and R2 are the load of the transistor switch. The input voltage $V_{IN}$ can be varied by turning

**Fig 8 and 9. Circuit and layout for Investigation 2.**
to increase the voltage. Watch the led. When you see it go out, stop turning VR1. This is the ‘turn off’ value. Make a note of this.

Turn VR1 back again a small amount, to reduce $V_{IN}$ by about 0.2V. Does the led come on again? If not, continue turning VR1 slowly back again, reducing $V_{IN}$ until the led does come on. Stop turning. This is the ‘turn on’ value of $V_{IN}$.

Make a note of this too.

Turn VR1 back in the original direction, increasing $V_{IN}$ again, by about 0.2V. Does the led go off again. If not continue turning. What value of $V_{IN}$ is needed to turn it off?

Disconnect the voltmeter from the circuit and reconnect is so as to measure $V_{EB}$, the voltage across the emitter resistor R3. Repeat the investigation, noting the value of $V_{EB}$ at each stage.

Keep the circuit assembled, as you need it for the next investigation.

**Summing up:** The led switches off very sharply when $V_{IN}$ is increased past the ‘turn off’ level. This is usually called the upper threshold. In this version of the circuit, the upper threshold is about 2.2V. The led does not go out again until $V_{IN}$ is reduced below the ‘turn on’ level. This is the lower threshold. The lower threshold is about 1.4V. This circuit shows hysteresis, by which we mean that the change-over level (or threshold) depends on whether $V_{IN}$ is increasing or decreasing.

**Discussion:** Below are the results we obtained when we tried the investigation. Check to see if you obtained similar results.

- **Start:** $V_{IN} = 0V$. TR1 is off. Because no current flows through R1 to the collector of TR1, there is no voltage drop across R1 - the voltage at point A is high. This means that a base current flows through the led.

- **Decreasing VIN:** The lower threshold $V_{IN}$ is now at 1.2V, base current continues to flow even though $V_{IN}$ is reduced by a small amount. $V_{IN}$ must fall below 1.2V before TR1 goes off and the circuit reverts to its original state.

- **Increasing VIN:** TR1 begins to turn on. Immediately, its collector current starts to flow and a voltage difference appears across R2. The voltage at point A starts to fall. The base current to TR2 is reduced. TR2 starts to turn off. The current through the led falls. So does the current through R5. The effect of this is important. As the current through R5 falls, the voltage across it falls and the voltage at point B falls. This makes the voltage at the emitter of TR1 fall too. Falling voltage at the emitter of TR1 means that the base-emitter voltage is increasing sharply, making a larger base current flow and turning TR1 further on. This causes all the actions described above to proceed even further and faster. Once the action has begun, currents and voltages change rapidly. TR1 switches sharply on; TR2 switches sharply off; the led goes sharply on.

At this stage $V_{EB}$ is only 0.6V, due to the relatively smaller current flowing through R2 and TR1. Since the voltage at point B has fallen to 0.6V, the voltage at the base of TR1 has fallen to 0.6 + 0.6 = 1.2V.

Decreasing $V_{IN}$ because the base of TR1 is now at 1.2V, have current continues to flow even though $V_{IN}$ is reduced by a small amount. $V_{IN}$ must fall below 1.2V before TR1 goes off and the circuit reverts to its original state.

**Schmitt Trigger**

The circuit of Investigation 3 is one example of the type of circuit known as a Schmitt trigger. Its advantages are:

- *** It has a sharp ‘snap’ action**
- *** It has hysteresis**

These features are important in control applications. For example, consider a circuit to turn on a porch lamp at night. This is done by using a light sensor to provide $V_{IN}$ for a Schmitt trigger. Instead of the led and resistor of Fig.10, we have a relay coil. The relay may switch a lamp working on mains voltage. We begin in daylight with $V_{IN}$ high, TR1 on, TR2 off, the relay coil not energised, and the lamp off. It is a slightly cloudy day. At dusk, the light level fails, and so does $V_{IN}$. As $V_{IN}$ falls below the lower threshold, the trigger energises the relay, which switches on the lamp. This is a *sharp action* - the current to the relay coil suddenly becomes strong enough to move the armature. A weak current would make the armature waver, making the lamp flicker on an off in a disturbing way and causing excessive sparking and corrosion of the relay contacts.

Now the lamp is on, but the sun has not yet set. Suppose that the clouds clear a little. The increase in light makes $V_{IN}$ rise a little. But this change is not likely to be enough to take it above the upper threshold. There is no change in the trigger circuit and the lamp stays on. Once the lamp has been switched on, small variations of light intensity have no effect. This is preferable to having the lamp going on and off every few seconds or minutes around the time of dusk. The lamp then stays on until dawn, when the reverse action occurs. The lamp goes off the first time that $V_{IN}$ rises above the upper threshold, and stays off for the rest of the day.

**Using Resistor**

When the subject of resistance was first introduced it was mentioned that electrical resistance is not just a nuisance and a waste of electrical power. There are several ways in which it is an asset. We now have seen enough examples of this to summarise the usefulness of resistance:

- *** For limiting current to safe levels; example, the resistor in series with an led (R4 in Fig.10).**
- *** For potential dividing; example, the potential divider VR1 in Fig.10.**
- *** For ‘turning a current into a voltage’**

The last point needs explaining. Of course it is not possible to turn a current into a voltage, since current and voltage are two entirely different things. But Ohm’s Law links current and voltage with resistance. A resistance through which a current is flowing has a voltage across its two ends. In Fig.10, R5 has a current flowing through it. This causes a voltage to develop across it, in proportion to the current. As far as the operation of the circuit is concerned, it is the voltage which is important, not the current. The voltage is developed because the emitter current goes through R5, rather than through a wire connection as in other circuits (Figs.3, 7, 8 etc). In this sense, the resistor has ‘turned a current into a voltage’.

Fig.10 includes another example of this. When TR1 is on, only the small base current of TR2 flows through R2. Only a small voltage develops across it. Point A is only a little less than 6V. When TR1 is off, a large current flows through R2. A large voltage develops across it. The voltage at point A falls to about 1V.
These are another type of transistor, working in an entirely different way. Mosfet stands for metal oxide silicon field effect transistor. There are several versions of the mosfet theme, of which one is shown in Fig.12. The transistor consists of a bar of p-type silicon, with a small n-type region at each end (Fig.12a). The transistor is connected so that one n-type region is positive to the other. It is from the more negative region that electrons with eventually flow, so this terminal is known as the source. Electrons will flow out of (or drain away from) the silicon through the more positive region. This is known as the drain. In Fig.12a, no conduction is possible because there is a pn junction at both ends of the bar - it is like having two diodes back-to-back as in Fig.5b. There is a metal plate, separated by an insulating layer of silicon oxide, on the side of the silicon bar (so that makes it a metal oxide silicon transistor). If we charge the metal plate, the electric field from the charge has an effect on the holes in the p-type silicon (so that makes it a mos field effect transistor, or mosfet).

If the metal plate (or gate) is charged positively, the holes are repelled (like charges repel) to the far side of the bar (Fig.12b). If you prefer to think in terms of what is happening to the electrons, free electrons are attracted toward the gate and accumulate close to it. They fill up all the holes in that region and there are electrons to spare. On the far side, there are very few electrons and most of the holes remain unfulfilled. The field effect has created a region of n-type silicon close to the gate. This makes a complete n-type path connecting the n-type regions at each end. Electrons now flow freely through the transistor from source to drain. In terms of conventional current, current flows from drain to source (Id). Note that no current flows in or out of the gate. The layer of silicon oxide prevents this. There is nothing equivalent to the base current of the bipolar transistor.

Investigation 4 - A mosfet switch
You need: battery box (6V), VR1 10k potentiometer (Module 3), D1 TIL209 or similar light emitting diode, TR1 VN10KM n-channel enhancement mosfet, testmeter

Set up the circuit of Fig.13, as in Fig.14. Begin with VR1 turned to make V_IN = 0V. Slowly turn VR1 to increase V_IN. At what level of V_IN does the led begin to glow? At what level does it reach maximum brightness?

- Remove VR1 and the testmeter. Plug a piece of wire about 10cm long into socket A. Watch what happens to the lamp when you:
  (a) rub a piece of polythene sheet with a woollen fabric and hold the sheet near the wire.
  (b) rub other plastics (eg a ball-point pen, a comb etc) with fabric and hold them near the wire.
  (c) touch the bare wire with your fingers; touch the insulated part of the wire with your fingers.

If the led lights only when the wire link is in position, or when current flows from A to B through the milliammeter. The current through the ammeter is only about 0.3mA, which is not enough to light the led. You can check this fact by wiring the led and the 22k resistor in series and connecting the 6V supply. If you put the testmeter in series with D1 and R2, you will find a much larger current (about 18mA) flowing, enough to light the led. The voltage between the base and emitter is about 0.6V (or a little more) when current is flowing.

Investigation 2: The 'just on' voltage is about 0.75V. The 'fully on' voltage is about 1.6V. When V_IN is 0V, no current flows to the base of the transistor, so there is no collector current. As V_IN is increased it is opposed, at first completely, by the in-built cell of the base-emitter pn junction. When V_IN exceeds about 0.6V, base current begins to flow. I_R increases and with it I_C, until I_C is large enough to make the led glow. This happens when V_IN is about 0.75V. As V_IN increases more, I_R and I_C increase, and the led becomes brighter until the led is fully bright at about 1.6V. Above this voltage, I_R increases but this has no further effect in increasing I_C. We say that the transistor is saturated.

Investigation 3: 'Turn off' voltage is about 2.2V. The led goes off very sharply at this voltage - it does not just 'dim out'. If voltage is reduced slightly to say 2.0V, the led stays off. The 'turn on' voltage is about 1.4V. The led turns sharply on. If voltage is increased slightly to say 1.6V, the led stays on. It does not go out until V_IN reaches 2.2V again.

Investigation 4: The led first begins to glow when V_IN is about 1.5V. It reaches maximum brightness at about 2.2V. Above this the transistor is saturated. Usually the lamp glows dimly, when the gate is unconnected.

A positively charged object in the region of the wire causes electrons to be attracted, increasing the positive charge on the gate (Fig.21 next month). Although the charge involved is small, the voltage at the gate may rise by many volts. No flow of current to the gate is involved. The increased gate potential increases the amount of current passing through the transistor and the led shines brightly. A negatively charged object causes the opposite effect, making the led go out.

Touching the wire (either bare wire or insulation) usually increases the gate potential, making the led brighter. The positive potential of the human body may be due to the body becoming charged either by clothes rubbing on the flesh, or by the soles of shoes rubbing on floor coverings. There is also the effect of magnetic fields produced by currents flowing in mains cables and in mains-powered equipment nearby. These field induce currents in the body fluids and may cause an alternating potential at the finger-tips. The led is turned on and off at 50Hz and appears to glow continuously.

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PHONE TYPE KEYPAD. Really first dass rear mounting unit White lettering on black buttons. Has conductive rule button with soft click and feel. Price £6.00. Our ref. 6P16 a 2 for £10.00. BT approved.
Although the IBM PC must be considered as being the industry standard, it suffers the drawback of being unable to produce a split baud rate from the serial port. This became apparent when trying to communicate with Prestel or any of the Viewdata bulletin boards operating on the V23 1200/75 baud rate using my manual modem which had previously operated successfully with both a BBC and Spectrum computer.

The problem arises from the fact that while the receiving baud rate can be set to the required 1200 baud, the modem expects anything typed on the keyboard to be sent at a baud rate of 75. However, due to the above limitation, most of the communications software packages available also send at the 1200 rate and expect the modem to produce the necessary baud rate conversion using what most manufacturers call a speed buffer. This article describes a unit which carries out this baud rate conversion and is easily installed in the serial cable path between the computer and the modem.

**UART**

The transmission and reception baud rates of the 6402 UART are controlled by separate clocks, the frequency of which must in both cases be at sixteen times the desired baud rate. The receive baud rate is therefore set at 1200 (19.2 kHz divided by 16) and the transmit baud rate at 75 (1.2 kHz divided by 16). In Fig.1, IC1 is a fourteen stage binary divider and clock oscillator running at 4.9152 MHz with R1, C1 and X1 determining the fundamental frequency. The Q8 output from IC1 divides the crystal frequency by 256 and drives the receive clock of the following 6402 UART (universal asynchronous receiver/transmitter) at 19.2 kHz. Similarly, the Q12 output from IC1 drives the transmit clock at 1.2 kHz.

C2 and R2 provide a positive pulse to the reset input of IC2 on initial power-up.

The standard word status for viewdata on Prestel at 1200/75 baud is 7 bits, even parity, with 1 stop bit. This mode is set up using the five control inputs (CLS1, CLS2, PI, EPE, SBS) and loaded with a high level on the control register load (CRL) input.

The receiver register disable input (RRD) is held at logic 0 enabling the eight (RBR) outputs of the receiver buffer register to be directly connected to the eight (TBR) bits of the transmitter buffer register inputs. The status flag disable input (SFD) is also at logic 0, enabling outputs from the transmitter buffer register empty (TBRE) and data received (DRR) flags.

The receiver register input (RRI) accepts the 1200 baud data output from the computer, while the transmitter register output (TRO) sends data to the modem at the converted rate of 75 baud.

The transmitter buffer register empty status flag output (TBRE) is used to control the

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**Robert MacFarlane**

Brings the PC down to speed for split-rate comms.

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**Fig 1. Circuit diagram for the baud rate converter.**
output of data from the computer using the clear to send (CTS) input. Thus, after the computer sends each individual character to the converter at the higher 1200 baud rate, the computer is made to wait by the CTS signal until the transmitter has finished sending at the lower 75 baud rate, this being indicated by the TBRE flag going high.

A high level on the data received flag (DR) indicates that a character has been correctly received and transferred to the receiver buffer register, but this output must be reset before a new character can be received. The quad two input NOR gate IC3 is used as an inverter, with R3, R4, C3 forming a simple timing circuit to stretch the data received (DR) output and reset it by driving the data received reset input (DRR) low. The stretched pulse is also used to load the transmitter buffer register (TBRL) with the next received character.

Fig 3. Interconnections

The RS232CD driver chip (IC4) is used since this chip only requires a single +5V supply and, using dc/dc converter techniques, derives its own 12 volt supplies internally, thus simplifying the power supply requirements of the baud rate converter circuit.

To accommodate the possibility of the CTS input on some computers being either active low or active high, one of the quad NOR gates (IC3c) is used as in inverter to drive the input of IC4b through the selectable link L1. A spare RS232CD driver is available, the input and output being brought out to connector S5 and S6.

POWER SUPPLY

The +5V supply can either be obtained directly from the computer, or from the modem and fed through a spare pin of the serial RS232 25-way cable, or from a separate supply provided. Adequate supply decoupling is provided on the board by C4, C5 and C6. The board is fitted into the box using adhesive horizontal hold down strips and the two 25-way D-type connectors fitted on either end. The through connections and the three signal lines from the board are then wired to the sockets as shown.

COMPONENTS

RESISTORS
R1 4M2
R2 4k7
R3, R4 2k2 (2 off)

CAPACITORS
C1 10p ceramic plate
C2 47µ 10V tantalum
C3 330p ceramic plate
C4 10µ 10V tantalum
C5, C6 100n min polyester (2 off)

SEMICONDUCTORS
IC1 4060
IC2 1M6402 UART
IC3 4001
IC4 RS 232CD

MISCELLANEOUS
4.9152Hz crystal, printed circuit board, case about 120 x 90 x 30mm, adhesive pcb guide strips, male and female 25 way D-type connectors, 14-pin dil socket, 16-pin socket, 40-pin dil socket.

Communications are established in the normal fashion with the converted now transmitting at the slower 75 baud rate. If difficulty is experienced when transmitting continuous characters, inverting the CTS output to the computer by changing link L1 should solve the problem.
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VAPOUR LIGHT HALOGEN LAMPS A19 40W A19 50W 2...3p.
A19 75W A19 100W 2...3p.
H1 12V 50W (CAR SPOT) 1p...3p.
25W 12V 50W 2...3p.
25W 12V 50W 2...3p.
100W 12V 50W 2...3p.
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MICROPROCESSOR AESO 250V 100W 2...3p.
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100W 12V 50W 2...3p.
Here's just a selection of our kits for PE-published projects. Many more in our catalist!

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PHONOSONICS, DEPT PE95, 8 FINUCANE DRIVE, ORPINGTON, KENT, BR5 4ED. Tel: 0689-37821 (answering machine)
Recently a friend bought a second hand car, and asked me to cure an electrical problem. He was sure that the intermittent setting on the rear windscreen wiper had worked when he bought the car a week earlier, but now it was not functioning. The wiring diagram in the handbook was inaccurate, and it was necessary to trace all the wiring to discover where the intermittent circuit was meant to be.

Several hours later we had proved conclusively that it could never have worked, because the only relay in the circuit, which the book manual described as containing an electronic pulse circuit, was in fact just an ordinary relay. The date code on the relay was later than the registration date of the car, so somebody had fitted the wrong replacement part, and generally made a pig’s ear of the wiring as well. By this time, all the main car dealers were closed, and because neither of us wanted to dismantle the relevant pieces of car a second time I decided to fit an intermittent wipe circuit into the relay case. It needed to be small, because there was very little space available. It also needed to be resistant to the spikes present on a car electrical system. This might reach 60V during a brief spike, while the gate is held to 0V by the electrolytic capacitor. The final design, shown in Fig. 3, avoids this problem by using a darlington pair of npn transistors. The base resistor for these is the same as the capacitor charging resistor used in the fet circuit, so the hold on time is similar. Any brief spike which may cause damage to the gate of a fet, will simply switch on the transistors for too short a time to matter, and they will protect themselves.

INTERMITTENT WIPER

more or less ruled out circuits using the ubiquitous 555 timer, because this is surprisingly vulnerable for a bipolar circuit, and is also susceptible to interference.

TIMING ELEMENT

I decided on the use of simple RC time constants both for the delay time and for the hold on period for the relay, to permit the wipers to traverse part of the screen so that the automatic park circuit would operate to complete the wipe. To make the unit reliable on a car electrical system, discrete components were chosen. There is one discrete component which is designed for timing and similar applications, that is the SCS (silicon controlled switch). Fig. 1 shows the circuit of the wiper system before modification. The reason that the autopark switch includes a small segment connected to 0V is that the motor, left to itself, would have enough momentum to pass this area of the switch and continue running when it was meant to stop. When the motor turns, it generates a back emf which opposes the applied voltage, while the current declined asymptotically towards 0. Short circuiting the motor allows the back emf generated by its rotation to cause a current to flow which opposes the movement. Thus the motor is brought smartly to a halt. Fig. 2 shows the initial design of circuit to provide the “intermittent” function. This seemed like a good idea at the time, but tests showed that the P channel dmos fet failed when the circuit was operated while the engine was running. Hindsight showed that spikes could easily place more than the specified maximum voltage between gate and source. The source

Andrew Armstrong has the foresight to give car drivers clearer hindsight.

DETAILED FUNCTIONING

The basic timing of the circuit uses a single RC time constant and a silicon controlled switch. This is like an scr (thyristor) but with two gate terminals. The approximate equivalent circuit of this using transistors is shown in Fig.4. From this circuit, it is clear that when the voltage on the anode rises one diode drop above the voltage on the anode gate, the SCS will trigger and remain switched on until there is not enough charge on C1 to maintain the holding current.

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When SCS1 switches on, its cathode current switches on TR1 on, which discharges C2 via R6, (there to limit the peak current). To ensure that the timing capacitor, C1, is fully discharged, D1 is included so that TR1 will discharge this as well. When C2 is discharged, TR2 and TR3 switch on, and the relay pulls in. Because the current required to hold a relay on is much less than that to pull it in, the relay remains on until C2 has charged to within about 3V of the positive supply. This gives plenty of time to take the motor past the park position, so where the autopark switch will take over. The circuit is deliberately designed so that a wipe is triggered immediately that power is applied. It might be that the wiper is switched on in a situation where visibility is needed quickly, so there must be no delay in operation. The component values shown here give a time period of approximately ten seconds, but this may be altered by changing R1, C1, R2, or R4. R1 and C1 form the time constant, while R3 and R4 determine the voltage to which C1 must charge before the SCS triggers. The low charging current of C1 means that this capacitor must be a low leakage type. In practice most components will work, but if any difficulty is experienced a bead tantalum type could be used instead of a conventional electrolytic.

The most obvious use of the design is to provide a simple and reliable intermittent rear screen wipe facility for cars not supplied with this. This application requires the addition of a 12V change-over relay and three diodes external to the PCB. The PCB, relay etc are best mounted in a small plastic box and fitted near the rear wiper motor. Cars not originally fitted with intermittent rear wipe will, of course, need a new switch. Normally the existing wiper switch can be replaced with a three position switch used on another car in the range. This is probably the neatest system, because the appearance and fixing will be compatible with other controls.

Failing this, a small switch can be connected in parallel with TR3, and fixed somewhere where it will not look too untidy, or the rear wiper can be left on intermittent mode permanently. In this latter case, it is recommended that the time period be shortened, by lowering R1 to 1M, so that there is no significant danger of the wiping action being insufficient. If R1 is replaced by a 1M potentiometer, the circuit could be used as a variable speed intermittent wiper for the windscreens. The connection scheme is much the same as the rear wiper motor, but there is the added complication of a high speed position on most cars.

If this is present, this part of the wiring should be ignored, and the relay connected to the standard speed circuit. If the electromechanical hazard warning flasher, or the trafficator flasher (the same unit on some cars) fails, this circuit can easily be used to replace it. The value of R1 should be reduced to speed it up appropriately, and it may be necessary to reduce the value of R5 to cut down the on time slightly. Suggested values to experiment with are 68k for R1 and 33k for R5. Finally, if an electronic beeping device is connected to the output, the unit can be used to pulse a reminder or warning signal.

**APPLICATION**

Ask PE is most-monthly column in which the most interesting readers’ technical enquiry (in the opinion of the Editor) will be answered to the best of the columnist’s ability. Individual queries will not be answered, even if stamped addressed envelopes are sent. Please mark envelopes clearly “ASK PE”, and enclose no other correspondence because these envelopes will be forwarded straight to the columnist.

<table>
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<th>COMPONENTS</th>
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<td><strong>RESISTORS</strong></td>
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| **CAPACITORS** |
| C1, C2, C3 | 10µ 16V radial electrolytic |
| 0.1in pin spacing (3 off) |

| **SEMICONDUCTORS** |
| D1 | 1N4148 |
| SCS1 | BRY39 |
| TR1 | BC182 or similar |
| TR2, TR3 | BC212 or similar |
GUARD DOG KIT
One of the best burglar deterrents is a guard dog and this kit provides the barking without the pet! Can be connected to a doorbell, pressure mat or any other intruder detector and produces random threatening barks, includes mains supply and horn speaker.

PROGRAMMABLE ELECTRONIC LOCK KIT
Keys could be a thing of the past with this new high security lock. Secure doors to sheds, garages, even your home or prevent the unauthorised use of computers, burglar alarms or cars. One 4-digit sequence will operate the lock while incorrect entries will sound an alarm. The number of incorrect entries allowed before the alarm is triggered is selected by you. Further entries will be ignored for a time also set by you. Only the correct sequence will open the lock and switch off the alarm. The sequence may easily be changed by entering a special number and code on the supplied keyboard. Kit includes, keyboard, alarm buzzer, high quality PCB and all electronic components. Supply: 5-15V DC. Will drive our Latch Mechanism (701 150 @ £16.50) or relay directly.

DISCO LIGHTING KITS
DL8000K 8-way sequencer kit with built-in opto-isolated sound to light input. Only requires a box and control knob to complete £23.95
DL1000K 4-way chaser features bi-directional sequence and dimming 1kW per channel £23.95
DL2100UK Uni-directional version of the above. Zero switching to reduce interference £13.95
DLA/TT (DL & DL2100UK) Optional op-to input allowing audio beat/light response £9.95
DL2400K 3-channel sound to light kit, zero voltage switching, automatic level control and built-in mic 1kW per channel £19.95

POWER STROBE KIT
Produces an intense light pulse at a variable frequency of 1 to 15Hz. Includes high quality PCB, components, connectors, 5Ws strobe tube and assembly instructions. Supply: 240V ac. Size: 290x250x45. XK124 STROBOSCOPE KIT £17.25

SIMPLE KITS FOR BEGINNERS
Especially aimed at the beginner. Have fun with your project even after you have built it and also learn a little from building 2. These kits include high quality solderless printed circuit boards, all electronic components (including speaker where used) and full construction instructions with circuit description.

VERSELTE REMOTE CONTROL KIT
Includes all components (+ transformer) for a sensitive IR receiver with 16 logic outputs (0-15V) which with suitable interface circuitry (re-ys, triacs, etc details supplied) can switch up to 16 items of equipment or off remotely. Outputs may be latched to the last received code or momentary (on during transmission) by specifying the decoder. A 9V PP3 battery and a 15V stabilised supply is available to power external circuits. Supply: 240V AC or 15-24V DC at 10mA. Size: (exc. transformer) 9x4x2 cms. Companion transmitter is the MK18 which operates from a 9V PP3 battery and gives a range of up to 60ft. Two Keyboards are available MK9(4-way) and MK10 (16-way).

MARK 112 IR Receiver (inc. transformer) £18.55
MK18 Transmitter £32.95
MK4 4-way Keyboard £27.75
MK10 16-way Keyboard £77.95
601133 Box for Transmitter £2.95

VOCAL RECORD/PLAYBACK KIT
This simple to construct and even simpler to operate kit will record and playback short messages or tunes. It has many uses — sealtoll or light reminder in the car, welcome messages to visitors at home or at work, voice messages in factories and public places. In fact anywhere where a spoken message is announced and which needs to be changed from time to time. Also suitable for toys — why not convert your daughter’s ‘EB doll to an EBO taking doll?!

SIZE
76 x 60 x 15mm

Message Time
1-5 secs normal speed, 2-10 secs slow speed

XK129 £25.95

ELECTRONIC WEIGHING SCALE
Kit contains a single chip microprocessor, PCB, displays and all electronic to produce a digital LED readout of weight in Kgs or Sts/Lbs. A PCB lex eects the scale-bathroom/itv types of kitchen scales. A low cost digital ruler could also be made.

XK129 £24.95

PROPORTIONAL TEMPERATURE CONTROLLER KIT
Uses ‘burst fire’ technique to maintain temperature to within 0.5°C Ideal for photography, incubators, wine making, etc.

Maximum load 3kW (240V AC)
Temperature range up to 80°C
Size: 7x4x2.5cms.

XK129 £8.95

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HOME-BASE

This month Ian Burley looks at a couple of pet topics of his: the new telepoint digital cordless phone services which have just been launched and the imminent arrival of the remarkable Keyline teleshopping terminal.

At last, telepoint digital cordless telephones are on sale from three of the four Department of Trade and Industry licensed telepoint operators - BT Phonepoint, Mercury Callpoint and Ferranti Zonephone. The fourth player, BYPS Communications (BYPs stands for Barclays Philips Shell) is set to enter the fray later this year.

Telepoint phones use the latest digital standards for personal communications and promise superior sound quality to existing analogue signal cellular phones. Telepoint is also cheaper than cellular, but at the cost of not being able to roam while you're making a call and when you're away from your personal base station the phone can only make outgoing calls.

RECHARGEABLE

The Forum phones currently use 30-hour continuous use Lithium battery cells as opposed to Ferranti's NiCad rechargeable set up. The former is lighter and more compact, but at a fiver a battery rather expensive. Not surprisingly Forum phones will soon have a rechargeable option. Like Mercury "blue-button" phones, Telepoint phones have a built in identity and users need to punch in their personal identity numbers before being able to make a call. Some phones enable this to be done automatically. The BYPS phone, developed by Plessey, even has an lcd read-out to aid dialling and dial-list compilation.

Call charging is down to the individual service providers, but the trend is towards call tariffs around that of call-boxes. This means calls will be cheaper than cellular phones but dearer than domestic phone rates. On top there are standing charges and further charges if you choose to rent your phone rather than buy it outright. So far telepoint phones don't look as though they will be sold on their cost advantage alone, when compared with cellular phones.

COMMON INTERFACING

Despite using the same CT-2 comms standard you can't yet use one service provider's phone in conjunction with someone else's base station. Different frequencies and caller ID's are the problem. The DTI has instructed that all telepoint phones must eventually operate under what's known as the Common Air Interface, or CAI. This will mean users will be able to physically use any phone with any base station, but they will be restricted to the service providers which they have signed up with. BYPS decided that they would be CAI compatible from the start. Customers of the other three service providers will be stuck with non-CAI phones, but they have been promised that these won't be rendered useless once CAI is universally adopted as base stations will be compatible with both old and new.

STATIC CALL

An obvious criticism of telepoint phones is that you can't receive incoming calls when you're on the move. Early on it was suggested that a message pager could be the answer. The service providers haven't been slow to recognise this and, for example, Mercury Callpoint now offers an all in one £25 a month package which includes the monthly service charge, rental of phone, annual subscription and a Sensar numeric pager. £25 a month is comparable with cellular phone deals, but it's argued that the pager adds versatility which cellular phones can't offer and running costs will be much cheaper. It has even been suggested that BYPS will incorporate a pager into certain models of its phones. Another way of countering reservations about not being able to receive calls has been a publicity campaign to promote the benefits of not being able to receive calls and the unsolicited hassle this can, it's claimed entail. Don't call me, I'll call you, seems to be the message here!

Disappointingly, the telepoint companies, with the exception of BYPS who haven't reviewed the Forum in May 89, Ed.) When folded, the handset is hardly larger than a small pocket calculator and can really fit comfortably into shirt pocket or a modest handbag, Ferranti's Zonephone looks like a miniaturized cellular phone, and though larger than the Forum Phone, it's small enough to fit very neatly inside a brief-case, for example.

CLOSE CALLING

You will have to be within about 200 metres of a 40 channel communal base station and these are currently being installed throughout the country at the busser of public sites like railway stations motorway service areas, petrol stations, building societies and banks. Telepoint is really a high-tech alternative to today's increasingly unattractive and usually unreliable public call-boxes. Phonepoint has set itself the target of installing base stations every 500 metres in major city centres and at 10 minute drive intervals along major road routes. Callpoint says that more than 2000 lines should have been installed by Easter and 8000 by the end of the year. Eventually 20,000 lines will be installed by Callpoint alone nationwide.

Telepoint is based around the CT-2 communications standard, CT-1 being used presently in conventional cordless phones. CT-2, being digital, offers better call security and sound quality. Though CT-2 phones are cheaper than their cellular counterparts, the digital technology required makes them up to four times more expensive than ordinary cordless phones.

One advantage of the new-technology CT-2 phones is that advanced integration and the relatively low power requirements inherent in the standard has enabled manufacturers to come up with some astonishingly small phones. Shaye Communications, which Sir Clive Sinclair has an interest in, has developed the fold up Forum Phone which is being used by Mercury Callpoint and BT Phonepoint.

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revealed their pricing intentions, have decided to price prohibitively their personal base stations for home use. Ferranti want £235 for theirs and the others £200, and that's in addition to £200 for the all important handset unless you rent it. For that kind of money you could go out and buy two or three CT-1 phones complete.

**EXPORTING BRITISH**

Telepoint is a British invention, but foreign interest is encouraging. By the end of this year there will be trial telepoint services underway in West Germany, France, Spain, Portugal, Finland and Belgium. The predictions are that up to 2 million telepoint phones could be in use in the UK by 1992, and BYPS is claiming that there could be 10 million telepoint users Europe-wide by 1995.

Cynics have predicted that telepoint will just be a flash in the pan between the progressing of today's ageing cellular technology and CT-3, or Personal Communications Networks (PCNs). These will be two-way, eventually pan-European, phone systems developed from telepoint technology and will replace existing cellular networks. However, estimates are that these won't begin operation until 1995 at least, so there is still time for telepoint to establish itself as a low cost alternative.

With cellular phone congestion reaching alarming conditions in some areas and running costs remaining prohibitive for many potential users, telepoint is a reasonably attractive alternative - especially used in conjunction with a pager. But will potential users be put off by the patchy distribution of base station sites and the inability to receive calls? Only time will tell if telepoint becomes the success or failure that many predict it will be.

**WHO NEEDS TO GO SHOPPING?**

For many, though I have to say - not me, the prospect of going shopping brings on attacks of high blood pressure and migraines. To avoid the bustle and queues you can resort to teleshopping. Using a Prestel/viewdata terminal, teleshopping enables you to order goods online and have them delivered. This has been around in selected areas for a few years now, but hardly more than pilot projects, none have been remarkably successful.

Along comes Chris Curry, ex of Acorn Computers, and amongst other things (remember those Red Box mains electricity computer network kits?) he forms a vision of an intelligent home teleshopping terminal which anybody, even my Mum, could use to order the weekly groceries, monitor a bank account or two, and even use to put a bob or two on the Grand National. Keyline was this vision.

**USER FRIENDLY**

An essential part of the Keyline concept was that it had to be available in a big way - to virtually anybody. This meant it had to be incredibly cheap to manufacture. Initially Curry wanted to give them away, like credit cards. Further still, the terminal had to be friendly to use and that meant the use of artificial intelligence.

After three years development and several missed deadlines, the Keyline Teleshopping terminal is close to commercial reality. In that time Curry's engineers managed to squeeze an 8-bit computer system, 1200 baud modem and smart card reader into just a couple of remarkable custom chips.

I first saw a prototype Keyline terminal almost two years ago. Since then the chunky prototype has been slimmed down, the ISO smartcard reader incorporated and the lcd screen improved with the adoption of a super-twist pixel addressable unit rather than the comparatively inflexible alpha-numeric only display previously used. Looking rather like a MkII Speak and Spell machine, the terminal is housed in a grey case with a colourful qwerty keyboard and numeric keypad incorporating calculator functions. Considerable psychological and ergonomic research went into the design in an effort to reduce the techno-fear element so sensitive to many people. Intensive development of the AI user interface means that the goal has almost been reached of enabling anybody who can remotely type to use the terminal. Simple English command phrases or sentences can be entered and understood by the computer. For example you could type: Buy half a dozen size A eggs and a can of baked beans from ..." and with a bit of luck your order would be placed. The computer will even log regularly purchased items and use that information to evaluate future orders.

**CREDITABLE AMBITION**

Settling bills will either be via credit card details securely entered into your terminal or via credits stored in a smartcard hence the smartcard reader. Besides buying the groceries you will be able to deal with insurance companies, bookmakers, banks and building societies, catalogue companies and even look up phone numbers from the BT phone directory computer.

Such an ambitious scheme requires the dedication of big high street names and already the following have been signed up to provide services on Keyline: Freemans, Kays, Littlewoods, Gateways, Racing Post, W H Smith, Philips Whirlpool (white goods), Thorn EMI Commercial Union, General Accident, Sun Alliance, National & Provincial, Nat West, Bank of Scotland, BT Directory Enquiries, Ladbroke's, Coral and William Hill.

STC is said to be preparing for full production of the terminals this summer in readiness for an autumn launch. Keyline obviously hopes the terminal will be finding its way into lots of Christmas 1990 stockings. At just £50, and that's a refundable deposit, plus a small standing charge, Keyline is a remarkable technical achievement. Meanwhile, Keyline has won an award from the Daily Mail for being one of the most innovative product concepts for the consumer market in 1990. Let's hope it's a commercial success as well.

Ian Burley is the News and Features Editor for BT Micronet, an on-line computer and technology magazine published on Prestel by British Telecom.

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OUT NOW! OUT NOW! OUT NOW!
CIRCUIT BASICS

The circuit breaker is inserted in the positive line on a power supply to protect the supply from short circuits, whether accidental or otherwise. I find the circuit particularly useful when developing new circuits. Instead of continually blowing fuses (due to rashly attempting modifications of the circuit while it is powered up) the circuit breaker simply trips out and protects the power supply and circuit from possible damage.

The circuit works by measuring the voltage drop across the shunt resistor of the power supply panel meter. If your supply doesn’t have a meter built in you can still use this circuit: simply connect a 0.25 ohm resistor (1 ohm and 0.33 ohms in parallel) in the positive lead of the supply. The value of a 0.25 ohms is suggested for use on a 0-1.5A supply. If your supply is different use a suitable resistor applying the following formula to calculate its correct value: R = 0.375/I_max.

The resistor must be of a suitable wattage, equal to IR watts. For the 1.5A supply the resistor needs to handle 0.563W, so a minimum rating of 1W would be suitable.

The voltage drop across the resistor is amplified and fed to a voltage comparator, which compares the voltage with that at the wiper of a potentiometer. This can be panel mounted and the voltage at the wiper switched to display the trip level on the supply meter. If your supply doesn’t have a meter the pot can be calibrated when the circuit is finished.

The comparator operates a relay to isolate the supply rails when a fault occurs. If your supply is a single rail you can use a double pole relay to isolate both supply terminals. For a dual supply with a common 0V rail, a double pole relay can be used to isolate both +ve rails. With an isolated dual supply you will need an opto-isolator to ensure isolation between the rails. A double pole relay can isolate the positive rails or you could use a quad pole relay to isolate all the terminals.

LEDs are used to give an indication that the circuit has tripped. This can be particularly useful on dual supplies to give an indication of where the fault lies.

HOW IT WORKS

In Fig. 1, the current sensing resistor is connected to the inputs of op-amp IC1a, half an LM833 or equivalent. IC1a acts as an amplifier whose gain is set by R1, Rb, Rcl and preset VR1. The gain is set by the formula:

$$Rc_1 = Rb_1 \times \frac{500}{appr ox \, mid \, position \, of \, VR1}$$

Gain = Rb1/Rc1

Vout = gain \times Vdrop across current sense resistor.

For a 1.5A supply a gain of approx 81 was required, so 27k was selected for R1 and 2M2 for Rb1. Other values may be calculated if your supply is different. VR1 is used to adjust the gain of the amplifier stage. With a current of 100mA flowing through the sensing resistor the voltage at the input of the opamp to the relay and an led, used to visually warn of the fault. The power for the scr, relay and led is supplied via a push-to-break switch; the latter is used to reset the circuit breaker by breaking the supply to the scr.

D4 protects the scr from reverse voltages when the circuit is reset. D2 and D12 protect the scr from reverse voltages when the circuit is reset. D2 and D12 are used on a dual supply to OR the outputs of both scrs. The opto-isolator is only required if your supply has dual isolated rails, so maintaining isolation between the supplies.

On my supply the minimum trip current that can be set is 90mA and can be increased to 1.5A. However, while the circuit was being developed, it was noted that the gain of IC1a could be set such that as little as 1mA would trip the circuit.

Note that this design is very sensitive. If you use circuits that have large capacitances or inductances, or switch currents of about 0.5A or more, then the circuit may keep tripping out. To prevent this a small capacitor can be placed between the gate of the scr and ground to form a time delay, with the 100k current limiting resistor, R1, on the gate of the scr. This modification makes the circuit act as a slow blow fuse instead of an anti-surge fuse.

The pcb has been designed to also allow a voltage to be fed directly to the positive input of the comparator so the circuit can be used as an over voltage protection circuit.
Fig 2 (above). Relay driver.
Fig 3 (below). PCB component and track layouts.

**SINGLE SUPPLY COMPONENTS**

**RESISTORS**
- Ra1 (2 off) (see text)
- Rb1 (see text)
- Rc1 (see text)
- R1 100k
- R2 1k5

**POTENTIOMETERS**
- VR1 1M preset
- VR2 47k lin

**CAPACITORS**
- C1 100µ 63V elect axial
- C2 100n (see text)

**SEMICONDUCTORS**
- D1, D2, D4 IN4001 (3 off)
- D3 red led
- SCR1 2N5064
- IC1 LM833

**MISCELLANEOUS**
- S1 push to break switch relay (to suit your supply) 8-pin ic socket (3 off)

**DUAL SUPPLY COMPONENTS**

**RESISTORS**
- Ra2 (2 off) (see text)
- Rb2 (see text)
- Rc2 (see text)
- R11 100k
- R12 1k5
- R13 100R
- R14 1k
- VR11 1M preset
- VR12 47k lin

**CAPACITORS**
- C11 100µ 63V elect axial
- C12 100n (see text)

**SEMICONDUCTORS**
- D11, D12 IN4001 (2 off)
- D13 red led
- SCR11 2N5064
- IC11 LM833
- IC12 4N26 opto-isolator

The dual supply requires all the parts for the single supply as well as those shown above.

**TESTING**

First leave the switch disconnected. Connect an ammeter between the positive terminal on the circuit and the power supply. Without the ics in place, power up and note the reading. It should be about 1mA but if a larger current flows switch off and re-check the pcb for errors. When satisfied, switch off and insert the ics into their sockets. Switch on the power and note the reading of the ammeter, which should be about 7mA. If the reading is higher than this, check the ics are inserted correctly.
When all is ok, connect a current sensing resistor between +IN (point B) and +OUT (by the relay) for the first half of the circuit. Now apply a load which will draw about 100-200mA to +OUT and with an ammeter in series. Measure the current drawn. Connect the load directly to the output and measure the voltage on the output of IClA (pin 1). Adjust VR1 until the voltage is as expected from the formulae given earlier. With IClA gain set at 81, a current sense resistor of 0.25 ohm and a current of 100mA, the output voltage should be 2.037V as measured on a digital voltmeter.

Next connect VR2 in place and adjust the wiper until the voltage is well above 2V. Connect the push-to-break switch, power up with the load in place and reset if necessary (the circuit usually powers up in the reset state). Now apply a load which will draw about 100-200mA to +OUT and with an ammeter in series. Measure the current drawn. Connect the load directly to the output and measure the voltage on the wiper of VR2 using the formulae given earlier, setting the pot to that voltage and marking the front panel.

If the relay doesn’t operate, check that the supply voltage is high enough to operate the relay and again check the construction of the pcb, especially the orientation of the scrs and the diodes D2, D12 and D4, where fitted. If the relay operates but the led doesn’t light, check that the led is fitted the right way round. When this is satisfactory repeat the above test, the relay should now operate and the led light.

The basic circuit is shown in Fig. 5. The multipole switch is used to change the displayed reading between output voltage, output current and trip level. The resistor for the meter can be the same as that for the voltage range if your supply uses a single meter. For a supply with a dual meter the resistor can be calculated from the formula:

\[ R = \frac{V_{\text{max}}}{A_{\text{FSD}}} - r \]

Where \( V \) = Vmax, \( A \) = FSD of meter in amps, \( r \) = internal resistance of meter.

If your supply has no meter you can calibrate the front panel around VR2 using the formulae given earlier, setting the pot to that voltage and marking the front panel.

---

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| 74LS24 | 15p |
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PRACTICAL ELECTRONICS JUNE 1990
Connect a multimeter, set to the 1A ac current range, in place of fuse FS1. Without any ics inserted in their sockets, connect power to the circuit. After the initial surge of power to the circuit should draw only a few milliamps. Next check the four dc supply voltages.

Disconnect the power, insert IC2 and IC3, switch on again and check the programming voltage $V_1$ can be varied between approximately 9V and 30V by VR101. Set $V_1$ to 15V and then check that the programming voltage $V_2$ can be varied between approximately 0V and 15V by VR102.

Now, using a short length of wire, connect 6 socket pin 31 to light the 'Error' led, then connect pin 20 to pin 35 to light the 'DTR' led. Finally, disconnect all power and insert the remaining ics.

Set the dil switches S1 and S2 to the 'parity option' required for your particular computer (see Fig.9). Power up the programmer and check the conditions obtained on the RS232 sockets are as follows:

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>TXD</td>
<td>-9V</td>
</tr>
<tr>
<td>3</td>
<td>RXD</td>
<td>+0.05V</td>
</tr>
<tr>
<td>4</td>
<td>RTS</td>
<td>-9V</td>
</tr>
<tr>
<td>5</td>
<td>CTS</td>
<td>+0.05V</td>
</tr>
<tr>
<td>6</td>
<td>DSR</td>
<td>+0.05V</td>
</tr>
<tr>
<td>7</td>
<td>COM</td>
<td>0V</td>
</tr>
<tr>
<td>20</td>
<td>DTR</td>
<td>-9V</td>
</tr>
</tbody>
</table>

Connect the programmer to your computer’s RS232 port and configure the port to 1200 baud. The green led (DTR) on the programmer should light. Any problems at this stage could indicate incorrect wiring or connections to the RS232 interface. (The programmer requires a valid DSR signal from the host computer before acknowledging with a DTR ready signal). Run a test program similar to the one below, which was written for a Sinclair Spectrum.

10 REM RS232 I/F TEST PROGRAM
20 FORMAT "B",1200 : REM - sets RS232 to 1200 baud
30 OPEN #4, "B" : REM - opens stream 4 to RS232 channel
40 FOR X=1 to 50
50 PRINT #4; CHR$ 13; : REM - sends C/R to RS232
60 NEXT X
70 PRINT "TRANSMISSION OK"

The DTR led should flash erratically during the program. If, however, the 'Error' led lights this will indicate some kind of data.
transmission problem. As a quick guide to any 'Error' problem encountered, the microcontroller will output an error code on pins 12 to 19. A quick check with a meter, comparing the state of pins 12 to 19 with Fig.19 will indicate the type or error detected by the microcontroller.

SOFTWARE CONTROL

A series of commands and data sent by the host computer instructs the eprom programmer to undertake specific actions. A flowchart showing the typical command sequence to program an eprom byte is shown in Fig. 20.

A full list of the commands available is detailed in Fig.21.

Any data which is required following a command code may be in either a decimal or hexadecimal format. For instance, the following basic lines are both valid and have the same effect of setting the data lines (DO to D7) to the decimal value of 20:

PRINT #4; CHR$ 106; CHR$ 20

(command code) (data)

PRINT #4; CHR$ 106; "14"

(command code) (hex data string)

Similarly, data from the programmer may be requested in either decimal or hexadecimal format. For instance, the following basic lines request the programmer to read the data lines (DO to D7) and return the value to the host computer:

PRINT #4; CHR$ 66 : INPUT #4; A$

A$ receives the character code 20; or, PRINT #4; CHR$ 74 : INPUT #4; A$

A$ receives the character string "14" which is the hex equivalent of decimal 20.

All data sent from the programmer is terminated by a carriage return code (dec 13).

The basic program shown in Fig.22 is written for Sinclair Spectrum and should give a good basis for writing a control program suitable for your computer.

<table>
<thead>
<tr>
<th>Wire Number</th>
<th>Use</th>
<th>Wire Number</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A15</td>
<td>Address</td>
<td>31 V15w</td>
<td>Prog supply 1</td>
</tr>
<tr>
<td>2 A14</td>
<td>&quot;</td>
<td>32 V2</td>
<td>Prog Supply 2</td>
</tr>
<tr>
<td>3 A13</td>
<td>&quot;</td>
<td>33 V2c</td>
<td>Prog control 2</td>
</tr>
<tr>
<td>4 A12</td>
<td>&quot;</td>
<td>34 V2sw</td>
<td>prog supply 2</td>
</tr>
<tr>
<td>5 A11</td>
<td>&quot;</td>
<td>35 -6</td>
<td>-5V supply</td>
</tr>
<tr>
<td>6 A10</td>
<td>&quot;</td>
<td>36 C3</td>
<td>Aux control 3</td>
</tr>
<tr>
<td>7 A9</td>
<td>&quot;</td>
<td>37 C2</td>
<td>Aux control 2</td>
</tr>
<tr>
<td>8 A8</td>
<td>&quot;</td>
<td>38 Ci</td>
<td>Aux control 1</td>
</tr>
<tr>
<td>9</td>
<td>- not used</td>
<td>39 CO</td>
<td>Aux control 0</td>
</tr>
<tr>
<td>10 D7</td>
<td>Data</td>
<td>40</td>
<td>LED 102</td>
</tr>
<tr>
<td>11 D6</td>
<td>&quot;</td>
<td>41</td>
<td>LED 102+</td>
</tr>
<tr>
<td>12 D5</td>
<td>&quot;</td>
<td>42</td>
<td>LED 101+</td>
</tr>
<tr>
<td>13 D4</td>
<td>&quot;</td>
<td>43</td>
<td>LED 101-</td>
</tr>
<tr>
<td>14 D0</td>
<td>&quot;</td>
<td>44</td>
<td>VR101</td>
</tr>
<tr>
<td>15 D1</td>
<td>&quot;</td>
<td>45</td>
<td>VR101</td>
</tr>
<tr>
<td>16 D2</td>
<td>&quot;</td>
<td>46</td>
<td>VR101</td>
</tr>
<tr>
<td>17 D3</td>
<td>&quot;</td>
<td>47</td>
<td>VR101</td>
</tr>
<tr>
<td>18 A0</td>
<td>Address</td>
<td>48 ETH</td>
<td>common</td>
</tr>
<tr>
<td>19 A1</td>
<td>&quot;</td>
<td>49 45</td>
<td>+5V supply</td>
</tr>
<tr>
<td>20 A2</td>
<td>&quot;</td>
<td>50 AC</td>
<td>Transformer</td>
</tr>
<tr>
<td>21 A3</td>
<td>&quot;</td>
<td>51 AC</td>
<td>Transformer</td>
</tr>
<tr>
<td>22 A4</td>
<td>&quot;</td>
<td>52 RXD</td>
<td>RS232 Pin 3</td>
</tr>
<tr>
<td>23 A5</td>
<td>&quot;</td>
<td>53 DSR</td>
<td>RS232 Pin 6</td>
</tr>
<tr>
<td>24 A6</td>
<td>&quot;</td>
<td>54 CTS</td>
<td>RS232 Pin 5</td>
</tr>
<tr>
<td>25 A7</td>
<td>&quot;</td>
<td>55 ETH</td>
<td>RS232 Pin 7</td>
</tr>
<tr>
<td>26 PP</td>
<td>Prog Pulse</td>
<td>56 XMD</td>
<td>RS232 Pin 2</td>
</tr>
<tr>
<td>27 PP</td>
<td>Prog Pulse</td>
<td>57 DTR</td>
<td>RS232 Pin 20</td>
</tr>
<tr>
<td>28 PV</td>
<td>Read/write control</td>
<td>58 RTS</td>
<td>RS232 Pin 4</td>
</tr>
<tr>
<td>29 V1</td>
<td>Prog supply 1</td>
<td>59</td>
<td>Reset S101</td>
</tr>
<tr>
<td>30 V1c</td>
<td>Prog control 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig 18. Wiring details.
8748 pin number
19 18 17 16 15 14 13 12
0 0 0 0 0 0 0 0
0 0 0 0 0 0 +5
0 0 0 0 0 +5 0 0
0 0 0 0 0 +5 0 +5
Error
Receive frame error
(usually incorrect baud rate).
Receive parity error.
Hex data format error
Invalid command type
+5 X X X X X X X X

Fig 19. Error codes.

Typical Basic
(#4 is RS232 channel)

SEND configure
write

PRINT #4; CHR$ 99

SEND out address

PRINT #4; CHR$, lowadr
PRINT #4; CHR$, hiadr

SEND program begin

PRINT #4; CHR$ 86

FOR X = start TO finish

PRINT #4; CHR$ 106; CHR$ data

PRINT #4; CHR$ 80; CHR$ 50

PRINT #4; CHR$ 10

NEXT X

END

STOP

Fig 20. Typical programming sequence.

Dec ASCII Command description
10 L/F 'Line Feed' increments the data on the eprom address lines (A0 to A15) by one.
13 C/R 'Carriage Return' is sent after every statement to signify the end.
Statements can be 1,2 or 3 bytes long:
single byte — Command word...C/R
two byte — Command word...dec data...C/R
three byte — Command word...hex data...C/R
66 B Read the eprom data lines (DO to D7) and send the data to the host computer (data sent in decimal format followed by C/R).
67 C Read the Aux input line (C3) and send data to the host computer. (Data sent in decimal format as:
C3=0V 0 C/R sent. C3=+5V 255 C/R sent.)
74 J Read the lines (D0 to D7): as command 66
(Data sent as a two byte Hex word followed by a C/R).
75 K Read Aux input (C3): as command 66 (Data sent as a two byte hex word followed by a C/R, as:
C3=0V '00' C/R sent.)
80 xx Pxx Generates a xx millisecond program pulse (PP)
(XX = 1 to 255 or '00' to 'FF')
82 R Set Read/Write control line to READ (PV=0V)
84 T Set Read/Write control line to WRITE (PV=+5V)
98 c Configures programmer in the WRITE EPROM mode, ie, the data lines (D0 to D7) are outputs.
(Also sets all address and data registers to zero).
99 c Configures program in the WRITE EPROM mode, ie the data lines (D0 to D7) are outputs (registers are zeroed as above).
100 d Re-configures programmer in the READ EPROM mode (Address and data registers are unchanged).
101 c Re-configures programmer in the WRITE EPROM mode (Address and data registers are changed).
104xx bxx Set EPROM address lines (A8 to A15) to xx
105xx jxx Set EPROM address lines (A0 to A7) to xx
106xx jxx Set EPROM data lines (D0 to D7) to xx
107xx kxx Set Aux control lines (C0 to C2) to xx
112 p Instructs the programmer to send to the host the data contents of the address register (A8 to A15). The eprom is NOT accessed.
(Data is in decimal format followed by C/R.)
113 q As above for address register (A0 to A7)
114 r As above for data register (D0 to D7)
115 s As above for Aux control register (C0 to C2)
120 x As for codes 112 to 115 except data is returned.
121 y As a two byte hex word followed by C/R.
122 z As a two byte hex word followed by C/R.
123 As a two byte hex word followed by C/R.

[Note that xx denotes data is required following the command word, this may be in either hex format (ranges '00 to 'FF or decimal format (range 0 to 255), see main text.]
REM E-Programmer Control Program
20 LET error = 0: LET prog= 50000
100 CLS
120 PRINT "EPROM Programming"
130 INPUT "EPROM Start Address? ";adr
140 INPUT "No, of Bytes? ";byte
150 LET byte = byte - 1
160 INPUT "Program Pulse Time (mS) ? ";pp
200 REM format RS232
210 FORMAT "b",1200
220 OPEN #4; "b"
500 REM program EPROM
520 PRINT #4; CHR$ 99
530 LET adrhi = INT (adr / 256)
540 LET adrl= adr - (256 * adrhi)
550 PRINT #4; CHR$ 104; CHR$ adrhi
560 PRINT #4; CHR$ 105; CHR$ adrl
570 PRINT #4; CHR$ 84
600 REM program loop
610 FOR X = 0 TO byte
620 PRINT #4; CHR$ 106; CHR$ (PEEK (prog + x) )
630 PRINT #4; CHR$ 80; CHR$ pp
640 PRINT #4; CHR$ 10
650 NEXT X
700 REM program finished
710 PRINT #4; CHR$ 82
720 PRINT AT 5.0; "Programming finished"
730 PRINT AT 5.0; "Verifying Data"
800 REM verify
820 PRINT #4; CHR$ 98
850 PRINT #4; CHR$ 106; CHR$ (PEEK (prog + x) )
860 PRINT #4; CHR$ 10; CHR$ pp
900 REM verify loop
910 FOR x = 0 TO byte
920 PRINT #4; CHR$ 74; INPUT #4; ";a$
930 IF data <> PEEK (prog + x) THEN LET error = error +1
950 PRINT #4; CHR$ 10
960 NEXT X
1000 PRINT "Verification complete"
1010 PRINT error; " ERRORS"
1020 CLOSE #4
1030 STOP

REM hex to dec conversion
2000 REM hex to dec conversion
2010 LET d$ = "0123456789ABCDEF": LET data = 0
2020 FOR y = 1 TO 2
2030 FOR z = 1 TO 16
2040 IF a$ (y) <> d$ (z) THEN NEXT z
2050 LET data = 16 * data + (z-1)
2060 NEXT y
2070 RETURN

NB: C/R is automatically sent by Spectrum software at the end of a 'PRINT' statement. 'Prog' is the address in Spectrum ram where data destined for an eprom is stored.
In order to program a particular type of eprom various pins on SK104 have to be configured to match the particular eprom required pin functions. Fig. 23 shows the layout of the three strapping sockets (SK101, SK102 and SK103), the various pin functions are detailed in Fig 24. A chart showing the strapping arrangements for the common 27' series eproms is shown in Fig 25.

Fig 26. 27xx series eprom strapping details.

Below: Fig 27. Hex dump of software program for 8748.

HARDWARE CONFIGURATION

A few final points to note for the successful operation of the programmer:
1. Set the voltage supplies V1 and V2 before inserting an eprom.
2. Always switch off the programmer before inserting or removing an eprom.
3. The green DTR led should glow steady once the programmer has finished processing commands. However, since the programmer contains a 20-character receiver buffer this may be some seconds after the control program has finished.
4. For 24 pin eprom pin conversions see Fig 25.

REFERENCE

A number of useful reference sources were used in the preparation of this project.
1. PE April 1987 issue: design of switched mode power supplies.
2. Intel 8255A data sheet (available from Maplin).
Dear Editor,

Reading with great interest (as I always do) my PE of Feb, I was delighted to see a complimentary mention of the Greenbank 'Interak' computer system in a letter from Mel Saunders.

The page lay open for much longer than usual (so that every passer-by my desk could be forced to read it), and eventually my eye strayed to the letter 'Number Crunching' where Colin Long had criticised your rendering of the words 'twenty-five'.

I am a great fan of the proper use of English by technical writers (on the grounds that if an engineer or technician can't be trusted to check on a doubtful word can we be sure he has checked on a doubtful parameter or a doubtful machine code?) We can usually cope with bad spellings and the like; their is no danger that we will knot no wot waz ment, it just amuses us when the client's great delight. So how did he write control programs and the like, then it shows that their is no danjer that we can usually cope with bad spellings and the like.

David Parkins.

Birkenhead, Merseyside.

---

K. West, Walmer, Kent.

I am not aware of legislation covering the simple replacement of a dead ic. As a matter of Editorial policy I would feel obliged to oppose it vigorously if such an inane law did exist.

However, it is accepted practice for many manufacturers to only supply parts to their appointed agents, not wishing to deal direct with the public, an action which could upset their agents.

Although in a quick search I cannot locate an NE652 in my own catalogues, I believe that JVC are unlikely to have a monopoly on this chip, and suggest that as a matter of principle (though not as a time saver) you continue searching for a source. Try those PE advertisers who specialize in its. Ed.

---

Dear Ed,

As nearly all my projects contain a cmos chip or two, I was very interested in your Editorial, "Beware the Cat", in PE Feb 90. Since then my anti-static precautions have relaxed with no adverse side effects!

From reading PE for three years now, I know you keep well inside the law (I recall that you refused a stun gun project, and I haven't seen any potentially-illegal radio transmitters as PE projects.) I was therefore quite surprised that neither you nor Kevin Kirk made specific mention of BT regulations in the PE Modern project. As far as I know, BT strongly disapprove of anyone connecting unapproved telecommunications apparatus to be connected to the British Telecom network. PE expects that readers who have the right of access to a BT phone connection point will be aware of the law and to abide by it. Ed.

---

MOLE MAGIC

Dear Ed,

PE's recent stories of moles' triumphs over science reminded me of a campaign a friend waged against them in a Cotswold village to which he had retired. He occasionally, but briefly, had a nice lawn. All the usual tricks were tried, including chemical warfare, but with no long term success.

Before incapacitating and emigrating to Ireland, a neighbour suggested calling in the local sorceress and offered to contact her. A few days later a lady arrived to "see the moles". She did: she selected a few twigs from the hedge and walked round the lawn sticking them here and there in an apparently random pattern. After about a quarter of an hour she knocked at the door, said she'd finished, and shuffled off up the road. There were never any more moles!

It seems that: "There are more things in heaven and earth, Dear Editor, than are dreamt of in your philosophy".

Alan Tomkins, Stourbridge, W.Midlands.

"Oh day and night, but this is wondrous strange!"

"Then we'll shift our ground."

"We'll say old mole! Canst work i' th' earth so fast?"

"Also from Hamlet, same scene (Act 1, Scene 5), rearranged a bit!"

Ed.
Dear Sir,

I have placed a regular order for PE having recently picked up a copy by chance. I have a fair yet amateurish background to the subject of electronics and decided that I would like to get my knowledge, skills and expertise more up to date. Clearly, the desire to learn was the motivating force behind my commitment to your magazine. I would point out that there were other reasons for placing my order. I am a science teacher and modern, rapidly changing demands in science education have meant that my self-confessed amateurism in the area of electronics is no longer sufficient. As a result of this, I turn to the experts.

I would suggest that your open criticism of the lady teacher (Short Circuit Teaching - Letters Feb 90) is unfair, and that she should be applauded for making the effort to 'find out' for the ultimate benefit of her pupils. My training in science education took place 20 years ago. Imagine the difficulties in trying to unravel the mysteries of modern electronics, a subject that is so conceptually interesting, yet certainly not conceptually straightforward. Your adverse comments can be likened to suggesting that non-swimmers should not go to the baths. How else can we learn?

My view is that you should be pleased and flattered that teachers do bother to come to you for help; it would surely be a very sorry state if educators simply dismissed the topic as somebody else's responsibility. I would point out that teachers do not have the automatic right to proper training in new subjects, yet many commit their own time and money to self-teach exercises. Surely this is to be applauded, as it shows a preparation to put personal time and funds 'up front'.

Perhaps your comments are an open admission that you do not view your role as one of educator to a willing audience. I wholly support your closing comment 'lack of attention to technology teaching must not be tolerated', and would suggest that teachers bothered enough to ask for your guidance implicitly support this view. They clearly do not tolerate lack of attention to technology, otherwise they would ignore your existence totally.

I have learned a great deal from your publication and despite your apparent hostility to the teaching profession, intend to continue reading PE. Given the choice, I would much prefer to be taught person to person by an electronics expert, and I am presently searching for an appropriate evening class in my area. The frustrations you must feel when approached by pupils who have lost faith in their teachers, should be aimed at those who rightly insist that topics such as electronics should appear in the National Curriculum. Perhaps this would lead to the properly funded training of those who have to deliver the subject to pupils. Teacher bashing is easy; it is simply not constructive. Be helpful and positive instead, then we will all benefit, especially the pupils.

Philip Howe, Shirley, Solihull.

More feedback

You are indeed headed me out in front of the class with your comments! However, you have incorrectly jumped to the conclusion that in my reply to the letter in question I was being critical of the teacher herself. Absolutely not! I fully agree that teachers who take the initiative and improve their own education in order to benefit their pupils should be applauded highly. The aim of my comments was to express my concern that electronics, which is a subject of great importance to the future welfare of this country is, by apparent necessity, being taught by some who have not had at least some training in it. This is not a criticism of the teachers who find themselves in such positions; it is a severe criticism of those in 'power' who have allowed this situation to occur in education.

By extension from the example of electronics education, I then speculated on which other subjects were being similarly taught by those who were not basically trained in them. On that point, your swimming example reinforces my concern: would non-swimmers really be expected to teach non-swimmers? Non-swimmers must certainly go to the baths, but there they should be taught by those who already know how to swim.

In the case of the electronics teacher to whom I referred, she had apparently been thrust in at the deep end. Full marks for then attempting to keep above water, but she should not have been put in that situation without adequate subject-training. Surely I'm not being too idealist by expecting that school authorities should make some provision for educating teachers in at least the basics of the subjects which they are expected to teach? In this instance the circuit diagram in question was of an extremely simple nature, whose meaning should have been clear, at least in essence, if not in full detail. But to her, it was not, and I spent some time trying to assist her with her problem, with willingness and sympathy for her predicament.

As a comparative newcomer to PE you probably have not yet had the opportunity to recognise that, as Editor, I am devoted to encouraging readers to enjoy and benefit from electronics as much as I have done, and still do. Practising electronics is to me a labour of love and complete satisfaction; I wish others to share the experience with me. (Read the 25th Anniversary issue of Nov 89 and you may begin to understand the ideals for which we all at PE stand.)

Throughout its 25 year history, PE has taken the role of educator seriously. However, we need feedback from the teaching profession itself if we are to provide those teachers with the material they need. Most of the feedback is from students (of all ages!), response from teachers is less frequent than it should be. A headmaster friend of mine comments cynically, though perhaps truthfully, that teachers are currently less willing to do extracurricular activities (such as letter writing to magazines!) in view of the repeated conflicts relating to money.

I am grateful that you took the extracurricular time to further highlight an area about which I have much concern. More power to all those who are determined that technology shall not become a second rate subject in Britain. And may Government at last recognise that current funding appears shamefully inadequate to provide the necessary technological training and facilities.

Phil Mayfield, Isleworth.

Feedback from inquiries

Dear Mr Editor,

Since 1966 I have been constructing and experimenting with analogue electronic classical organs (see PE 1969/70, for example).

In recent years, as you well know, computer techniques are used to produce the sounds, and multiplexing has reduced the bird's nest wiring. For the benefit of those like me who have not ascended far towards the heights of digital electronics, how about a design? Preferably, this should apply also to the complete miniaturisation while retaining hi-fi quality, suitable for music listening.

I understand the NHS belief that hearing aids should be unobtrusive, but surely their first priority should be that the aids work satisfactorily.

Howard Barnes, Lower Shelton, Beds.

I have also sent in a sketch of a combined stereo microphone/headphone set and amp which he thinks might be capable of miniaturisation while retaining hi-fi quality, suitable for music listening. However, I'm not sure that it would achieve the acceptability that he suggests. Comments, anyone? Ed.

Micro music

Dear Mr Editor,

How many of you remember the the impossible computerlab exercises of the 1960's? How many of you remember the audience of one that my teacher and I found at the BBC around a computer that was connected to the then new electron tube screen? Or the excitement I felt when I heard an electronic music circuit designed by Mike Sanders very unravelling by the microprocessor, and how the program for the eprom is compiled.

I found the well-written series on computers by Mike Sanders very interesting and helpful. This comment applies also to the complete magazine. Thank you.

Wilfrid A. Sawyer, Beaconsfield, Bucks.

Electronic music circuits are of primary interest to me as well. I have every intention of sometime publishing an article in line with your suggestion. Ed.

Dear Mr Editor,

I used my father's hearing aid recently. He's not actually deaf, but his hearing needs amplification, though he doesn't like using his National Health hearing aid. I now know why.

Two distinct faults were immediately evident. Distortion was so bad that listening fatigue soon set in. The other fault was most unexpected. Resonances occurred in the spaces between the ear and earpiece, even at low volume.

I understand the NHS belief that hearing aids should be unobtrusive, but surely their first priority should be that the aids work satisfactorily.

Howard Barnes, Lower Shelton, Beds.

More feedback

I endorse your comments on the need for the teaching profession to have their qualifications in keeping with the requirements of the National Curriculum. With the roll-out of miniaturisation and the need for adequate subject-training, many teachers are left underqualified.

As letter writing to magazines! in recent years, as you well know, computer techniques are used to produce the sounds, and multiplexing has reduced the bird's nest wiring. For the benefit of those like me who have not ascended far towards the heights of digital electronics, how about a design? Preferably, this should apply also to the complete miniaturisation while retaining hi-fi quality, suitable for music listening.

I understand the NHS belief that hearing aids should be unobtrusive, but surely their first priority should be that the aids work satisfactorily.

Howard Barnes, Lower Shelton, Beds.

A new product

Dear Ed,

I have recently picked up a copy of PE with the special 25th Anniversary issue of Nov 89 and you may begin to understand the ideals for which we all at PE stand.)

Throughout its 25 year history, PE has taken the role of educator seriously. However, we need feedback from the teaching profession itself if we are to provide those teachers with the material they need. Most of the feedback is from students (of all ages!) response from teachers is less frequent than it should be. A headmaster friend of mine comments cynically, though perhaps truthfully, that teachers are currently less willing to do extracurricular activities (such as letter writing to magazines!) in view of the repeated conflicts relating to money.

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Phil Mayfield, Isleworth.
The first images of Venus have now been received from the Galileo spacecraft. They were transmitted on the low-gain antenna, and show the famous cloud patterns over Venus’ equatorial region; the range was 1,600,000 kilometres, and the limit of resolution was around 40 kilometres. It cannot be said that the pictures themselves add to what we have already found out about the planet, but at least they show that Galileo is working well. Two further Earth fly-by encounters must be made before Galileo can set off on the final ‘leg’ of its journey, reaching Jupiter in 1995. It is a roundabout route (I have compared it with going from Brighton to Bognor by way of Grimsby), but under the circumstances there was no alternative; the Challenger disaster meant that the rocket used for Galileo was much less powerful than the one originally planned.

Preparations for further testing of the Giotto Space-craft are well in hand, and it is hoped that initial overheating problems will soon be solved. Meantime, all eyes are of course on the Hubble Space Telescope, due to be launched on April 10. By the time this issue of PE reaches you, we will know whether or not everything has gone according to plan; I will have much more to say about it next month.

The Gamma Ray Observatory (GRO) was taken to Cape Canaveral a few weeks ago, and is due to be launched by the Shuttle Atlantis next November. It should be able to detect gamma-ray sources ten to fifty times fainter than any previously recorded, and should remain operating for about ten years.

### THE MAY SKY

At the time when I write these notes (early April) it is still too soon to say whether or not Austin’s Comet will make a really brave showing. It has already been photographed from Britain, but we have to admit that the magnitude is rather fainter than was predicted last month and we must simply hope for the best. If the comet comes up to expectations, as I suggested in my April article, it will remain a naked-eye object in the east before dawn throughout most of May, in the general area of the Square of Pegasus.

Of the planets, Mercury is out of view, but Venus is a splendid object in the early morning sky, with a magnitude of -4.5 - much brighter than any other star or planet. However, more than half the sunlit face is now turned toward us, and it cannot be claimed that it is an interesting telescopic object. Mars moves from Aquarius into Pisces, and has risen to magnitude 0.7, but it is still a long way away. Jupiter is in the west after dark, but has passed its best, while Saturn now rises well before dawn, even though it is inconveniently low down.

Incidentally, the remote planet Pluto comes to opposition on May 7. It is in Serpens - not one of the constellations of the Zodiac, but of course Pluto’s orbit is much more highly inclined than those of the other planets. The magnitude is 14, so that a telescope of some size is needed to show Pluto at all.

We have now lost most of the brilliant winter stars, though a few members of Orion’s retinue remain visible after sunset. Ursa Major, the Great Bear, is almost overhead. In the south the scene is dominated by Leo, the Lion, with its curved ‘Sickle’ of which the brightest member is Regulus. Lower down, look for Alphard in Hydra, the Watersnake, which is as bright as the Pole Star and is the Great Bear’s ‘Pole Star’ and is decidedly reddish; it is nicknamed ‘the Solitary One’ because of its isolated position. Castor and Pollux, the celestial Twins, point to it.

Follow round the curve of the Great Bear’s tail, and you will come first to the brilliant orange Arcturus, in Bootes (the Herdsman) and then to Spica in Virgo (the Virgin). Low in the south lies the little quadrilateral of stars forming Corvus, the Crow, which is distinctive even though it is not particularly bright. Of the really brilliant stars, Vega is rising in the north-east and Capella dropping in the north-west.
period of 0.5 millisecond (0.0005 of a second), much the quickest known.

This was strange enough, but even stranger was the fact that the observations could not be repeated. The pulsar seemed to vanish as mysteriously as it had appeared. Searches at all the major observatories from which the cloud is accessible were uniformly negative, and theorists did their best to explain it. Could the pulsar have 'switched off'? Could the flashes have been masked by intervening material? Or could the pulsar's axial inclination have been altered, so that we no longer passed through the 'beam'? Astronomers simply did not know, and the only hope seemed to be to wait for the pulsar's reappearance.

A pulsar spinning as fast as this would be a major theoretical problem. The known millisecond pulsars are old, and have been 'spun up' since their formation in their parent supernova. But at least we know the exact moment when SN 1987A exploded, and if the pulsar were spinning as quickly as this it would have had to have been produced in precisely that way.

Of course, the production of a pulsar in the remnant is more than likely - it would be difficult to see how it could be avoided, unless the progenitor were massive enough to cause a black hole (which, all in all, did not seem very likely). It was also clear that the outburst did not follow the regulation idea of a supernova, and because there were no precedents all the astronomers were working, metaphorically, in the dark. Instrumental error was expected - but this did not seem plausible either, in view of the experience of the observers and the known excellence of the Cerro Tololo telescope and its equipment.

Now, at last, the mystery has been solved. It was due to error. Dr. John Middleditch, head of the team which made the observation, has established that the signals were due simply to interference from a television system which was being used for guiding the telescope - and had nothing to do with the supernova.

This does not mean that no pulsar exists; very probably it does, and in time, when the force of the initial outburst has died away, we ought to find out. But at the moment we much now concede that there is no evidence, and the intriguing superfast pulsar reported by the Cerro Tololo team does not exist.
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  - 220, 330, 470 20p
  - 1000 35p
  - 2200 48p
  - 3300 65p
  - 4700 85p

**Disc Ceramic**
- 5% tolerance 150Volt values in Pf
  - 15, 22, 39, 47, 68, 100, 150, 220, 330, 470 6p
  - 10% tolerance value in Pf
  - 220, 330, 470, 680, 800, 1000, 1500, 2200 8p
  - 3300, 4700, 6800 10p

**CMOS**
- **Diode**
  - 1N4148 4p
  - 1N4001 3p
  - 1N4002/3/4/5/6 4p
  - 7812 7p
  - 7402/4/6/8 11p

**Zener Diodes**
- 500 mW

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**Diodes**
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- **Bench Power Supply 2.5–35 Volt** @ 2 Amps

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**HUNDREDS OF KITS AVAILABLE - SEND FOR LIST**
BC Basic Procedures provide the means of writing very modular or structured programs which are easier to read and therefore easier to alter, debug, etc. As with standard Basic subroutines, Procedures can be nested. It is also possible to write test programs consisting of these modules, using them as if they were keywords. In other words, by writing a number of procedures and then calling them by name, programs can be constructed by treating the procedure names as keywords. For example:

10 DEF PROCexchange
20 CLS
30 PROCMESSAGE
40 PROCREPLY
50 ENDPROC

The above routine is a Procedure containing two other Procedures. It can be seen that it is a simple matter to write very high level language modules which effectively consist of 'commands' or 'keywords'. This gives the programmer the capability of virtually writing programs in a very high level language, or designing his own pseudo-language (like LOGO, etc.). It is a very useful tool and an added bonus from BBC Basic.

## Building a Robot Car

### Module 1: DEF PROCexchange
```plaintext
CLS
PROCMESSAGE
PROCREPLY
```

### Module 2: DEF PROC manual-controls
```plaintext
CLS
PROCFORWARD
PROCREVERSE
GOTO
```

### Module 3: DEF PROCfsrs
```plaintext
CLS
PROCFORWARD
PROCREVERSE
GOTO
```

### Module 4: DEF PROCfsrs_sound_light
```plaintext
CLS
PROCFORWARD
PROCREVERSE
PROCSOUND
```

### Module 5: DEF PROCfsrs_left_right_beep
```plaintext
CLS
PROCFORWARD
PROCREVERSE
PROCBEEP
```

### Listing 5

Fig.30 details the 'command' program modules, and Fig.31 shows the contents of the library of individual procedures situated at the end of the program. These can be utilised for other combinations of test functions to form new command programs.

The program can be considered to consist of three main sections, as in Fig 29. This program and its individual modules are structured to enable DIY construction of test programs. The final program is detailed in Listing 5. Lines 60-310, enable the various modules of the command programs to be selected from a menu of six items.

To make full use of the BBC Basic Procedures, they are named such that they indicate their actual function. As previously stated, this name or label can be in lower case (These would indicate the procedure names as keywords).

### Menu-Driven Program

Fig.29 is a block diagram showing the construction of the full menu-driven program shown in Listing 5.

### Fig. 29. Structure of main menu-driven test program (Listing 5).

<table>
<thead>
<tr>
<th>TITLE</th>
<th>MAIN PROCEDURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>MENU</td>
<td>1. PROCexchange</td>
</tr>
<tr>
<td></td>
<td>2. PROCmanual_controls</td>
</tr>
<tr>
<td></td>
<td>3. PROCfsrs</td>
</tr>
<tr>
<td></td>
<td>4. PROCfsrs_sound_light</td>
</tr>
<tr>
<td></td>
<td>5. PROCfsrs_left_right_beep</td>
</tr>
<tr>
<td></td>
<td>6. PROCcollision</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SUB-PROCEDURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXCHANGE</td>
</tr>
<tr>
<td>MOTION</td>
</tr>
<tr>
<td>SOUND</td>
</tr>
<tr>
<td>LIGHT</td>
</tr>
<tr>
<td>COLLISION</td>
</tr>
</tbody>
</table>

### Fig. 30. Main procedures.

### Part 3 - in which Alan Pickard concludes Microbe 3.

Apart from module 1 which is straightforward, enabling programming of user keys, the rest of this section consists of five test modules (see Fig.30) which themselves are constructed from individual procedures. These are situated after the main body of the program and can be considered to be a 'library' of procedures to be drawn as required.

Module 2, designated PROCexchange, consists of two procedures. When this procedure is called, PROCMESSAGE 'sends' a sequence of tones from the BBC machine using the SOUND statement. PROCREPLY produces a sequence of tones and led flashes from the MICROBE 3. This provides an amusing 'conversation' between the robot and mother ship, establishing that both machines are operational. This theme could of course be expanded at a later stage, especially if speech synthesis were available on either or both machines!

Module 3, (PROCfsrs) replaces the original FSRs program and consists of two procedures PROCFORWARD and PROCREVERSE (each procedure could be used separately if required).

It will be seen that new test routines can be developed by using various combinations of procedures as used in the main body of the program.

Module 4, designated PROCfsrs_sound_light, demonstrates forward and reverse motion and also left and right turns. Changes in direction are signified at MICROBE 3 by the BEEP sound.
Continued on next page
Program Listing 5.
(Continued from previous page).

```
2210 REM COLLISION:
2220 DEF PROCCOLLISION(PB7)
2230 PRINT "FORWARD"
2240 IF (?&FE60 AND 128) = 0 THEN GOTO 2260
2250 IF (?&FE60 AND 128) = 128 THEN GOTO 2240
2260 PRINT CHR$(136) "COLLISION"
2270 ?&FE60=&00
2280 PRINT "REVERSE"
2290 FOR M=1 TO 2000
2300 NEXT
2310 GOTO2220
2320 ENDPROC
```

SECTION 3

This consists of a library of sub-procedures which can be used in various combinations to make up test modules. New sub-procedures can be added at later stages, thus extending the library as experimental work progresses (see Fig 31).

USING THE PROGRAMS

To avoid confusion and unexpected (not to mention unanticipated!) movements and actions, it is advisable to adopt the following sequence of switching on the system:

1. Switch on computer;
2. Load program;
3. Run program;
4. Switch on Robot dc supplies.

Running the program before powering the robot enables inactivity codes to be selected before the beast breaks loose!

NEXT STAGE

It can now be seen that using some fairly simple hardware and software, a fully programmable vehicle can be despatched into the environment and can operate either remotely (manually) or under program control.

MICROBE 3 enables the robotics enthusiast to experiment with hardware and software and provides an insight into the requirements and capabilities of a robot system.

**COMPONENTS**

<table>
<thead>
<tr>
<th>IC</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Octal darlington driver with</td>
</tr>
<tr>
<td></td>
<td>Rin RS 303 510</td>
</tr>
<tr>
<td>C2</td>
<td>NE555 timer</td>
</tr>
<tr>
<td>TR1,TR3</td>
<td>BC182 (2 off)</td>
</tr>
<tr>
<td>TR2</td>
<td>MPSA12</td>
</tr>
</tbody>
</table>

**CAPACITOR**

| C1   | 100 n polyester              |

**RESISTORS**

| R1,R2,R9 | 22k (3 off)                  |
| R3       | 5k6                          |
| R4       | see text                     |
| R5       | 27k                          |
| R6       | 2k2                          |
| R7,R8    | 470 (2 off)                  |
| R10      | 1k                           |
| R11      | 4k7                          |

All 0.25W 5% carbon film.

**SEMICONDUCTORS**

| L1,L2   | TIL 20 red 0.2 inch (2 off)  |

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IC skt dil 18-way
IC skt dil 8-way
Veroboard 95x292x1.6 0.1

Sub-miniature spco relay 12V 320 ohm pcB mounting RS 348 510 (3 off)

Motors, microswitches and on/off switches to suit, batteries, battery holders, loudspeaker.

**COLLISION:** PROCCOLLISION

Fig 31. Sub procedures library

By constructing a system based on MICROBE 3, and maybe improving or extending the basic hardware and software, a 'feel' for robotics will be achieved and some useful experience in microelectronics and interfacing will be gained.

Hopefully this article will encourage you to experiment and develop some of your own ideas.

In a future article, the approach to adding on-board 'intelligence' to MICROBE 3 in the form of a 6502-based microcontrolled system will be discussed. This will provide the robot with independent operation and the ability to communicate with the 'host' computer and also be able to run under its own (machine code) programs. Thus a dedicated but reprogrammable robot will be created.

This should provide a useful exercise in practical machine code, downloading of software and the interfacing of two computers.

MICROBE 3 will continue to be used in the future article as a basis for hardware and software expansion, using various electronic and microelectronic techniques.
Your Ed looks at some of the new books recently received.

Computer Engineer's Pocket Book - 2nd Edition. Michael Tooley. Heinemann Newnes £9.95. ISBN 0-434-91969-1. In his preface, Mike Tooley offers a brief word of advice—"Don't be content to leave this book on the shelf - it should form part of your everyday 'tool kit'...use it in much the same manner as your trusty pocket calculator." Indeed, in many ways it is probably even more useful than your calculator, certainly when you quickly need to look up answers that are not necessarily of a mathematical nature. It truly is a 'pocket book', measuring 7 x 3.75 inches, but it has over 200 pages crammed with enormously valuable data for use in countless circumstances relating to computers and digital electronics. The book includes a highly comprehensive list of abbreviations in general use, manufacturers' prefixes for semiconductor devices, a very full list of the 7400 and 4000 cmos series, including functional descriptions and a selection of pinouts. It covers memory maps, Karnaugh maps, cics and memories, conversion tables for octal, hex, binary, decimal etc. Other sections include useful interface circuits, resistor colour codes, Basic keywords, examples of hardware faults and recommendations, and much more. There is a lengthy index as well, always a useful factor. This book is a recent addition to the PE Book Service. It's excellent value.

Microprocessor Pocket Book. Steve Money. Heinemann Newnes £9.95. ISBN 0-434-91290-5. This is a companion to the above Computer Engineers' Pocket Book and is equally worthy of a place in the 'tool kit'. There is a minor amount of repetition of some information between the two books, but you will benefit from owning both of them. Steve Money says that he has tried to present a wide selection of information likely to be of general use to the engineer involved in designing, servicing or just wishing to learn more about microprocessor systems. It appears that he has succeeded, with flying colours. In over 250 pages he presents concise and highly relevant information on many aspects of the subject. The nature of Ics is covered, including the handling of cmos. Data formats, such as Ascii codes, signed binary numbers and floating point numbers are covered, as are instruction sets, stack and instruction set architecture. RISC processors are also discussed, together with single chip computers. Serial and parallel input/output parameters and protocols are presented. Multipurpose chips, display systems and systems development also have their own sections. A list of useful manufacturers' addresses is given. This highly useful book has recently been added to the PE Book Service.

Radio and Electronics Engineer's Pocket Book - 18th Edition. Keith Brindley. Heinemann Newnes £9.95. ISBN 0-434-90187-3. This book is an absolute 'must' for anyone remotely interested in radio and associated electronics. It shows, too, how a good book, suitably updated can withstand the test of time. The first edition was published 50 years ago, in 1940. I still have, and use, the 13th edition from 1962. A short review really cannot do justice to the full range of data this book presents. Just as a few examples: a very lengthy list of abbreviations, letter symbols and conversion factors is given. So too are useful formulae and charts. Healthy tables of transistor and diode data and parameters are shown, together with suggested equivalents. Symbols are again covered, showing their diagrammatic representations. The 7400 and 4000 series of Ics is listed and pinouts shown. A lengthy section covers British and European radio and tv transmission frequencies, plus the designations of the general frequency allocations. International telephone codes are quoted too, as are wind scale factors and UK weather forecast regions. There is a good glossary of radio and electronic terms. A few examples of useful circuits and formulae are presented, and there are several tables of fascinating data you'd probably be hard-pressed to find elsewhere - velocity of sound, electrical properties of elements, mains voltages in other countries, etc. I shall use this book, and recommend that you get a copy too. It's recently been added to the PE Book Service.

The Semicon International Semiconductor Index - 8th Edition. Semicon Indexes. £29.50. ISBN 0-904944-21-2. This another publication about which I can enthuse. It can, to all intents and purposes, be regarded as a complete catalogue of all integrated circuits and their manufacturers. In reality, it can be much more than that since it can be regarded as a living volume which grows with the technology. In its main form, it is a manual in a loose-leaf binder and contains around 600 pages of sectionalised data. It is supplemented by Semicon's subscriber update service which permits updating of the volumes as changes and additions become available. A large part of each volume is re-issued each year and the cost is considerably less than the purchase of a new fully bound volume. (The cost of the update is currently £19.50.) The contents include alpha-numeric listings of all devices, type numbers, characteristics and manufacturers, cv listings with commercial equivalents, pin-out drawings, logic drawings for integrated circuits, and extensive substitution guides. In addition to the ic listings and data, an enormously valuable section is that relating to manufacturers. The section gives the manufacturer's address, his main worldwide distributors, his logo, his common prefixes and house codes. This ic index is Volume 3 of a series of Semicon Indexes, Volume 1 covers transistors, and Volume 2 covers diodes and sds. Each volume is currently identically priced. I've used the transistor index since its 6th edition of 1975 and know the value of the information contained. This is the first time I've owned the ic index volume and very much welcome it to my library. I look forward to informing you about further editions of this extremely valuable series of volumes. If you are seriously involved in electronics you really should treat yourself to these excellent workshop manuals.

Learning Electronics - Theory and Experiments with Computer-aided Instruction for the Apprentice. £16.30. ISBN 0-8306-2982-3. Learning Electronics Theory and Experiments with Computer-aided Instruction for the IBM. £13.20. ISBN 0-8306-9582-3. Both books are by R. Jesse Phagan & Bill Spalding, and published by Tab Books. I am treating them together since in reality, they are the same book but with the software program material written in different dialects of Basic. The books present basic electronic theory, back-ground maths, lab and practice exercises, with corresponding computer programs. The authors assume that the reader has no prior experience, and "thoroughly cover all the aspects of electronics necessary for a complete understanding of the technology." I wish Tab would not make grandiose statements such as this one - no single book can achieve that degree of perfection. Nonetheless, the books do cover a great deal of electronic theory and should prove to be good source of elementary knowledge of electronics. In addition to presenting the theory, the books provide instructions for projects and experiments to give you actual experience with particular principles. The computer programs graphically show the electronics concepts and the mathematical relationships. Numerous sample problems and experimental exercises are included, and there are quizzes and two 'exams' which should enable you to assess your progress. The text material appears to be very good, without the related program material. It's difficult to assess the latter since there are nearly 40 pages of it to be typed in, but if quantity is anything to judge by, the programs should be a useful and interesting additional teaching technique. You can treat the listings as several independent sections, and 'don't necessarily need to type them all in. Alternatively, you can buy the programs on disk direct from Tab. I think, though, that Tab would find a wider UK market for this educational material if a version of the book devoted to the BBC computer were to be introduced.

PUBLISHERS' ADDRESSES


Semicon Indexes, PO Box 470, Lee, London SE12 8AF. Tel : 081-852 2309.

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PRACTICAL ELECTRONICS JUNE 1990
Electronic engineers have always complained that their industry is far too much under control of accountants and lawyers. They cite examples of wrong decisions being made in the boardroom and imply that if engineers had been in charge these mistakes would not have occurred.

I don’t know how much truth there is in this. Accountants and lawyers seem to be equally dubious about the abilities of engineers to run firms profitably and keep them on a sound financial footing. But in the past few years, particularly with the current unleashing of competition and market forces, the engineers’ long-standing complaint has been getting support from a new direction. There is a strengthening groundswell of opinion - from industrialists, economists, social commentators, politicians and even financial specialists - that money, as mere exchange value, is getting in the way of good financial performances.

Financialists serve interest of financiers threaten industrial stability?

FERRANTICS

Sometimes the result can be disastrous, as with the recent Ferranti affair. Earlier this year Ferranti had to sell off several subsidiaries, including Ferranti Defence Systems Ltd, for about £400 million in order to remain solvent and stay in business as an independent company. It had lost £215 million as a result of buying a dubious American firm, International Signal & Control (ISC), in 1987. In the words of Ferranti’s chairman: "... ISC’s assets and profits were substantially inflated by a serious fraud which had been running for some years prior to the merger; the audited accounts of the ISC group at 31 March 1987 did not show a true and fair view of that company’s assets and liabilities; as a result, Ferranti was induced to enter into a merger it would not otherwise have contemplated and paid far too much for ISC by issuing too many Ferranti shares in exchange for ISC shares; and, as a result of the merger, Ferranti International had had to recognise a substantial reduction in its net worth."

The main point is that Ferranti really took over ISC (as discussed in this column in February 1988) to make itself bigger and so thwart the takeover bids that seemed to be threatened at the time. In the event it seems that Ferranti was cheated because the company and its advisers did not look into the proposed acquisition carefully enough. But if Ferranti had been properly financed on a long-term basis in the first place (as practiced in Germany and Japan) there would have been no need for this rather desperate merger.

CARDBOARD AND LODGING

On my occasional trips into central London I encounter two manifestations of the fast-buck environment in which British industry leads this somewhat precarious existence. They have been named Cardboard City and Cuckoo City. Walking out of Waterloo Station, I first encounter the beggars under Waterloo Bridge. These are the people who sleep rough at night in cardboard boxes and other makeshift shelters. You may have seen it on tv, but you have to be there and smell it as well to experience the full degradation.

Whether these people are genuinely disposed or just tricksters, they have made direct begging for money on the streets a new feature of British city life (at least in this century).

CLOUD-CUCKOO

Later on, in the financial centre, I go for lunch in a pub and encounter young men in £500 suits drinking champagne and talking in very loud voices. Their arrogance is in sharp contrast to the hang-dog demeanour of the Waterloo beggars. But they too are engaged in getting money by persuasion. They buy and sell shares on the Stock Exchange.

These dealers work in what is called financial services. But this term gives something of a wrong impression. Financial self-serving would be better. Since deregulation, the City of London has become an international trading centre which, through the huge volume of its business, has quite outgrown the domestic economy of the host country. It has no particular concern for British industry. Appropriately, it has been called Cuckoo City. The parasitic birds has taken over the nest.

With its swollen size and power, the Cuckoo decides what is best for those with the money - the investors - and incidentally for itself, rather than what is best for the companies that are generating the real wealth of the country. The original function of exchange value has become distorted. In the UK, money is becoming an end in itself and increasingly detached from productive reality and public benefit. This is a good recipe for ruining an economy.

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R.A.Penfold. There are two books - Book 1 : 128 pages. £1.95. Order Code BP117
Book 2 : 112 pages. £1.95. Order Code BP118
Book 1 is about oscillators and gives circuits for a wide range, including sine, triangle, square, sawtooth and pulse waveforms and numerous others from voltage controlled to continuous types. Book 2 looks at amplifiers, ranging from low level discrete and quas amplifiers to hi power amps. A section of mixers, filters and regulators is included.

30 Solderless Breadboard Projects
Each project is designed for building on a Veroboard breadboard and is accompanied by a description, circuit and layout diagrams and relevant constructional notes. Many of the components are common to several projects. Book 1 covers linear devices, and Book 2 covers mains logic chips.

Shows the complete beginner how to tackle the practical side of electronics and includes simple constructional projects.

SATELLITE TV

Full of vital information for any competent diyer who wishes to install a satellite tv antenna and obtain optimum reception quality.

An Introduction to Satellite Television
Informative answers to many of the questions about this communications revolution. The information is presented on two levels; one aimed at the complete beginner, the other at professional engineers and serious amateur enthusiasts.

TEST AND MEASUREMENT

Getting the Most from Your Multimeter
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Test Equipment Construction
Describes in detail how to construct some simple and inexpensive, but extremely useful, pieces of test equipment.

Oscilloscopes 2nd Edition
Subtitled 'How to Use Them. How They Work' the book is illustrated with diagrams and photographs and is essential reading for anyone who wants to know about scopes, from first principles to practical applications.

How to Get Your Electronic Projects Working.
Essential reading for anyone who wants first-time success in project assembly. Covers tracing mechanical faults as well as testing for failures of active and passive components of most types.

AUDIO AND MUSIC

Introducing Digital Audio
I.Sinclair. 112 pages. £5.95. Order Code PC102.
A non mathematical introduction to the new digital technology, discussing the principles and methods involved in devices such as cd, dat and sampling.

Electronic Music Projects
24 practical constructional projects covering fuzz, wail, sustain, reverb, plating, tremolo etc. The text is split into four sections covering guitar, general sound generation and accessory projects.

More Advanced Electronic Music Projects
Complementing BP74 by covering more advanced and complex projects including flanging, chorus, ring modulation, plus a selection of drum, cymbal and gong circuits.

Computer Music Projects
Shows how home computers can produce electronic music and covers sequencers, analogue and Midi interfacing, digital delay lines and sound generators, plus a selection of drum, cymbal and gong circuits.

Practical Midi Handbook
A practical how-to-do-it book for musicians and enthusiasts who want to exploit the capabilities of Midi. Covers keyboards, drums, sequencers, effect mixers, guitars and computer music software.

Midi Projects
Practical details of interfacing many popular home computers with Midi systems, and also covering Midi interfacing to analogue and percussion synths.

Electronic Synthesiser Construction
Even relative beginners should find the monophonic synthesiser described here within their capabilities if the book is thoroughly read. Individual aspects of the synth are dealt with separately and pcb designs are shown for the main modules.

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DIGITAL AND COMPUTING

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An Introduction to Computer Peripherals. R.A. and J.W. Penfold. 80 pages. £2.50. Order Code BP170
Covers such items as monitors, printers, disc drives, cassettes, modems, etc. explaining what they are and how to use them with your computer and with each other.

Intelligently looks at the basic building blocks of all digital circuits and is intended for enthusiasts, students and technicians who seek to establish a firm grasp of fundamental principles.

The book covers systems hardware, programming concepts and practical experimental work that will assist in understanding the 6800/6802 microprocessor, with additional information on the 6802/D8255 evaluation system.

An Introduction to 68000 Assembly Language. R.A. and J.W. Penfold. 112 pages. £2.95. Order Code BP184
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Getting the Most from Your Printer. J.W. Penfold. 96 pages. £2.95.
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Book 1: £2.25. Order Code BP130
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Component identities are usually clearly marked on them. Even if they are colour coded, like some resistors and capacitors, their values are easily worked out from component colour code charts. From time to time we publish these charts, but if you don't already have one, send a 9in x 4in stamped and self-addressed envelope to the Editorial office asking for one.

For many projects you only need a few simple tools - Soldering iron between 15W and 25W, with a bevelled tip. Damp sponge for keeping the tip clean. Good multicore solder of 18swg or 22swg grade. Fine nose pliers for wire shaping. Adjustable spanner or heavy pliers for tightening nuts. Miniature screwdriver for adjusting preset controls. Small wire cutters for trimming component leads. Drill and selection of bits for drilling holes in boxes. Strong magnifying glass for checking joins in close up. It's also preferable to have a multimeter for setting and checking voltages. There are some very good low cost ones available through many of our advertisers, but get one that is rated at a minimum of 20,000 ohms per volt. Many projects do not require you to have a meter, but if you are serious about electronics, you really should have one.

Connecting the pcb to the various panel controls is the final assembly stage. Do this just as methodically, following the published wiring diagram. You can connect the wires to the pcb in one of three ways. The best is to insert terminal pins into the connecting holes on the pcb, and then solder wires direct to them. Or, pass the end of the wire through the pcb hole, soldering it on the other side. Alternatively, the wire can be carefully soldered direct to the pcb tracking. In all cases first strip the plastic covering off the wire, twist the strands together, and apply solder to them to keep them secure.

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Occasionally a specific part may only be available from a particular supplier, if so the source will be given in the parts list. Otherwise there should be no difficulty in buying the parts. We have many good suppliers advertising in PE so have a look through their adverts - that's why they're here! Even though a part may not be listed in the adverts, a phone call or two should find a supplier who will be pleased to help. Like us, they too are in the business of encouraging you to enjoy electronics!
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