

ELECTRONICS

SCIENCE AND TECHNOLOGY

MESSAGE MAKER

How to get the programmable intelligent lcd message across

BAUD RATE CONVERTER

Bringing pcs down to modem management speed

INTERMITTENT WIPER

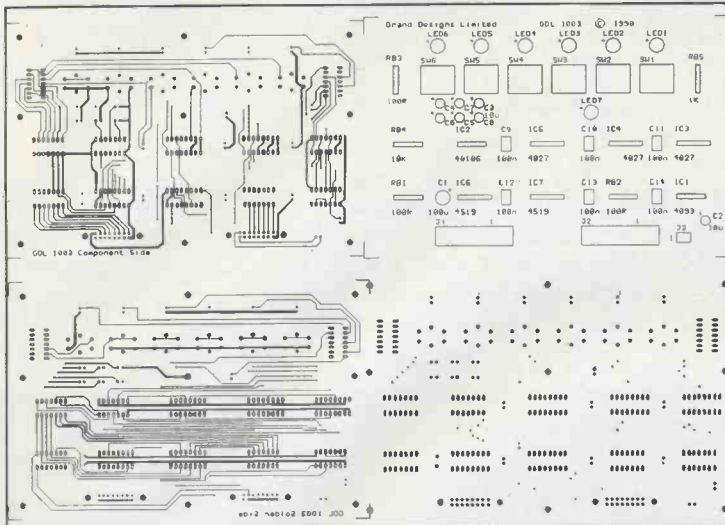
Better hindsight for forward-looking drivers

HOME BASE

Lining up for shopping without sore feet



MAKING ELECTRONICS C.A.D. AFFORDABLE

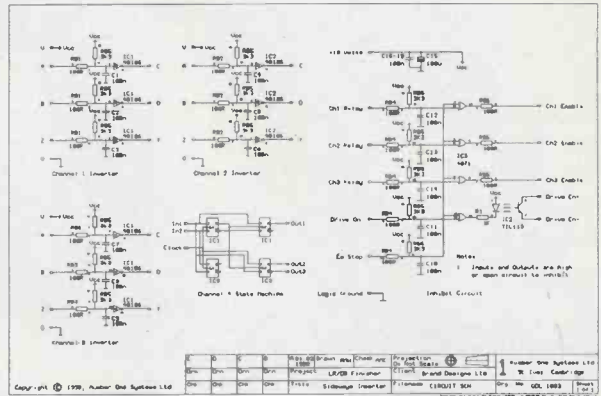


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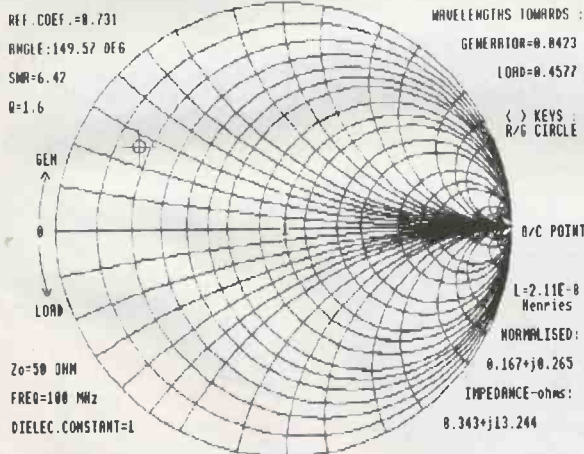
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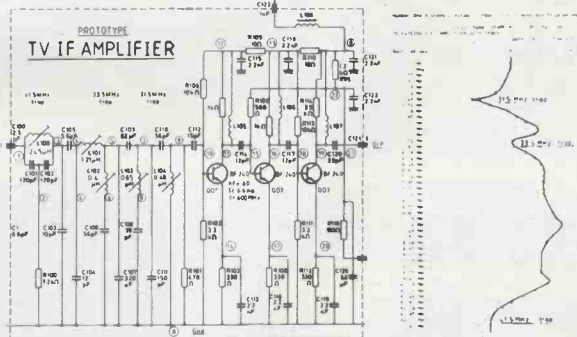
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PRACTICAL ELECTRONICS

VOL 26 NO 6

JUNE 1990

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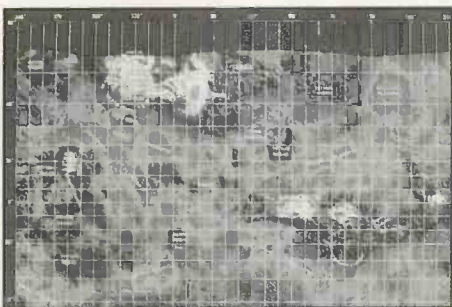


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NEXT MONTH

You needn't know how to dot your Is or dash your Ts to understand morse comms across the airwaves if you build our semi-intelligent lcd morse decoding display module. Speech comms have their mysteries revealed in our feature on mobile radio, the first in a series that will also look at cellular radio and radio paging. And if you've been thinking about building your own IBM PC compatible you'll find that our useful advice could help you realise your ambition. All this and more to show you how to enjoy electronics to the full.

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JULY 1990 ISSUE

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FROM FRIDAY
JUNE 1ST

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PE TAKES TECHNOLOGY FURTHER - BE PART OF IT!

AUDIOPHILE DECKS



CD inventor Philips are adding a new three head Dolby HX Pro cassette deck, the FC870, to their acclaimed 8' series hifi separates range.

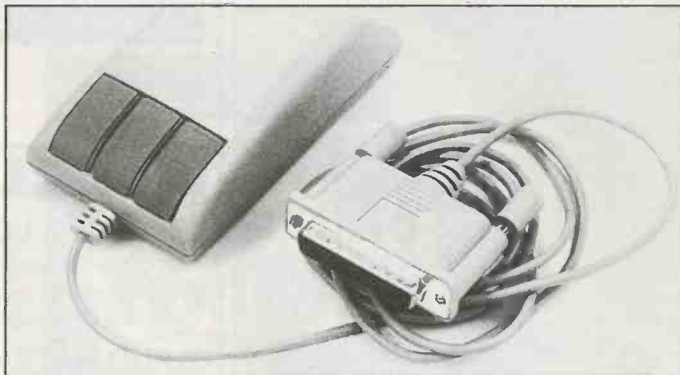
The FC870 cassette deck features a three-head design with separate hard permalloy heads for recording, playback, off tape monitoring and direct source tape comparison.

Separate capstan and reel motors are included in the solenoid electronic tape transport, with precision ground capstan featuring a large flywheel to eliminate wow and flutter.

Philips say that superb recordings are guaranteed by the Dolby HX Pro

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, Artillery Row, London SW1P 1RL. Tel : 01-222 0833.



SEE HOW THEY RUN

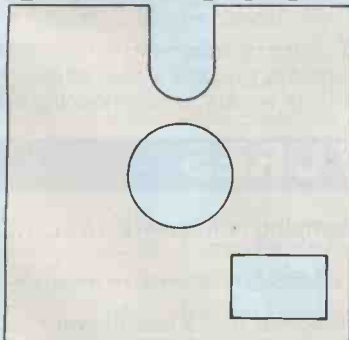
Maplin tell us they are assisting the mouse breeding cause by introducing two all-new 3-button serial computer accessories, designed for use with IBM PC/XT/AT and compatible computers. At just £29.95, the neatly styled 3-button serial mouse produces a serial output signal. This is connected to the serial (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 £59.95.

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

CATALOGUE



DATABASE

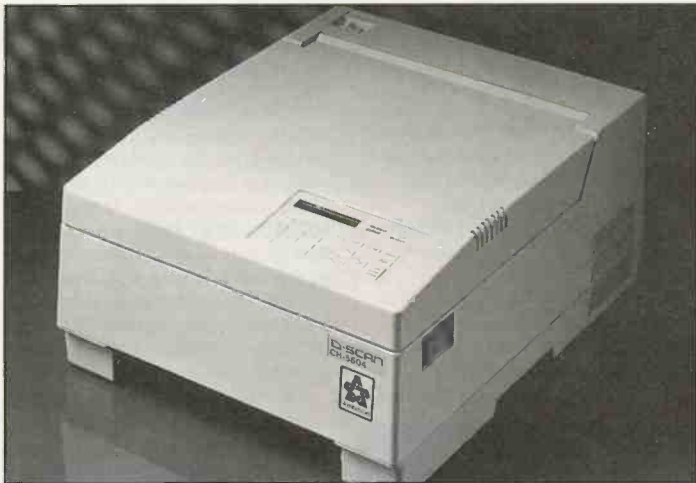
Our browse through recently received literature

Greenweld's great 32-page spring supplement catalogue can hardly have been missed by readers who bought our May 90 issue, into 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 Metex 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 0HX. Tel : 0703 772501.

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 tools 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!) Levery apart, electronic pcbs have recently been linked to matters concerning CFCs (those ozone-unfriendly products).

BOC, formerly the British Oxygen Company, became aware that the cleaning process involved prior to commercial assembly of pcbs required the use of chemicals containing CFCs. The company has now developed a process which allows board makers to mount parts without such potentially hazardous cleaning.

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

CFC 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 cut environmental damage and costs.

PARALLEL PROCESSING TRAINING

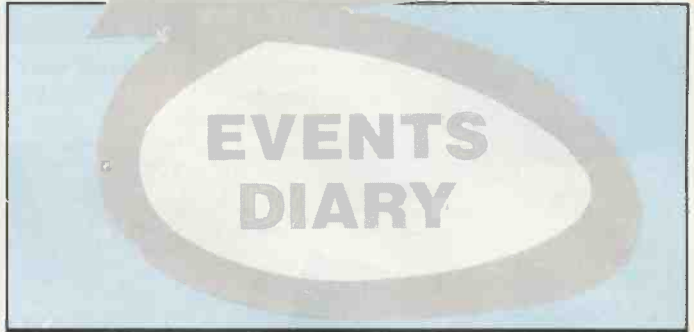
Salford ITeC has been chosen as one of only 14 training centres in the UK to offer assistance to local businesses in a rapidly expanding area of computers, parallel processing.

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



If you are organising any event to do with electronics, big or small, drop us a line, we shall be glad to include it here.

Please note : Some events listed here may be trade or restricted category only. Also, we cannot guarantee information accuracy, so check details with the organisers before setting out.

May 27. Plymouth Radio Club annual radio and electronics fair. Plymstock School, Church Road, Plymstock, Plymouth. 0752 340946.

May 30-Jun 1. Computer Training and Services Show. Olympia, London. 01-486 1951.

Jun 26-28. Infrared Technology. Wembley Conference Centre. 0799 26699.

Sep 25-27. British Laboratory Week. Olympia, London. 0799 26699.

Oct 2-4. Eurostat 90. Barbican Red Hall, London. 0799 26699.

Nov 6-8. Total Solutions. NEC Birmingham. 0799 26699.

SATELLITE TRUCKING

Bids for the new series of Inmarsat 3 mobile communications satellites have been arriving at the organisation's London headquarters by the truckload.

The size and weight of the proposals reflect the degree of technical and financial detail needed to assess the new satellite series. The bids, received from satellite manufacturers around the world, and each taking up to a year to prepare, totalled more than 11 tonnes of paper.

The rewards to the winner will be considerable. The contract, to be awarded in December this year, will cover an initial purchase of three or four dedicated spacecraft which, with the additional options for up to a total of nine, could cost well in excess of \$US 1 billion.

The new satellites, which will reach orbit beginning in 1994, will have enough power and capacity so

that customers all over the world will be able to communicate with each other via telephone, fax, personal computers or pagers using terminals small enough to be hand-carried.

The total EIRP (effective isotropically radiated power) of the satellites will be 48dBW, nearly ten times the effective capacity of the Inmarsat 2 satellite, due to be launched later this year and in 1991, or 30 times the capacity of the satellites currently in operation.

Inmarsat is at present operating a system of eight satellites to provide mobile satellite communications worldwide.

For further information contact Elizabeth Hess, Inmarsat, 40 Melton Street, London NW1 2EQ. Tel : 01-387 9089.

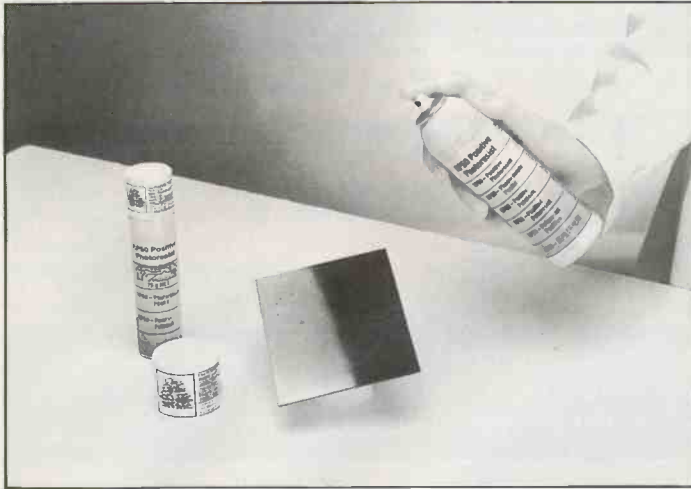


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a good photo and we'll do our best to publicise them

First come first served, and it must be interesting. It's up to you to keep us all informed!



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.

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 fibreglass 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. Developing is carried out using diluted Electrolube photoresist developer PRD, producing a clear green image of those areas not 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 8AW. Tel : 0734 404031.

ROBUST CASING

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

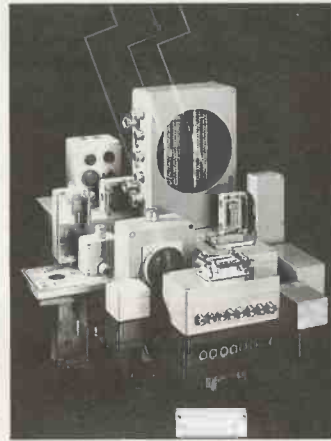
The diecast aluminium range offers excellent screening properties.

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. Recessed 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 toughest 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 Faraday Road, Aylesbury, Bucks, HP19 3RY. Tel : 0296 399339.



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.

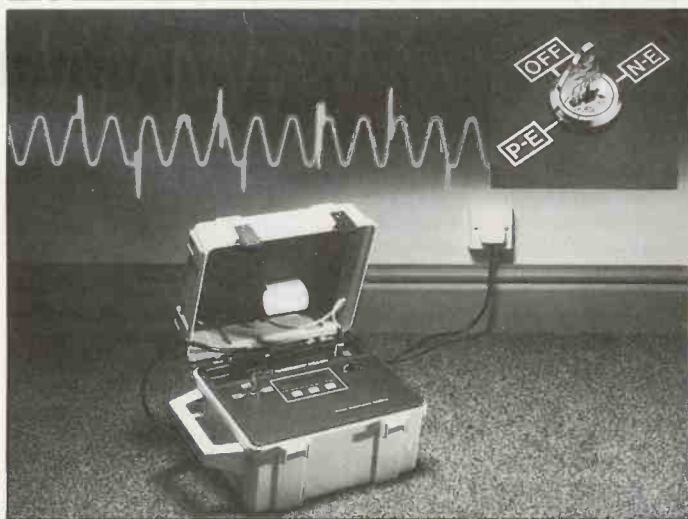
Starting and destination points are keyed in by the operator, together with any other details such as day of travel and time of departure. The system then rapidly produces a journey plan showing routes, times and changing points for even the most complicated journey. Other useful information, such as availability of refreshments or the need for advance 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 operators have expressed interest.



DISTURBANCE ANALYSING

An 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

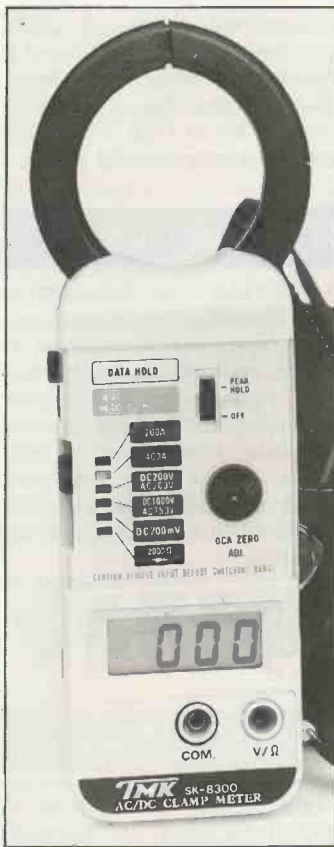
such sectors as computer maintenance and system installers.

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 202620.

POWERFUL CLAMP-DOWN



Measuring both ac and dc current and voltage, the new SK8300 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 $\pm 2\%$ 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 SK8300 is fully guaranteed for 12 months and costs £115, plus vat.

For further information contact **TMK Instruments**, Building 3, GEC Estate, 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 Battelle.

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, electro-optics systems engineer at Battelle. "People are amazed when I demonstrate by showing them selected frames of a firecracker exploding or a

balloon bursting," he said. "We're aware of no other video system that can record so much so fast."

The camera can freeze action rates ranging from 200 to 12,000 frames per second. The high-volume memory stores 4096 images before, during and after an event is detected. Images can be retrieved arbitrarily from memory for display and permanent disc storage.

Battelle is an international technology organisation that serves industry and government in developing, commercialising and managing technology. With a wide range of scientific and technical capabilities, Battelle puts technology to work in more than 30 countries.

For more information contact Renate Siebrasse, Operations Manager, **Battelle Institute Ltd**, 15 Hanover Square, London W1R 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, Chickenhall Lane, Eastleigh, Hants, 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 μ PD78310 is the rom-less version of the μ PD78312. 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 μ PD78310 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 in/out 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 0.5 μ s 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 μ PD78310 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 Microsystem's SPARC, Motorola's 88000 and Intel's 1860. 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 systems 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 ram, 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 7.5ns PAL architecture. This new architecture offers designers higher performance products with a proven process technology which eliminates risks and simplifies product qualification.

BST25A AND BFG25AX RF TRANSISTORS

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

The BST25A is an npn device in the SOT-23 outline, and uses second generation rf techniques to achieve a gain of 15dB 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

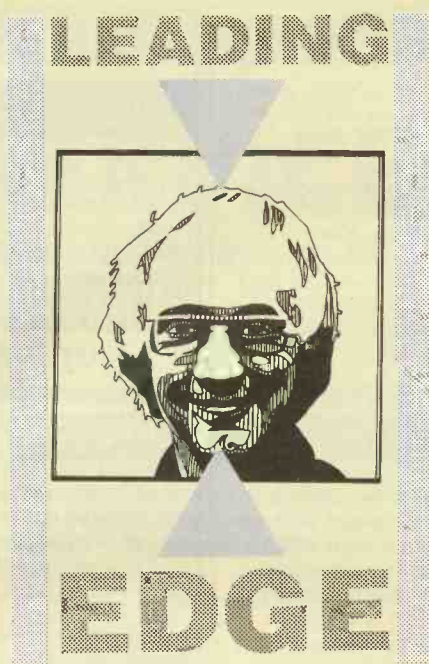
Impulse Electronics, Hammond House, Caterham, Surrey, CR3 6XG. Tel: 0883 46433.

Philips Components Ltd, Mullard House, Torrington Place, London WC1E 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.



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

RADIO LINKING

SATELLITE MEDIA

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 streams. Each gives broadcast quality stereo pairs; 15kHz bandwidth with 15 bit linear coding companded 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.

BY BARRY FOX
Winner of the
UK Technology Award

Implementing hi-tech advertorial links makes sound sense for commercial radio.

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.

SPACE WATCH

Actually, there's quite 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,

are the station's only (or main) source of revenue. Likewise radio stations have to provide the PRS (Performing Rights Society) and MCPS (Mechanical Copyright Protection Society) with a listing of all music played, so that copyright fees can be charged.

A station only gets its money from advertising, after all the necessary transmission certificates have been provided, and all queries settled. This can take many months when everything is done on paper.

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 arrangements 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 scheduled in November. **PE**

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

PRACTICAL ELECTRONICS



UNDUMPING CONSUMERS

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.

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7477	0.55	7478	0.55	7479	0.55	7480	0.55	7481	0.55	7482	0.55	7483	0.55
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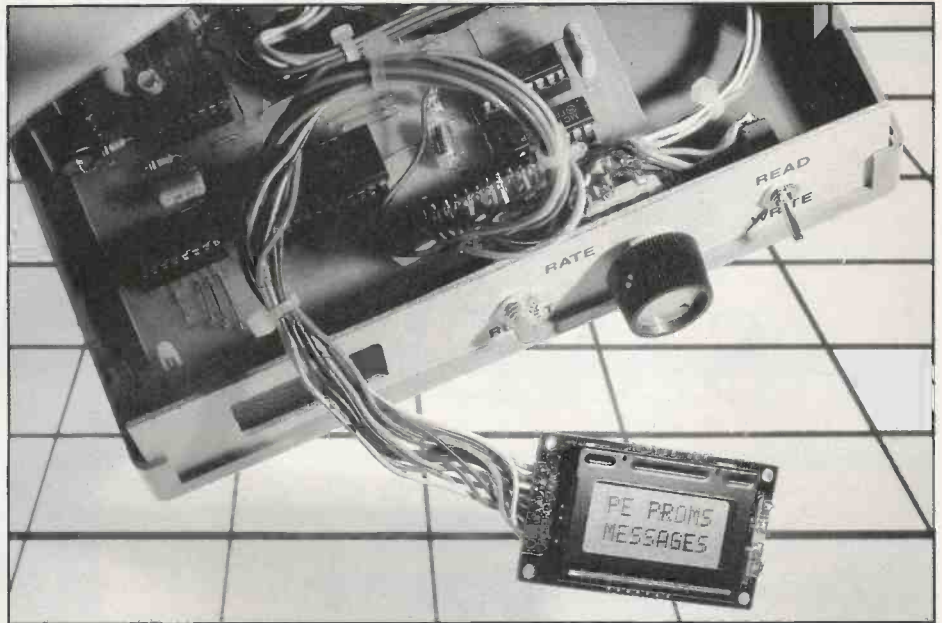
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In last month's *Intelligent LCD Modules* article we examined in detail the nature of the Sanyo LCM570 display module. We saw that it contains an 80 symbol memory and a liquid crystal screen on which sixteen symbols can be displayed simultaneously 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 eeprom, 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, eeprom, or eeprom. 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 lcd module directly from the computer without the need for any interfacing electronics. The purpose of the circuit is to allow you to use an eeprom or eeprom as the main lcd controller, and to program it either in

John Becker's experimental crystal gazing softly rams the message home to the board.

an ordinary eeprom programmer, or directly from a computer. Once the eeprom 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 lcd lines D4-D7. DA4 controls the lcd read/write (RW) operation, DA5 controls the lcd 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 eeprom 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 eeprom (IC2), a computer interface buffer (IC3), and the lcd 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 lcd module.

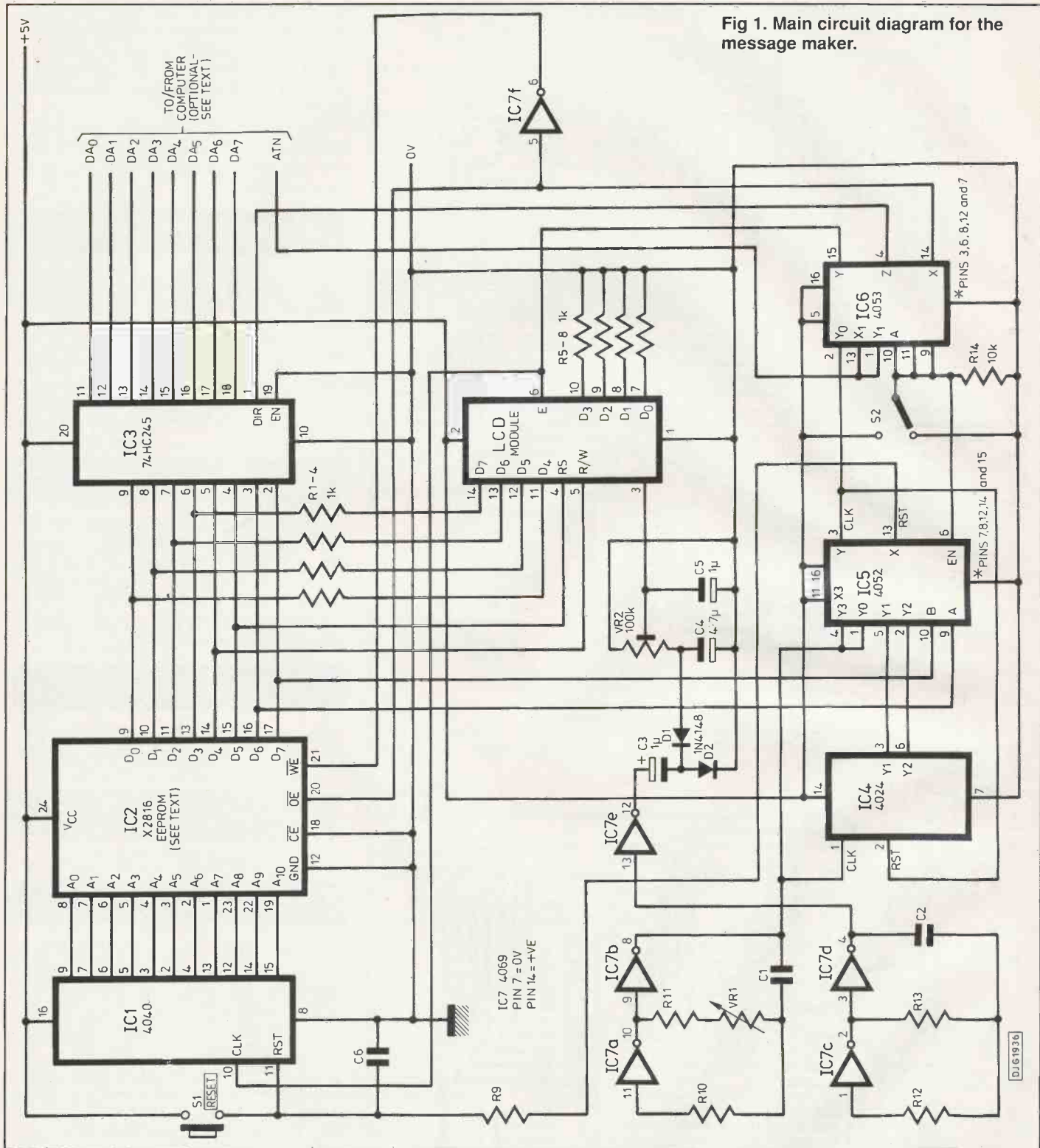
NEGATIVE GENERATOR

IC7c 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 of C3, D1, D2 and C4, the latter smoothing and storing the resulting negative voltage. The lcd 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 eeprom 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,

Fig 1. Main circuit diagram for the message maker.



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

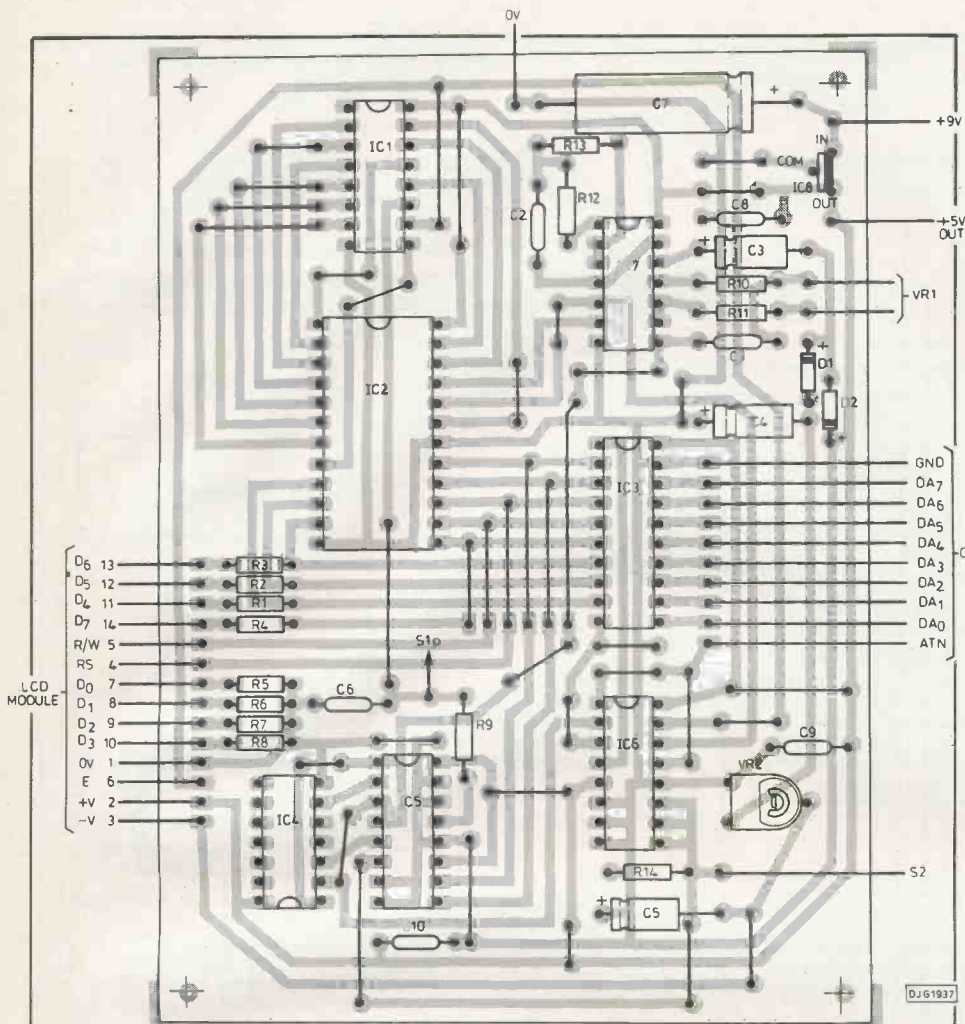
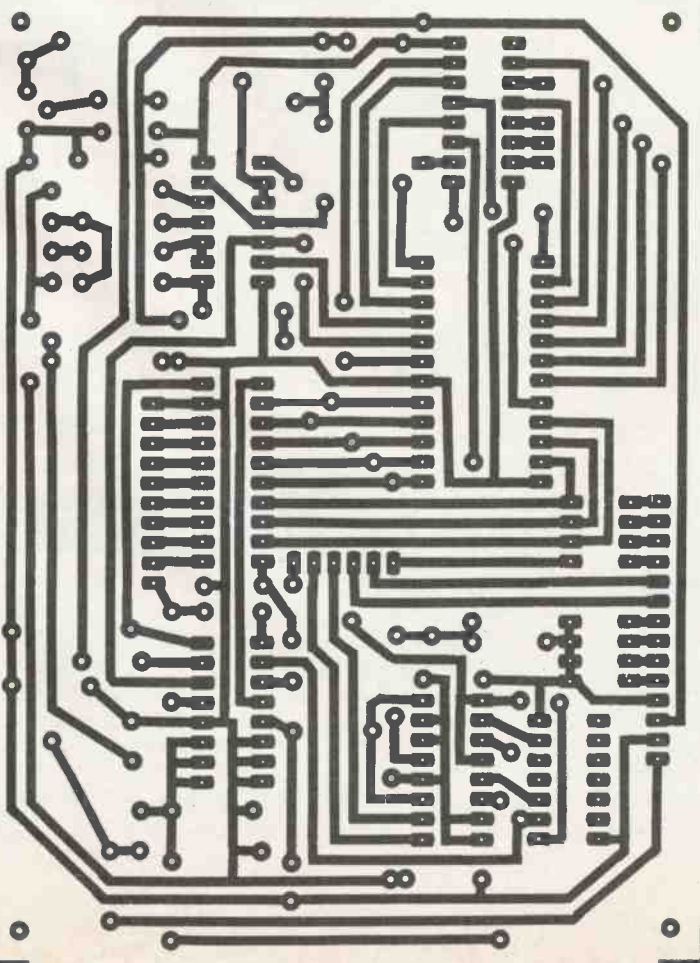


Fig 2. PCB component and track layouts.



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 IC5 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

= 56577, DN = 251, UP = 199, AT = 56576.
Line 110 sets DRT as an output, placing zero on the output port lines. In line 120 the required DIM statements are set and the codes which control lines RS and RW set into the array C().

As we saw last month, the lcd module's control codes are varied by the setting of individual bits in a binary code. In order to make these codes clearer in this illustrative example, in most instances I show the actual binary code we need to use and then let a subroutine in lines 130-150 handle the conversion from binary to decimal.

Since we shall be working with the module in its 4-bit control mode each control code must be split into two parts, representing the decimal value of the left hand four data bits, and the right hand four data bits of the binary code. For simplicity, this extraction is done by manipulating the equivalent decimal value of the complete 8-bit binary code, and is carried out in line 170. E holds the equivalent left hand code, and F the equivalent right hand code. The PRINT statement also in line 170 simply shows the conversion on screen, plus the current code held for lines RS and RW. The PRINT statement may be omitted if preferred.

Lines 190-200 hold the routine which sends data to the output port and toggles the ATN line up and down. The meanings of the other variables shown in line 190 will become apparent once you start using the program.

The delay pauses that can be built in to the eeprom program are accessed in the subroutine at lines 220 and 230. The Y loop is just for the computer simulation; it is X which sets the relevant code on to lines DA6 and DA7.

INITIALISATION

When the lcd module is first powered up it needs to be taken through an initialisation routine, setting the number of display lines, the font, the 4-bit or 8-bit control mode, and various other parameters as discussed last month.

At switch on, the module automatically resets itself to 8-bit mode, therefore, since we are about to use 4-bit control, this is the first parameter that must be changed. In line 240, R is set to 0, determining the status to which RS and RW will be set, and B\$ is set to hold the first data code to be sent, ie 00110011. The subroutine at line 130 converts this to decimal, line 170 splits it into two halves, which are then sent to the output from lines 190 and 200. This code has to be sent twice to the module; but since we have already converted and split it, the second sending can be performed by immediately going to the subroutine in line 190, as performed in line 250. We next need to send code 00110010, as in the second part of line 250. Having sent the above codes the module now knows that any subsequent data will be sent in 4-bit format.

We next tell the module how many lines and which font we wish to use. In this instance we want two lines, which have only one font available. The code is 00101100, and is sent from line 260.

Line 270 controls the on/off modes for the screen, cursor and blinking. The code 00001000

```

100 PRINT"MESSAGE MAKER 21JAN90":DRT=59459:OUT=59471:DN=205:UP=237:AT=59468
110 POKEOUT,0:POKEDRT,255
120 DIMC(11),A(255):C(0)=0:C(1)=16:C(10)=32:C(11)=48:GOT0240
130 REM BINARY TO DECIMAL CONVERSION
140 POKEDRT,255:J=0:C=-1:FORB=LEN(B$):T01STEP-1:C=C+1
150 D=(2^C)*VAL(MID$(B$,B,1)):J=J+D:NEXTB
160 REM EXTRACT CODES
170 E=INT(J/16):F=(J-(E*16)):PRINTC(R),E,F
180 REM SEND DATA
190 V=C(R):OREORX=W=C(R):ORF=X=0:S=S+2
200 POKEOUT,V:POKEAT,UP:POKEAT,IN:POKEOUT,W:POKEAT,UP:POKEAT,IN:RETURN
210 REM PAUSES
220 FORY=1TO1000:NEXTY:X=128:RETURN
230 FORY=1TO200:NEXTY:X=64:RETURN
240 PRINT"INITIALISE":R=0:B$="00110011":GOSUB130
250 PRINT"SET FOR 4-BIT OPERATION":GOSUB190:R=0:B$="00110010":GOSUB130
260 PRINT"FUNCTION SET, 2 LINES":R=0:B$="00101100":GOSUB130
270 PRINT"SET DISPLAY OFF, CURSOR OFF, BLINK OFF":R=0:B$="00001000":GOSUB130
280 PRINT"DISPLAY CLEAR":R=0:B$="00000001":GOSUB130
290 PRINT"ENTRY MODE SET":R=0:B$="00000110":GOSUB130
300 PRINT"RETURN HOME - CURSOR AND DD RAM TO ZERO":R=0:B$="00000010":GOSUB130
310 REM ... END INITIALISATION ...
320 PRINT"SET DISPLAY ON, CURSOR ON, BLINKING OFF":R=0:B$="00001110":GOSUB130
330 PRINT"DISPLAY DATA AT RAM ADDRESS ZERO":R=10:B$="00110000":GOSUB130
340 PRINT"CONVERT LAST CHARACTER INTO DECIMAL":M=E*16+F
350 PRINT"CHANGE DD RAM ADDRESS":R=0:B$="10000011":GOSUB130
360 PRINT"INCREMENT CHARACTER AND ADDRESS 20 TIMES"
370 R=10:J=M:FORA=1TO20:J=J+1:GOSUB170:NEXTA
380 PRINT"REVERSE DISPLAY IN 16 STEPS"
390 R=0:B$="00011000":GOSUB130:FORA=1TO15:GOSUB190:GOSUB230:NEXTA
400 PRINT"FORWARD DISPLAY IN 10 STEPS"
410 R=0:B$="00011100":GOSUB130:FORA=1TO9:GOSUB190:GOSUB230:NEXTA
420 PRINT"RETURN HOME":R=0:B$="00000010":GOSUB130
430 PRINT"CHANGE DD RAM ADDRESS TO LINE 2":R=0:B$="11000000":GOSUB130
440 J=96:REM CHANGE CHARACTER
450 PRINT"INCREMENT CHARACTER AND ADDRESS 20 TIMES"
460 R=10:FORA=1TO20:J=J+1:GOSUB170:NEXTA:GOSUB230
470 PRINT"REVERSE DISPLAY IN 20 STEPS"
480 R=0:B$="00011000":GOSUB130:FORA=1TO19:GOSUB190:GOSUB230:NEXTA:GOSUB230
490 PRINT"RETURN HOME":R=0:B$="00000010":GOSUB130:GOSUB230
500 PRINT"BLANK BOTH LINES":R=10:J=32:GOSUB170:FORA=1TO39:GOSUB190:NEXTA
510 R=0:B$="11000000":GOSUB130:REM LINE 2
520 R=10:J=32:GOSUB170:FORA=1TO39:GOSUB190:NEXTA
530 PRINT"DISPLAY SPECIFIC MESSAGE"
540 B$(1)="READ PRACTICAL ELECTRONICS EVERY MONTH!"
550 B$(2)=" AT ONLY $1.50 IT'S GOOD 1990'S VALUE!"
560 FORA=1TOLEN(B$(1)):R=0:J=127+A:GOSUB170:REM LINE 1
570 R=10:J=ASC(MID$(B$(1),A,1)):GOSUB170:REM CHARACTER
580 R=0:J=191+A:GOSUB170:REM LINE 2
590 R=10:J=ASC(MID$(B$(2),A,1))
600 IFJ=36THENJ=7:REM CHANGE SYMBOL TO NEW ONE (ONCE PROGRAMMED)
610 GOSUB170:IFA=7THENR=0:J=24:GOSUB170:REM LEFT SHIFT
620 NEXTA:GOSUB230
630 PRINT"DISPLAY LOOP"
640 B=LEN(B$(1)):R=0:J=24:GOSUB170:FORA=1TOB:GOSUB190:GOSUB230:NEXTA
650 PRINT"FLASH DISPLAY"
660 FORA=1TO3:R=0:B$="00001000":GOSUB130:GOSUB230:REM BLANK DISPLAY
670 R=0:B$="00001100":GOSUB130:GOSUB230:REM SHOW DISPLAY
680 NEXTA:GOSUB230
690 R=0:B$="10000000":GOSUB130:REM SET DD RAM ADDRESS TO ZERO
700 PRINT"BLANK BOTH LINES":R=10:J=32:GOSUB170:FORA=1TO39:GOSUB190:NEXTA
710 R=0:B$="11000000":GOSUB130:REM LINE 2
720 R=10:J=32:GOSUB170:FORA=1TO39:GOSUB190:NEXTA
730 PRINT"RETURN HOME":R=0:J=2:GOSUB170
740 PRINT"CHANGE CG RAM CONTENTS"
750 DATA1111,1000,1000,1000,1000,1000,1000,1111:REM NEW SYMBOL 0
760 DATA1111,0001,0001,0001,0001,0001,0001,1111:REM NEW SYMBOL 1
770 DATA1000,1000,1000,1000,1000,1000,1000,1111:REM NEW SYMBOL 2
780 DATA0001,0001,0001,0001,0001,0001,1111,0000:REM NEW SYMBOL 3
790 DATA1111,0000,0000,0000,0000,0000,0000,1111:REM NEW SYMBOL 4
800 DATA0000,0000,0000,0000,0000,0000,1111,0000:REM NEW SYMBOL 5
810 DATA1111,0000,0010,0110,0100,0000,0000,1111:REM NEW SYMBOL 6
820 DATA0010,0100,0100,1100,0100,0100,1111,0000:REM NEW SYMBOL 7
830 PRINT"SEND NEW SYMBOLS TO CG RAM"
840 FORP=0TO7:R=0:J=P*8+64:GOSUB170:REM SET SG RAM ADDRESS
850 R=10:FORA=0TO7:READB$:GOSUB130:NEXTA
860 R=0:J=P+128:GOSUB170:REM SET DISPLAY ADDRESS
870 R=10:J=P:GOSUB170:REM DISPLAY NEW SYMBOL
880 NEXTP
890 PRINT"DISPLAY NEW SYMBOLS AS PATTERN SET IN A$":A$="0464646127575753"
900 R=0:B$="10000000":GOSUB130:REM SET ADDRESS LINE 1
910 FORA=0TO15:IFA=8THENR=0:J=192:GOSUB170:REM SET ADDRESS LINE 2
920 R=10:J=VAL(MID$(A$,A+1,1)):GOSUB170:NEXTA:GOSUB220:REM SEND CHARACTER
930 PRINT"DISPLAY CLEAR":R=0:B$="00000001":GOSUB130
940 F=192:GOSUB190:STOP:REM SET RESET MARKER AT END
950 :
960 :
970 :
980 :
990 :
1000 PRINT"DISPLAY FULL SYMBOL SET WITH CODE NUMBERS"
1010 R=0:B$="10000000":GOSUB130:GOSUB220:REM SET FUNCTION
1020 FORA=0TO255:B$=RIGHT$(" "+STR$(A)+",",4):R=0:E=0:F=2:GOSUB190:REM HOME
1030 R=10:FORB=1TO4:J=ASC(MID$(B$,B,1)):GOSUB170:NEXTB:REM SEND NUMBER
1040 J=A:GOSUB170:REM SEND SYMBOL
1050 GOSUB230:NEXTA
1060 :
1070 :
1080 :
1090 :
1100 PRINT"SET AND DISPLAY AS SINGLE LINE 5X7 DOTS"
1110 R=0:B$="00100000":GOSUB130:GOSUB220:REM SET FUNCTION
1120 PRINT"SET AND DISPLAY AS SINGLE LINE 5 X 10 DOTS"
1130 R=0:B$="00100100":GOSUB130:GOSUB220:REM SET FUNCTION
1140 PRINT"RETURN TO DOUBLE LINE DISPLAY OF 5 X 7 DOTS"
1150 R=0:B$="00101100":GOSUB130:REM SET FUNCTION
1160 R=0:B$="00001100":GOSUB130:REM BLANK CURSOR
READY.

```

Fig 3. Experimental software listing.

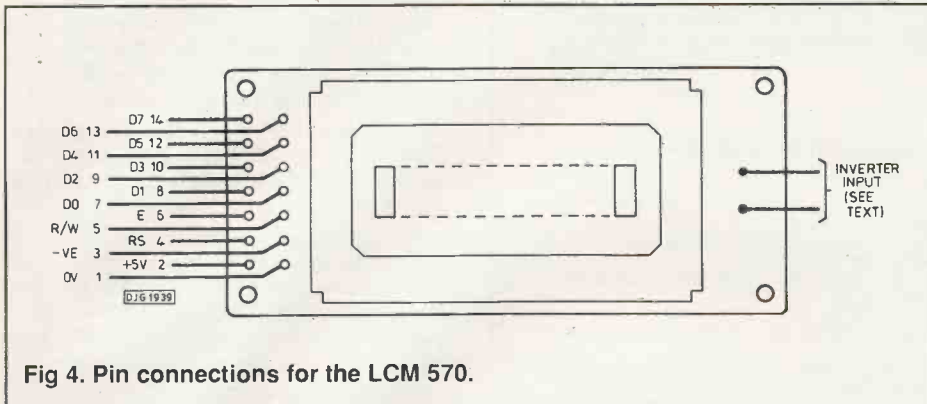


Fig 4. Pin connections for the LCM 570.

sets them all off. In line 280 the display is cleared using code 00000001. 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 00000010, 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.)

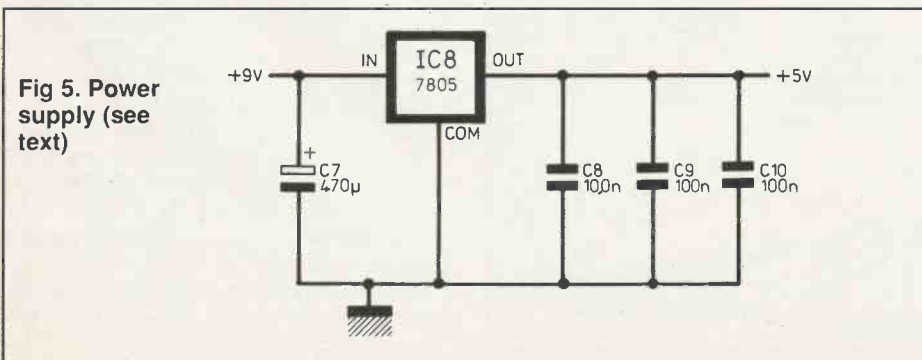


Fig 5. Power supply (see text)

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 100n polyester (5 off)
C3, C5 1µ 16V elect (2 off)
C4 4µ7 16V elect
C6 1n polystyrene
C7 470µ 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)eeprom using an (e)eeprom programmer (of which PE has published several examples recently), and then to insert the (e)eeprom into the unit. (Note that only eeproms can be directly programmed while in the Message Maker.)

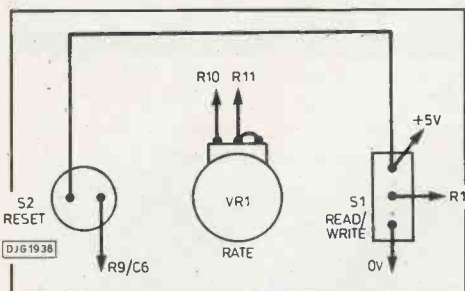


Fig 6. Control wiring details.

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.

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

CHAR	x	LINES	BACK LIT	CODE
16	x	1	EL	585-012
16	x	2	EL	585-028
24	x	2	EL	585-034
40	x	2	EL	585-040
40	x	4	EL	585-056
8	x	2	LED	585-084
16	x	1	LED	585-090
16	x	2	LED	585-107
24	x	2	LED	585-113
40	x	2	LED	585-129

Do not use the other modules with the Message Maker without first consulting RS data sheet 9811. Note the difference in V0

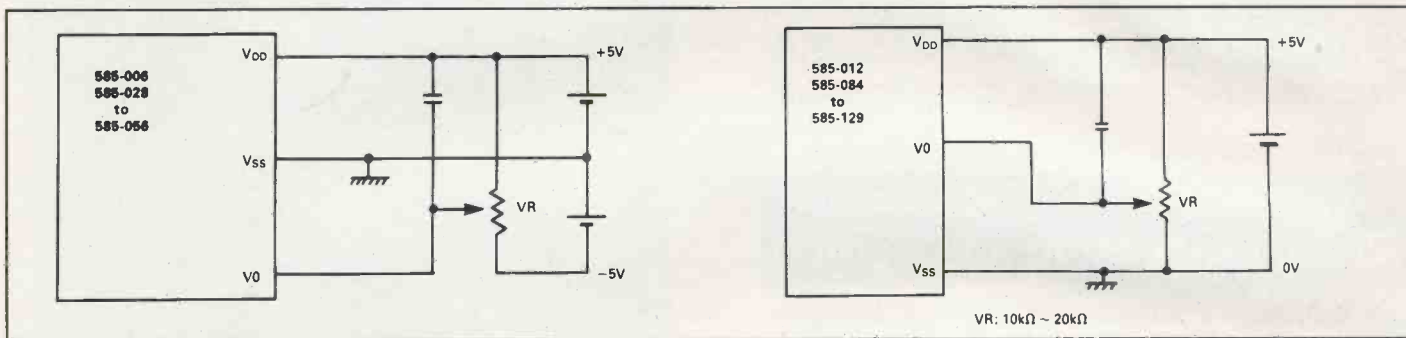
drive for some modules, as in Fig.7. The optional backlight inverter for module 585-056 is coded 585-078, but the other EL modules can all use the 585-062 inverter. The led backlit modules do not need an inverter.

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 lcd module can be initialised and controlled.

PE

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.



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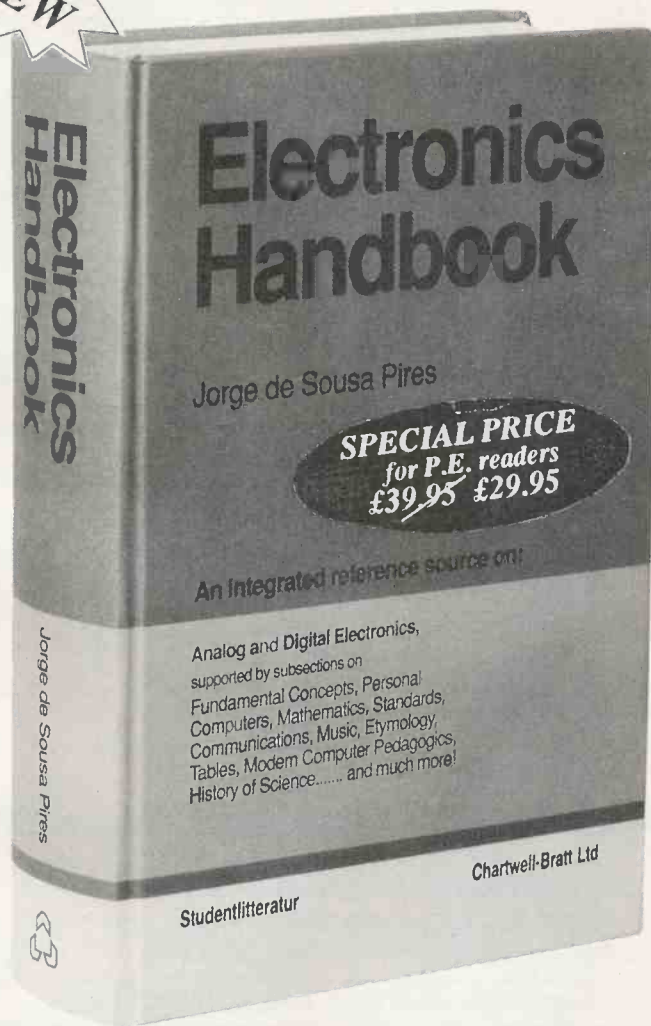
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Last month we looked at conduction in semiconductors. We saw that there are two types of semiconductors:

- * 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 p-type semiconductor adjoins 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*

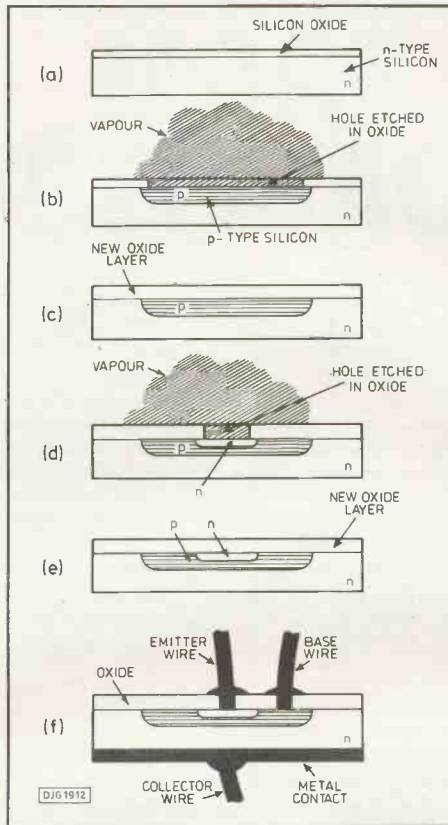


Fig 2. Stages in making an npn silicon transistor.

continuous layer of oxide is then formed over the slice (c). A similar hole is made in this. The slice is then exposed to the vapour of an element which has 5 electrons in its outer shell, 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

You need: battery box (6V)

R1 22k

R2 180 ohms

D1 TIL209 or similar light-emitting diode

TR1 ZTX300 npn junction transistor

testmeter, breadboard

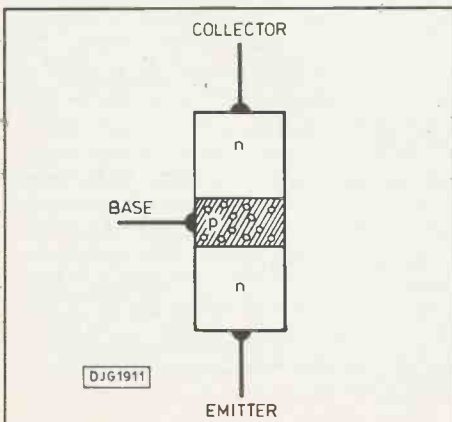
BASIC ELECTRONICS

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.

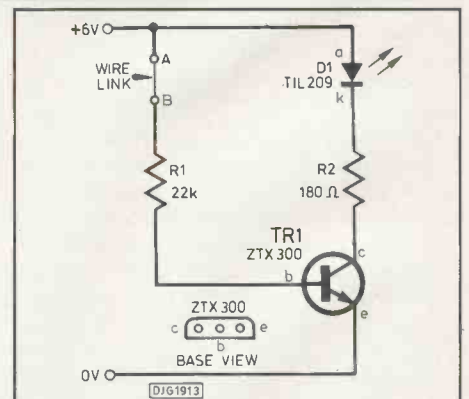
Fig 1. Simplified structured of a transistor.



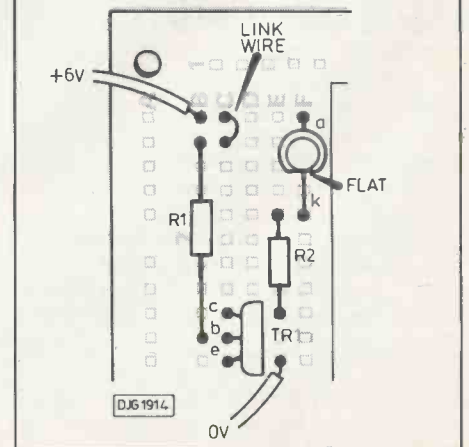
By Owen Bishop
Part 6 - Transistors.
The current goes one way, the electrons go the other, and the holes don't move at all - they just change place. This is a PN junction.

MAKING A TRANSISTOR

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 produce 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 only three electrons in its outer shell, such as boron. The boron atoms diffuse a little way into the silicon. The silicon is already n-type, so we have to diffuse enough boron into it so that there are, on balance, more holes than free electrons. The overall effect is to form p-type silicon (b). A



Figs 3 and 4. Circuit and layout for Investigation 1.



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?

Add the 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 light?

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 little more than 0.6V, which is a typical value for the forward voltage drop of a diode.

Now for the problem. We also found that a relatively large current flows *into* the collector terminal of the transistor. Yet this would have to flow through a *reverse-biased* diode. It seems difficult to understand how this could possibly happen. Fig.5c gives more detail about what is going on. One really important point that the diagrams do *not* make clear is that the p-type layer in a transistor is *very thin*. When the transistor is operating as in Investigation 1, there is a small voltage (or *potential difference*, pd) across the base and emitter. The base-emitter pn junction is forward biased. The pd, which has to be a little over 0.6V to overcome the in-built cell of the pn junction, causes a current to enter the base. We call this the base current, symbol I_B .

When we speak of current *entering* the base, we are referring to conventional current. What really happens is that electrons *leave* the base. These come from the lattice of the p-type material and, as each electron leaves the base, a hole is created. The base current now consists of holes flowing in the p-type material toward the base-emitter junction. At the

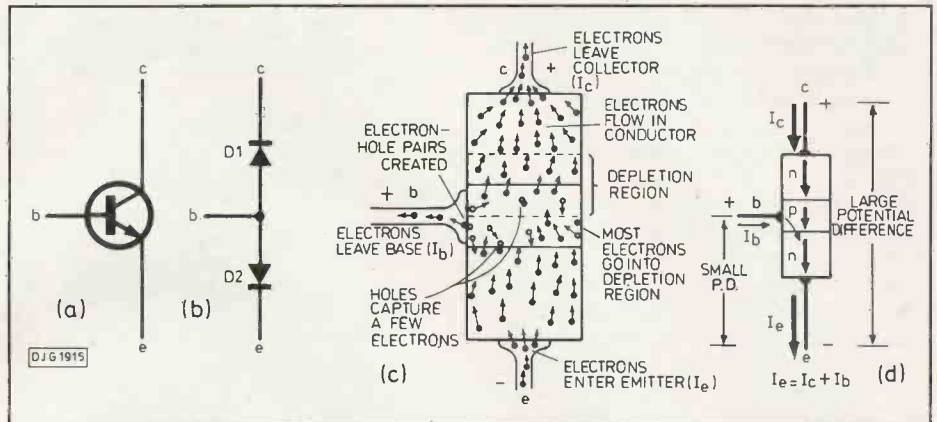


Fig 5. The action of an npn transistor: (a) symbol; (b) equivalent pair of diodes; (c) motion of charge carriers; (d) currents through a transistor.

junction, the holes are filled with electrons that have come from the emitter. The electrons have come through the emitter from the external circuit, as the *emitter current*, I_E . So far, everything we have described is perfectly normal for flow across a forward biased pn junction.

Now we look at the base-collector junction. There is a higher pd across this than across the base-emitter junction. In Investigation 1 the pd was about 5.4V (6V - 0.6V). The collector-base junction is *reverse biased* and the depletion region on either side of it is wide. As electrons enter the base from the emitter, only a few of them are captured by the holes of the base current. This is because the base material is only lightly doped, so there are few holes in it. Most of the electrons from the emitter pass into the depletion region of the collector-base junction. This is aided by the fact that the base layer is so thin that the wide depletion region extends well into it. The electrons entering the depletion region extend well into it. The electrons entering the depletion region find themselves in the field of the in-built cell of that junction. This field accelerates the electrons across the junction into the collector. From there they pass through the collector, attracted toward the positive potential of the collector terminal. They flow out of the collector into the external circuit forming the *collector current*, I_C .

In a typical transistor, of every 100 electrons leaving the emitter, only one becomes captured by a hole in the base region. The other 99 electrons move into the depletion region and become the collector current. But this action of the 99 electrons can only occur if there is a base current - without a base current there would be no electrons coming from the emitter. In this way a very small base current I_B allows a much larger (about 100 times larger) collector current I_C to flow through the transistor:

I_C is much larger than I_B .

The size of the base current determines how many electrons flow through the emitter. This determines how many electrons enter the depletion region and then flow into the collector. In other words:

The size of I_C depends on the size of I_B .

In Investigation 1 we simply switched I_B

on or off so were not concerned with variations in its size. This is the subject of an investigation which appears in a future part.

The electrons entering the emitter go either to the base or to the collector. The emitter current I_E is therefore the sum of the base current and collector currents:

$$I_E = I_B + I_C$$

Since the base current is relatively small, it is usually accurate enough to write:

$$I_E = I_C$$

Summing up: In a transistor we use a small current, the base current, to control the strength of a much larger current, the collector current. The transistor behaves as if it is a variable resistor with collector current flowing 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*.

THERMAL RUNWAY

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 this too. The current flows through the base and then through the base-emitter junction to the emitter. This current becomes added to any current that is already flowing from base to emitter. Leakage current is small - only a few microamps - so in itself does no harm. But once it is in the base region and flowing to the emitter, it has exactly the same effect as ordinary base current. It causes a much larger collector current to flow. The leakage current may be small but it results in an additional collector current a hundred or more times greater flowing through the transistor. This causes the transistor to become warmer and, since the higher temperature causes more minority charge carriers to be generated in the transistor, the leakage current increases. This causes even further and larger increases in the collector current. This runaway effect increases the collector current more and more until the transistor becomes so hot that it is damaged or destroyed. The effect is called *thermal runaway*.

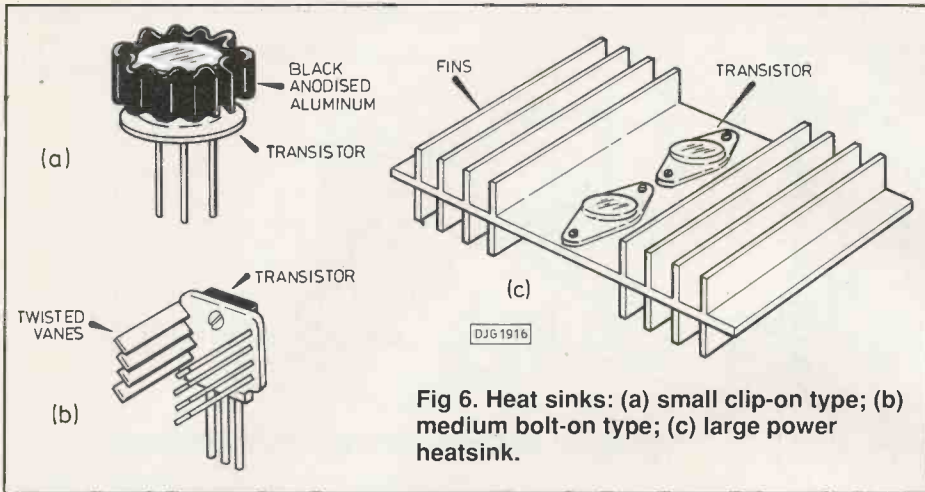


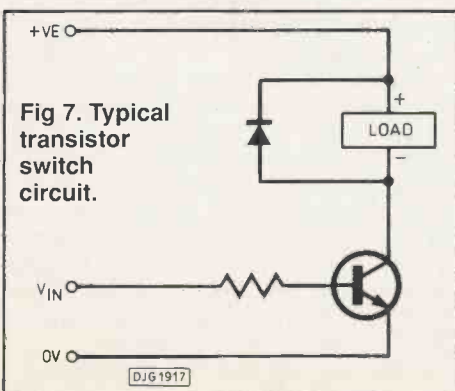
Fig 6. Heat sinks: (a) small clip-on type; (b) medium bolt-on type; (c) large power heatsink.

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 vanes of 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).



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 large 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 4k7

R2 180 ohms

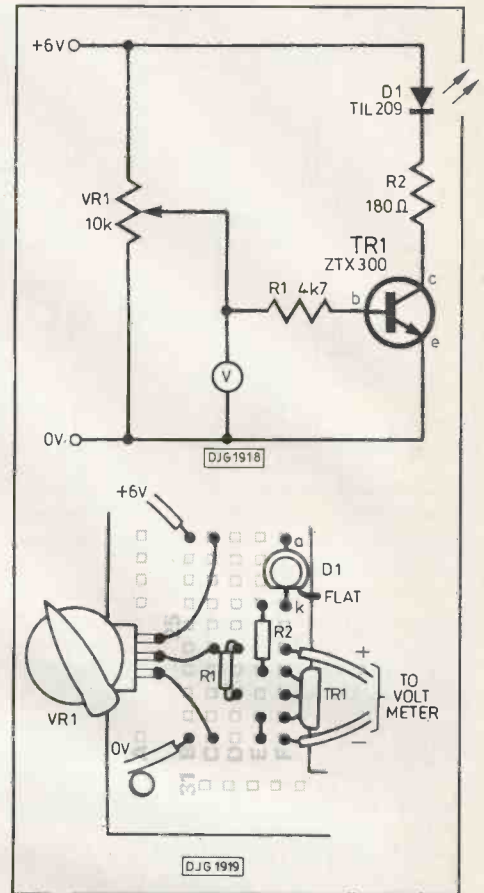
VR1 10k potentiometer (eg Module 3)

D1 TIL209 or similar light-emitting diode

TR1 ZTX300 npn junction transistor

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



Figs 8 and 9. Circuit and layout for Investigation 2.

VR1, which is a potential divider. The testmeter is set to a voltage range to measure V_{IN} .

Turn VR1 so that V_{IN} is zero. The transistor is off and the led is not lit. Slowly turn VR1 to increase the voltage. Watch the led. When you see the first glimmer of light, stop turning VR1. This is the 'just on' value of V_{IN} . Make a note of this too.

Try to put into words what has happened in this investigation.

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

You need: battery box (6V)

R1, R3 4k7 (2 off)

R2 1k

R4 180 ohms

R5 100 ohms

VR1 10k potentiometer (eg Module 3)

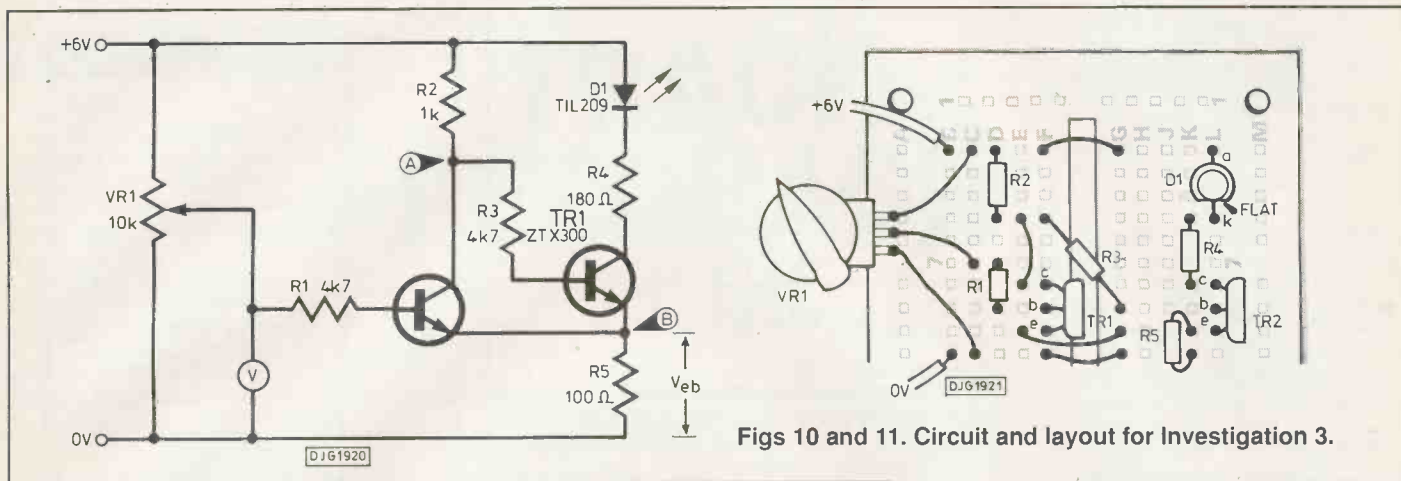
D1 TIL209 or similar light-emitting diode

TR1, TR2 ZTX300 npn junction transistor (2 off)

testmeter

Set up the circuit of Fig.10, as in Fig.11. The left-hand side of this circuit is like Fig.8, except that we have a 1k resistor instead of the load. Also the emitter of TR1 is connected to the emitter resistor (R5) of TR2. The right-hand side of this circuit is also like Fig.8, except that it takes its input from point A instead of from a potential divider. Also the emitter is not directly connected to 0V, but through the emitter resistor R5.

Turn VR1 so that V_{IN} is zero. TR1 is off, TR2 is on and the led is lit. Slowly turn VR1



Figs 10 and 11. Circuit and layout for Investigation 3.

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 lamp 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 it so as to measure V_{ER} , the voltage across the emitter resistor R5. Repeat the investigation, noting the value of V_{ER} 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 along R1 and R3, turning TR2 on. A collector current flows in TR2, lighting the led. The emitter current from TR2 goes through R5. V_{ER} is 1.6V. This shows that the current through R5 is $1.6/100 = 16mA$. This is I_E , which is virtually the same as I_C , the current through the led.

At this stage, the voltage at point B is 1.6V. This means that the emitter voltage of TR1 is also 1.6V. Owing to the forward voltage drop across its base-emitter junction, its base must be at $1.6 + 0.6 = 2.2V$.

Increasing V_{IN} : because its base is already at 2.2V, no current can flow to TR1 until the voltage at its base exceeds 2.2V. As soon as VR1 is turned enough to make V_{IN} equal to

2.2V, 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 out.

At this stage V_{ER} 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, 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.

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 falls, 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 RESISTORS

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 off, 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 on, a large current flows through R2. A large voltage develops across it. The voltage at point A falls to about 1V.

DISCUSSION

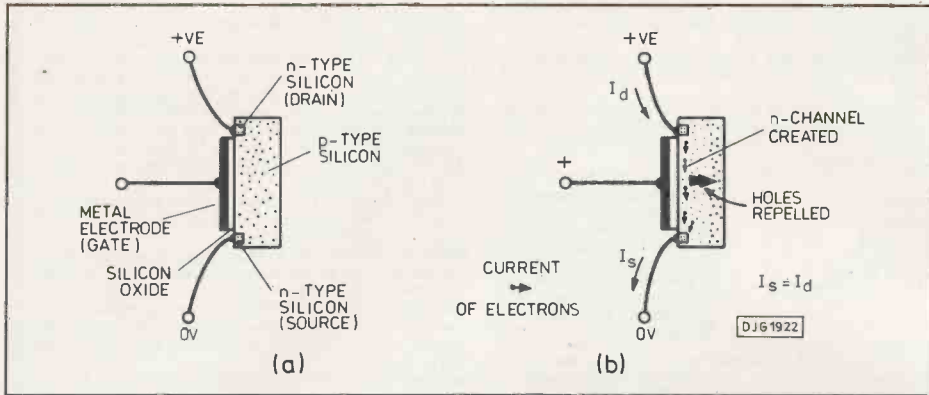


Fig 12. Action of an N-channel enhancement mosfet: (a) with no bias; (b) with gate positively biased.

MOSFETS

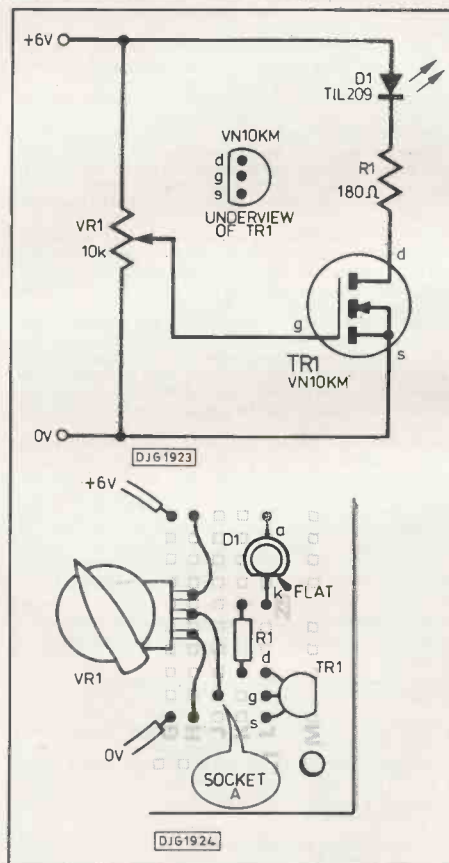
These are another type of transistor, working in an entirely different way. Mosfet stands for *metal oxide silicon field effect transistor*. There are several versions of the mosfet theme, of which one is shown in Fig.12. The transistor consists of a bar of p-type silicon, with a small n-type region 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 unfilled. 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 (I_D) to source (I_S). 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)
- R1 180
- VR1 10k potentiometer (Module 3)
- D1 TIL209 or similar light emitting diode
- TR1 VN10KM n-channel enhancement mosfet
- testmeter



Figs 13 and 14. Circuit and layout for Investigation 4.

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.

Explain what is happening.
Keep the circuit made up for the next investigation.

Investigation 1: 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_B 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_B and I_C increase, and the led becomes brighter until the led is fully bright at about 1.6V. Above this voltage, I_B 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.

Next month we'll look at other mosfets and have some modules for you.



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All packs are £1 each. Note the figure on the extreme left of the pack ref number and the next figure is the quantity of items in the pack, finally a short description.

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- BD13 12 30 watt reed switches, it's surprising what you can make with these - burglar alarms, secret switches, relay, etc., etc.
- BD22 2 25 watt loudspeaker two unit crossovers.
- BD30 2 Nicad constant current chargers adapt to charge almost any nicad battery.
- BD32 2 Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.
- BD42 5 13A rocker switch three tags so on/off, or change over with centre off.
- BD45 1 24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day, original cost £40 each.
- BD49 5 Neon valves, with series resistor, these make good night lights.
- BD56 1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse to motor, moves switch through one pole.
- BD67 1 Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
- BD103A 1 6V 750mA power supply, nicely cased with mains input and 6V output leads.
- BD120 2 Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
- BD128 10 Very fine drills for pcb boards etc. Normal cost about 80p each.
- BD132 2 Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
- BD134 10 Motors for model aeroplanes, spin to start so needs no switch.
- BD139 6 Microphone Inserts - magnetic 400 ohm also act as speakers.
- BD148 4 Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.
- BD149 6 Safety cover for 13A sockets - prevent those inquisitive little fingers getting nasty shocks.
- BD180 6 Neon indicators in panel mounting holders with lens.
- BD193 6 5 amp 3 pin flush mounting sockets make a low cost disco panel.
- BD199 1 Mains solenoid, very powerful, has tin pull or could push if modified.
- BD201 8 Keyboard switches - made for computers but have many other applications.
- BD211 1 Electric clock, mains operated, put this in a box and you need never be late.
- BD221 5 12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
- BD252 1 Panostat, controls output of boiling ring from simmer up boil.
- BD259 50 Leads with push-on 1/4in tags - a must for hook-ups - mains connections etc.
- BD263 2 Oblong push switches for bell or chimes, these can mount up to 5 amps so could be foot switch if fitted to patress.
- BD268 1 Mini 1 watt amp for record player. Will also change speed of record player motor.
- BD283 3 Mild steel boxes approx 3in x 3in x 1in deep - standard electrical.
- BD305 1 Tubular dynamic mic with optional table rest.
- BD653 2 Miniature driver transformers. Ref. LT44, 20k to 1k centre tapped.
- BD548 2 3.5V relays each with 2 pairs changeover contacts.
- BD667 2 4.7V of non-polarised block capacitors, pcb mounting.

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REMOTE CONTROL FOR YOUR COMPUTER With this outfit you can be as much as 20 feet away as you will have a joystick that can transmit and a receiver to plug into and operate your computer and TV. This is also just right if you want to use it with a big screen TV. The joystick has two fire buttons and is of a really superior quality, with four suction cups for additional control and one handed play. Price £15 for the radio controlled pair. Our ref 15P27.

ASTEC PSU. Mains operated switch mode, so very compact. Outputs +12V 2.5A, +5V 6A, -5V .5A, +12V 5A. Size: 7.5in long x 4.75in wide x 2.25in high. Cased ready for use. Brand new. Normal price £30+, our price only £12.95. Order ref 13P22.

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ORGAN MASTER is a three octave musical keyboard. It is beautifully made, has full size (piano size) keys, has gold plated contacts and is complete with ribbon cable and edge connector. Can be used with many computers, request information sheet. Brand new, only £15 plus £3 postage. Our ref 15P15.

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POPULAR ITEMS - MANY NEW THIS MONTH

JOYSTICKS for BBC, Atari, Dragon Commodore, etc. All £5.00 each. All brand new, state which required.

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REMOTE TEMPERATURE PROBE FOR ABOVE. £3.00. Our ref. 3P60.

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SPECTRUM PRINTER INTERFACE Add aronics interface to your Spectrum complete with printer cable for only £4.00. Our ref. 4P52.

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MAINS SOLDERING IRON Price £3.00. Our ref. 3P65.

SOLDERING IRON STAND Price £3.00. Our ref. 3P66.

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NEW PANEL METERS 50uA movement with three different scales that are brought into view with a lever. Price only £3.00. Ref. 3P81.

STROBE LIGHTS Fit a standard edition screw light fitting 240V 40/min. flash rate available in yellow, blue, green and red. Complete with socket. Price £10 each. Ref. 10P80 (state colour required).

EXTENSION CABLE WITH A DIFFERENCE It is flat on one side making it easy to fix and look tidy. 4 core, suitable for alarms, phones etc. Our price only £5.00 for 50m reel. Ref. 5P153.

METAL PROJECT BOX Ideal for battery charger, power supply etc. Sprayed grey size 8in x 4in x 4.5in. Louvred for ventilation. Price £3.00. Ref. 3P75.

BAUD RATE CONVERTER

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

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 (1.2kHz 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 19.2kHz. Similarly, the Q12 output from IC1 drives the transmit clock at 1.2kHz.

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 (DR) 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

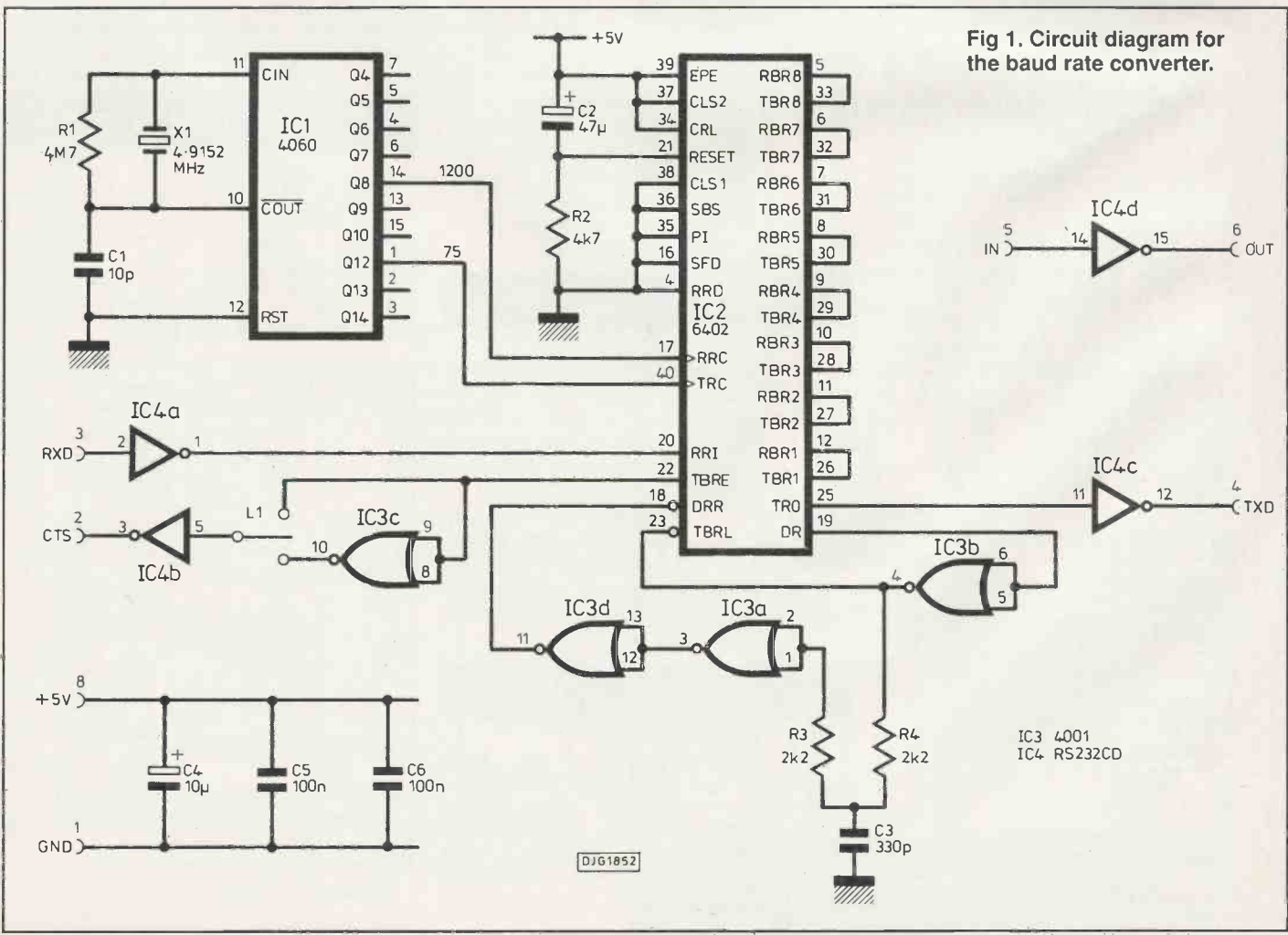
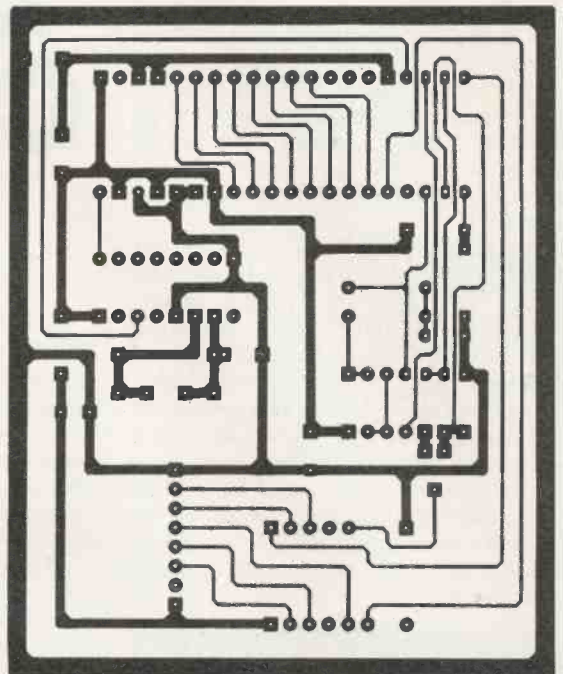
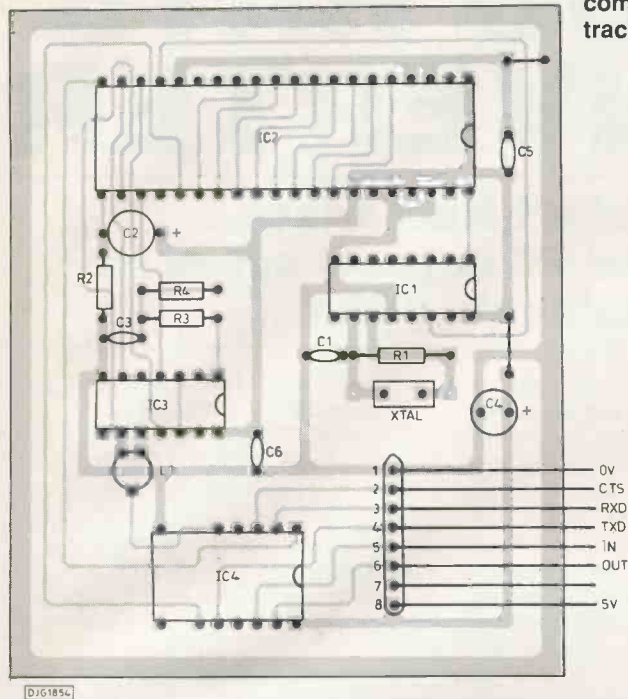


Fig 1. Circuit diagram for the baud rate converter.

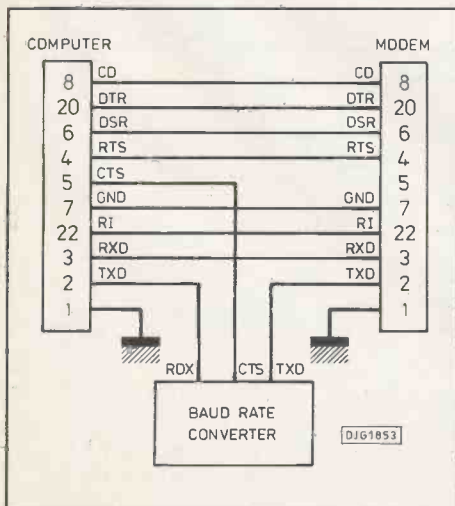
Fig 2. PCB component and track layouts.



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 an 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.

CONNECTION

The standard 25-way D-type serial connector is used as input and output to the baud rate converted circuit with all major modem connections being looped through. The TXD input of the modem and the CTS signal from the board must be connected to the CTS of the computer as shown in Fig. 3.

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.

PE

COMPONENTS

RESISTORS

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

All 0.25W 5% carbon or better

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	IM6402 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.

COMPUTER ICs

Table listing computer ICs such as 80C31 MICRO, 8086 processor, and various ICs with prices.

REGULATORS

Table listing regulators like LM317T PLASTIC and LM338 5A VARIABLE.

CRYSTAL OSCILLATOR

1.8342 MHz £1 each

CRYSTALS

2.7 MHz/4.000 MHz/4.9152 MHz/20 MHz/49.504 MHz, 8M, 16.588M

TRANSISTORS

Table listing transistors like BC107, BCY70, BC548B, BC238C, BC308B.

POWER TRANSISTORS

Table listing power transistors like N POWER FET, TIP35B, TIP35C.

QUARTZ HALOGEN LAMPS

Table listing quartz halogen lamps like A1/216 24V 150 WATTS.

TEXT WOLF SKT

Table listing text wolf skt components.

CAPACITORS COMPUTER GRADE

Table listing computer grade capacitors like 3300uF, 2200uF.

TURNS COUNTING DIALS

Table listing turns counting dials with various specifications.

MISCELLANEOUS

Table listing miscellaneous items like MAINS ADAPTOR, SLOPING FRONT PLASTIC CASE.

Table listing various electronic components like TO-220 HEAT SINK, SMALL MICROWAVE DIODES, D.I.L. SWITCHES.

Table listing more electronic components like HALL EFFECT IC, OSCILLOSCOPE PROBE, CHEAP PHONO PLUGS.

Table listing more electronic components like TO-220 MICAS, POTENTIOMETERS, DIODES AND RECTIFIERS.

Table listing SCRS, TRIACS, DIACS, TRANSFORMERS, and other components.

Table listing more electronic components like PULSE TRANSFORMERS, TRIACS, DIACS.

CONNECTORS

Table listing connectors like D25 IDC SOCKET, 34 way card edge, CENTRONICS 36 WAY.

USED D CONNECTORS price per pair

D9 60p, D15 £1.50, D25 £2, D37 £2, D50 £3.50 covers 80p ea.

WIRE WOUND RESISTORS

Table listing wire wound resistors like W21, W22, W23, W24.

PHOTO DEVICES

Table listing photo devices like SLOTTED OPTO-SWITCH, LEDs, PHOTO DIODE.

STC NTC BEAD THERMISTORS

Table listing Stc ntc bead thermistors like G22, G23, G24, G25.

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IC SOCKETS

Table listing ic sockets like 6 pin 15/£1 8 pin 12/£1 14/16 pin 10/£1 18/20 pin 7/£1.

SOLID STATE RELAYS

Table listing solid state relays like 40A 250V AC SOLID STATE RELAYS.

POLYESTER/POLYCARB CAPS

Table listing polyester/polycarb caps like 100n, 220n, 63v 5mm.

RF BITS

MINIATURE CO-AX 50u URM95 100m/£12

Table listing rf bits and trimmer caps.

MINIATURE RELAYS

Table listing miniature relays like 5 volt coil 1 pole changeover.

MONOLITHIC CERAMIC CAPICITORS

Table listing monolithic ceramic capacitors like 10n 50v 2.5mm.

STEPPER MOTORS

Table listing stepper motors like 4 PHASE 2.9V WINDINGS.

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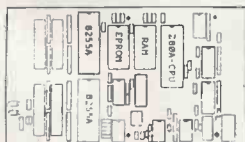
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A star feature is that no special or custom chips (ie PALs, ULAs, ASICs etc) are used — and thus there are no secrets. The Z80A is the fastest and best established of all the 8-bit microprocessors — possibly the cheapest too!

Although no serial interface is included, it is easy for a Z80A to waggle one bit up or down at the appropriate rate — the cost is a few pence worth of code in the program: why buy hardware when software will do?

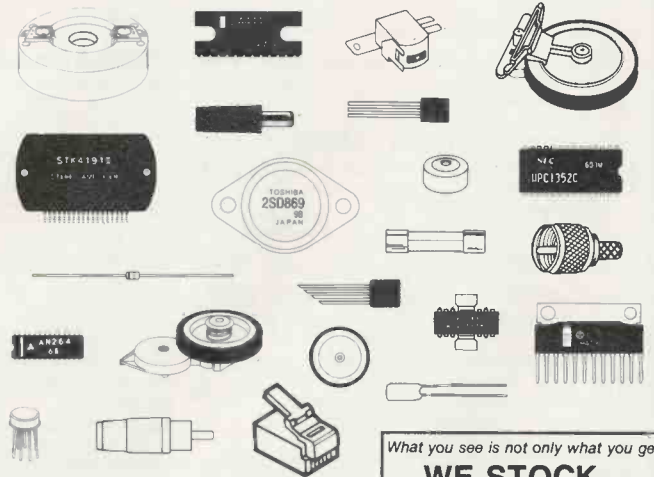
Applications already identified include: Magnetic Card reader, mini printer interface, printer buffer, push button keypad, LCD alphanumeric panel interface, 40-zone security interface for auto sending of security alarms, code converter (eg IBM PC keyboard codes to regular ASCII), real time clock (with plug in module), automatic horticultural irrigation controller.

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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

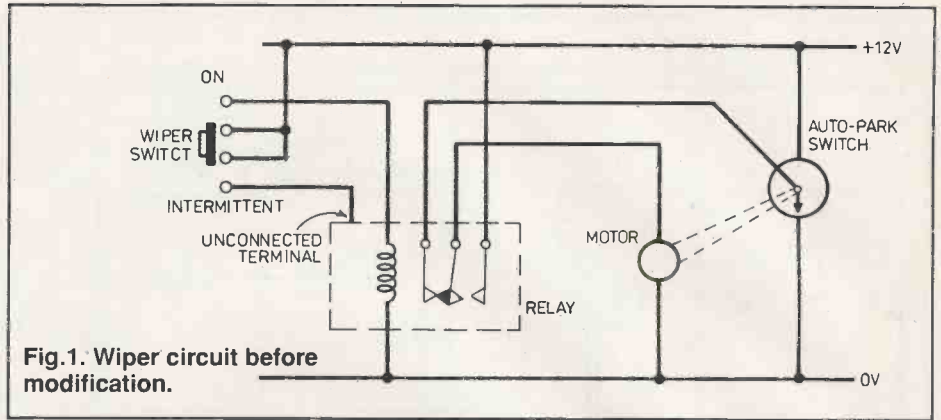


Fig. 1. Wiper circuit before modification.

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

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 pnp 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

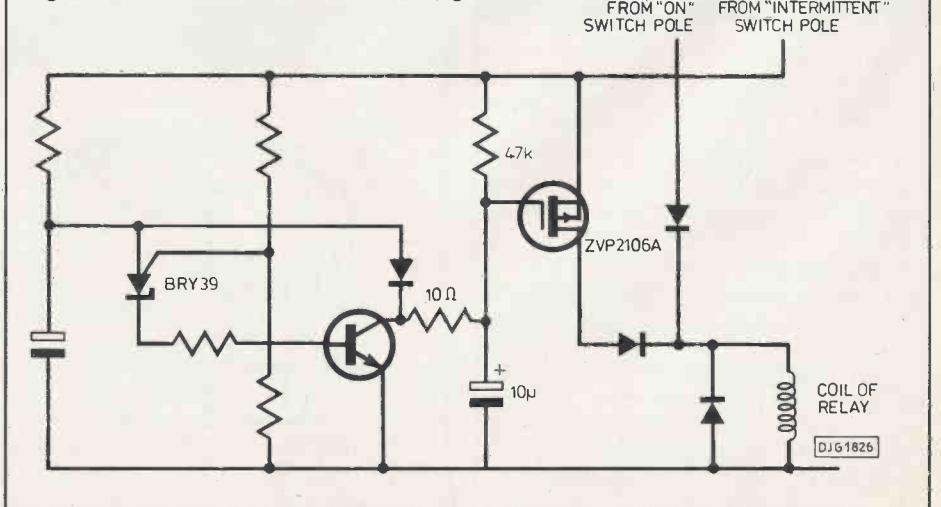
I decided on the use of simple RC time constants both for the delay time and for the hold on period for the relay, to permit the wipers to traverse part of the screen so that the automatic park circuit would operate to complete the wipe. To make the unit reliable on a car electrical system, discrete 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, and the only reason that this does not completely oppose the applied current is that mechanical and electrical losses demand a constant supply of energy. A perfect motor in a vacuum, with superconducting wire and friction free bearings, would tend asymptotically towards a speed at which the back emf balanced 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

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.

Fig 2. Initial intermittent function design.



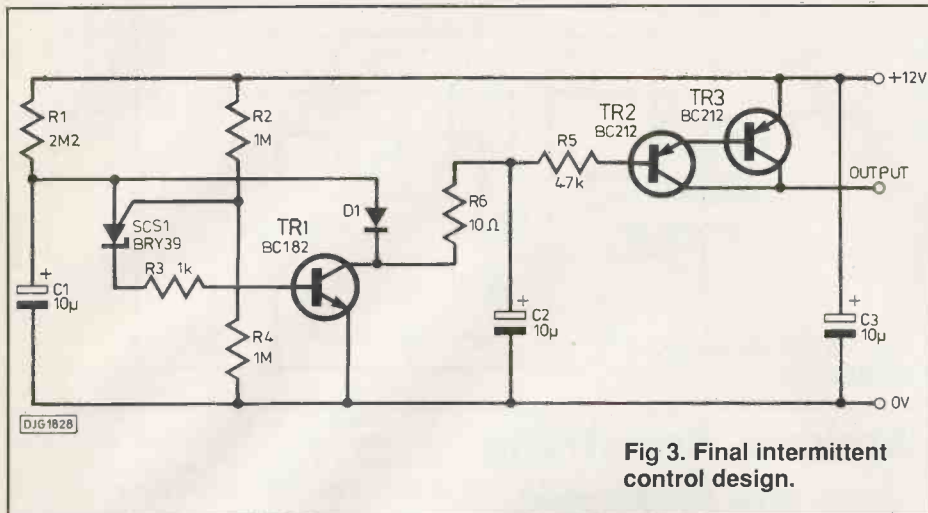


Fig 3. Final intermittent control design.

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, to 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.

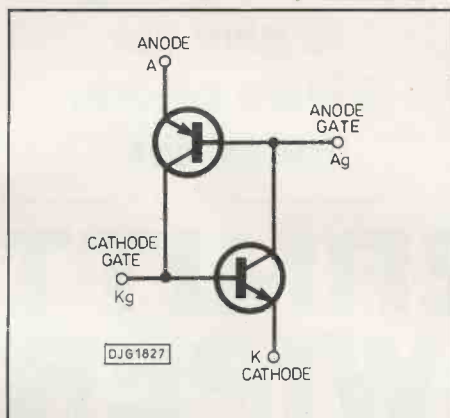


Fig 4. Equivalent transistor circuit for a silicon controlled switch device.

APPLICATION

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 to the rear wiper switch. 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 windscreen. 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.

ABOUT ASK PE

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.

PE

COMPONENTS

RESISTORS

R1	2M2
R2, R4	1M
R3	1k
R5	47k
R6	10R
All 0.25W carbon 5%	

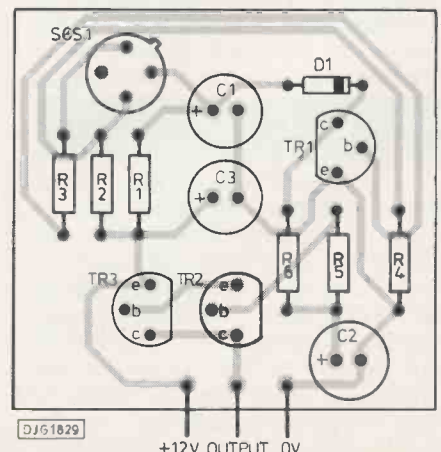
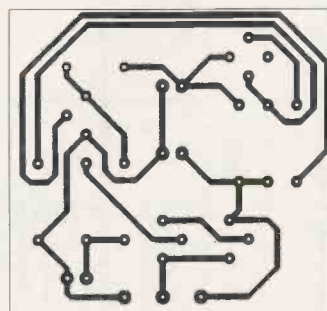
CAPACITORS

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

Fig 5. PCB track layout (lifesize), and component layout details (greater than lifesize).



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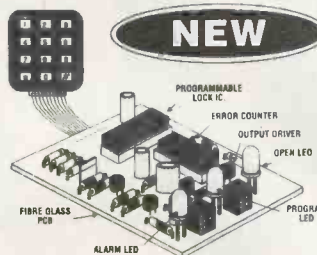
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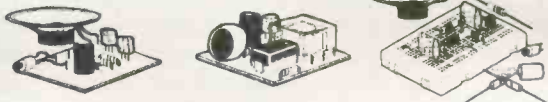
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before the alarm is triggered is selected by you. Further entries will be ignored for a time also set by you. Only the correct sequence will open the lock and switch off the alarm. The sequence may easily be changed by entering a special number and 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.
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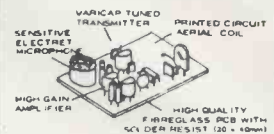
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SK2 WHISTLE SWITCH switches a relay on and off in response to whistle command **£4.50**

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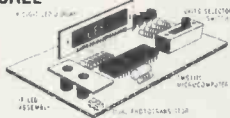
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MK18 Transmitter ... £8.95
MK9 4-way Keyboard ... £2.75
MK10 16-way Keyboard ... £7.95
601133 Box for Transmitter ... £2.95

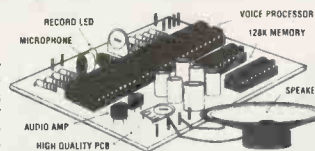
ELECTRONIC WEIGHING SCALE



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ES1 £8.25

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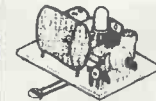
This simple to construct and even simpler to operate kit will record and playback short messages or tunes. It has many uses - seatbelt or light reminder in the car, welcome messages to visitors at home or at work, warning messages in factories and public places. In fact anywhere where a spoken message is announced and which needs to be changed from time to time. Also suitable for toys - why not convert your daughter's £8 doll to an £80 taking doll!!



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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.

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 busier 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 ic 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. (*PE*

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.

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





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 supertwist 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

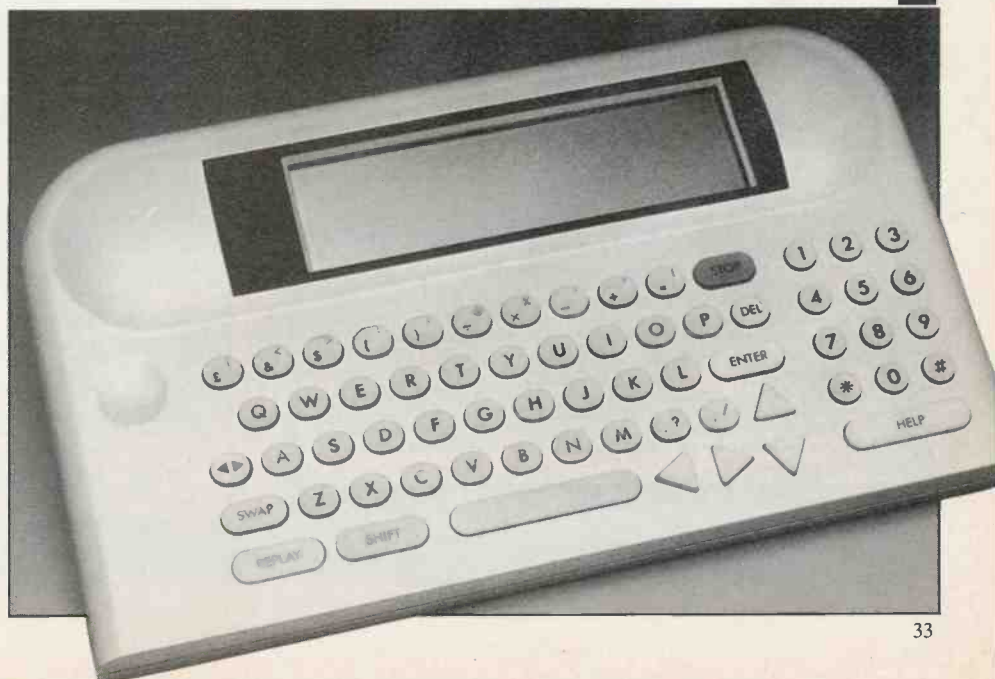
Settling bills will either be via credit card details securely entered into your terminal or via credits stored in a smartcard hence the smartcard reader. Besides buying the groceries you will be able to deal with insurance companies, bookmakers, banks and building societies, catalogue companies and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

We shall have another Home-Base feature for you next month. **PE**



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This electronic circuit breaker was designed for use mostly in an experimental environment where it is an inconvenience to keep blowing fuses all the time! Such situations may occur not necessarily as a result of bad design but simply out of carelessness due to attempting alterations while the circuit is powered up or accidentally disturbing wires on the breadboard. Not only can this be most annoying but also quite costly - a major drawback if you are on a low budget.

I decided to use a circuit breaker as a source of protection in the power supply I had built rather than use a conventional current limiting circuit. Most of the circuits I have encountered of this type limit the voltage as well, which I considered to be a disadvantage. The circuit can be set to trip out at whatever current you decide to be safe, so protecting your experimental circuit in case of errors in design or building. In the development stage it was noted that the current could be set to limit at less than 1mA, but the circuit presented has been designed to set the limits between 90mA and 1.5A.

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

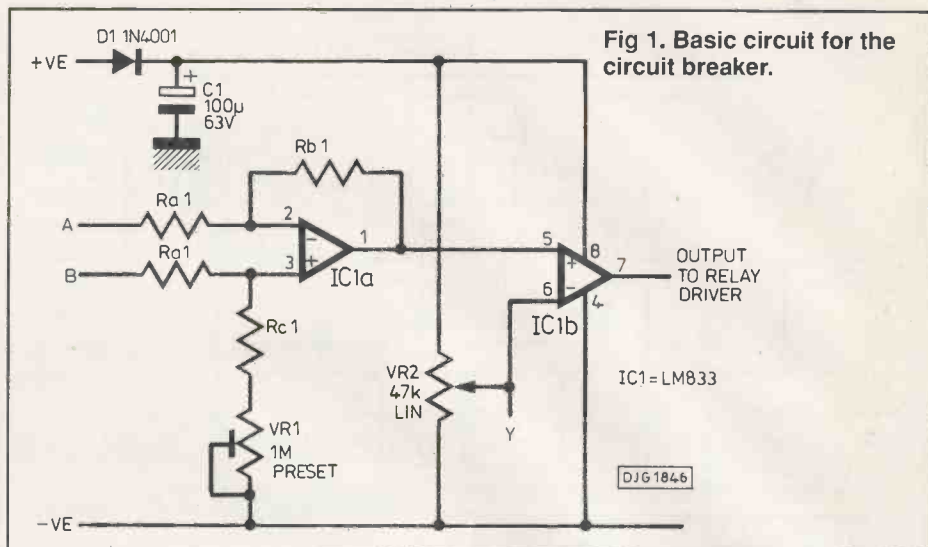


Fig 1. Basic circuit for the circuit breaker.

**Steve Bailey
makes you a
circuit offering you
can't refuse -
because it doesn't
blow any!**

is 25mV. The output is therefore just over 2V, since 2V corresponds to the 100mA mark on the meter in my own supply I use the voltage on the wiper of VR2 to display the trip level on the meter.

The amplifier output is fed into the positive input of the other half of the LM833, which is used as a voltage comparator. The other input is fed by the wiper of VR2. The comparator trip point is set so that if the amplifier output exceeds the wiper voltage, the output goes high. In Fig. 2, voltage change triggers thyristor SCR1. The scr feeds power

CIRCUIT BREAKER

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 I^2R 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 R_{a1} , R_{b1} , R_{c1} and preset VR1. The gain is set by the formulae:

$$R_{c1} = R_{b1} - 500k (\text{approx mid position of VR1})$$

$$\text{Gain} = R_{b1} / R_{a1}$$

$$V_{out} = \text{gain} * V_{drop \text{ across current sense resistor.}}$$

For a 1.5A supply a gain of approx 81 was required, so 27k was selected for R_{a1} and 2M2 for R_{b1} . 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 scr's. 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.

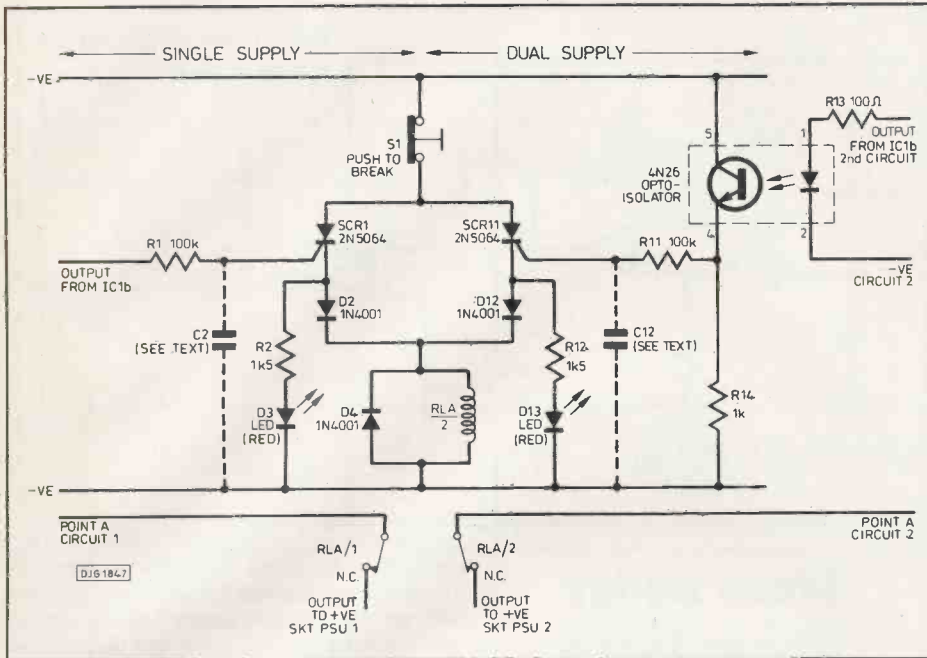
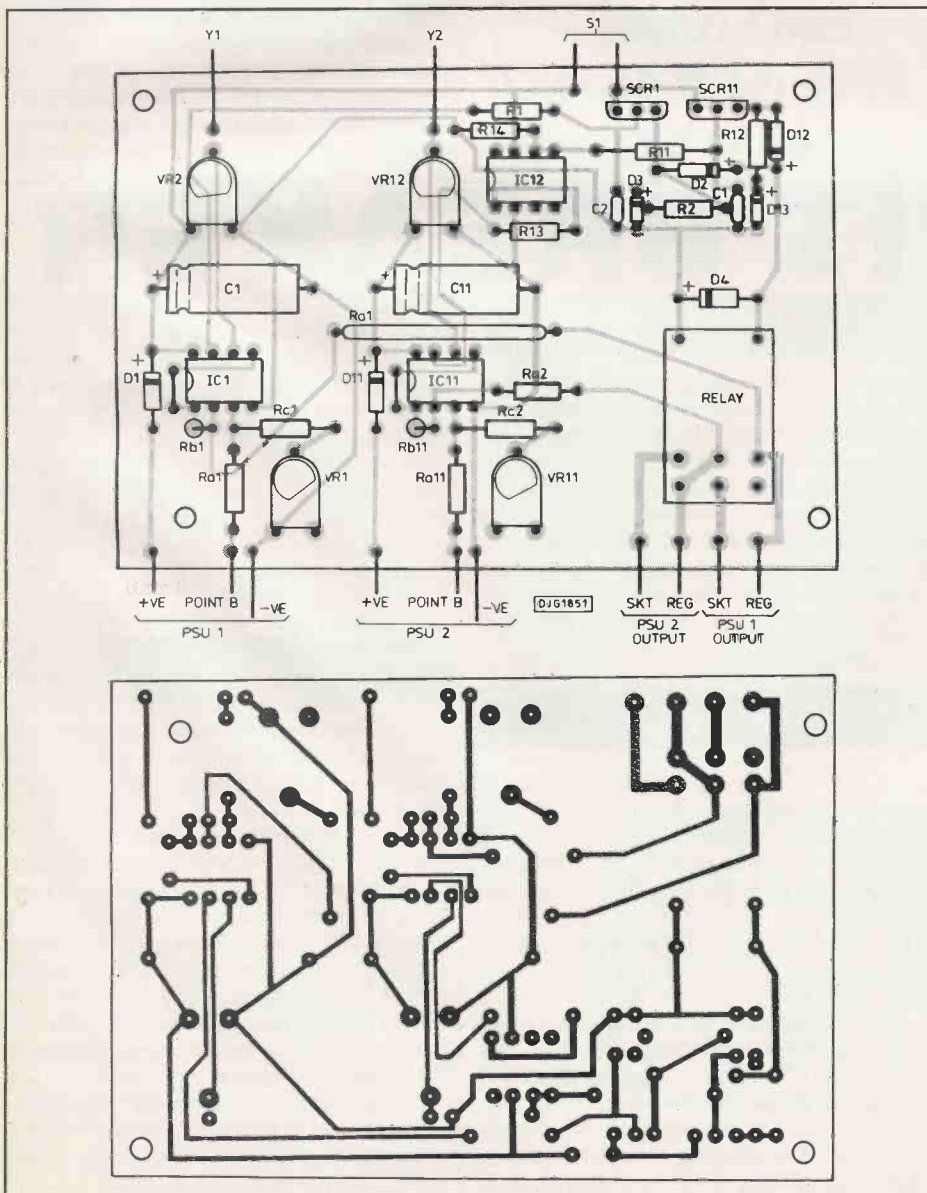


Fig 2 (above). Relay driver.
Fig 3 (below). PCB component and track layouts.



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	1N4001 (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	1N4001 (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.

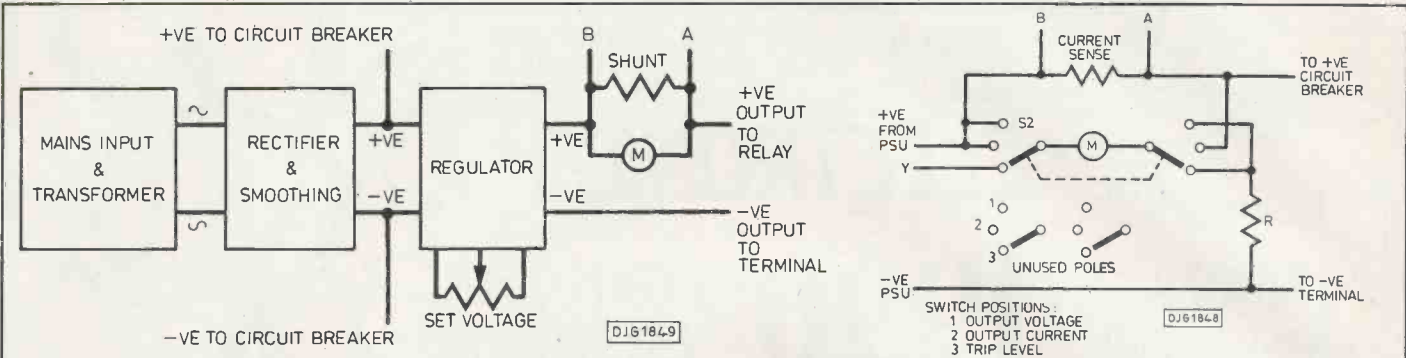


Fig 4. (left). Typical psu and connection to circuit breaker. Fig.5. (right). Meter switching.

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 IC1a (pin 1). Adjust VR1 until the voltage is as expected from the formulae given earlier. With IC1a 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). Measure the voltage on the wiper of VR2 and gradually reduce the voltage. When the voltage

drops below 2.037V the relay should operate and the led should light. Turn VR2 back up to above 2V and press the push-to-break switch, the relay should turn off and the led go out.

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 circuit breaker should now be working properly and can be fitted into the power supply, as in Fig. 4. It is advisable to retain the fuse in the power supply to act as extra protection in the event that a fault should occur on the circuit breaker. (The prototype circuit breaker has been in use almost daily for over a

TRIP LEVEL METERING

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:

$$R = (V/A) - r$$

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

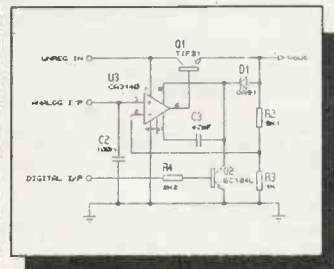
If your supply has no meter you can calibrate the front panel around VR2 using the formulae given earlier, setting the pot to that voltage and marking the front panel.

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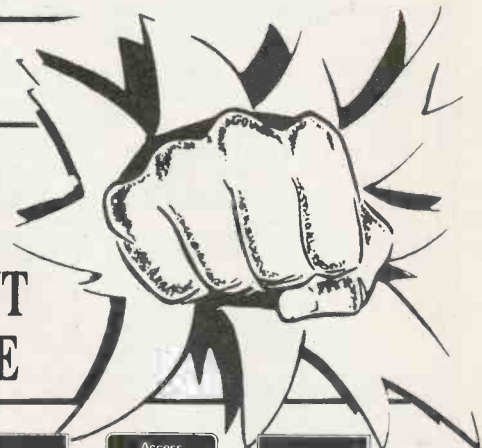


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		74LS03	10p
		74LS04	10p
		74LS14	12p
		74LS15	12p
		74LS20	15p
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Connect a multimeter, set to the 1A ac current range, in place of fuse FS1. Without any ics inserted in their sockets, connect power 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 V1 can be varied between approximately 9V and 30V by VR101. Set V1 to 15V and then check that the programming voltage V2 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:

Part two: Kevin Browne describes the testing and using of the RS232 based universal programmer.

Pin 2	TXD	-9V	(output)
3	RXD	+0.05V	(input)
4	RTS	-9V	(output)
5	CTS	+0.05V	(input)
6	DSR	+0.05V	(input)
7	COM	0V	
20	DTR	-9V	(output)

Connect the programmer to your computer's RS232 port and configure the port

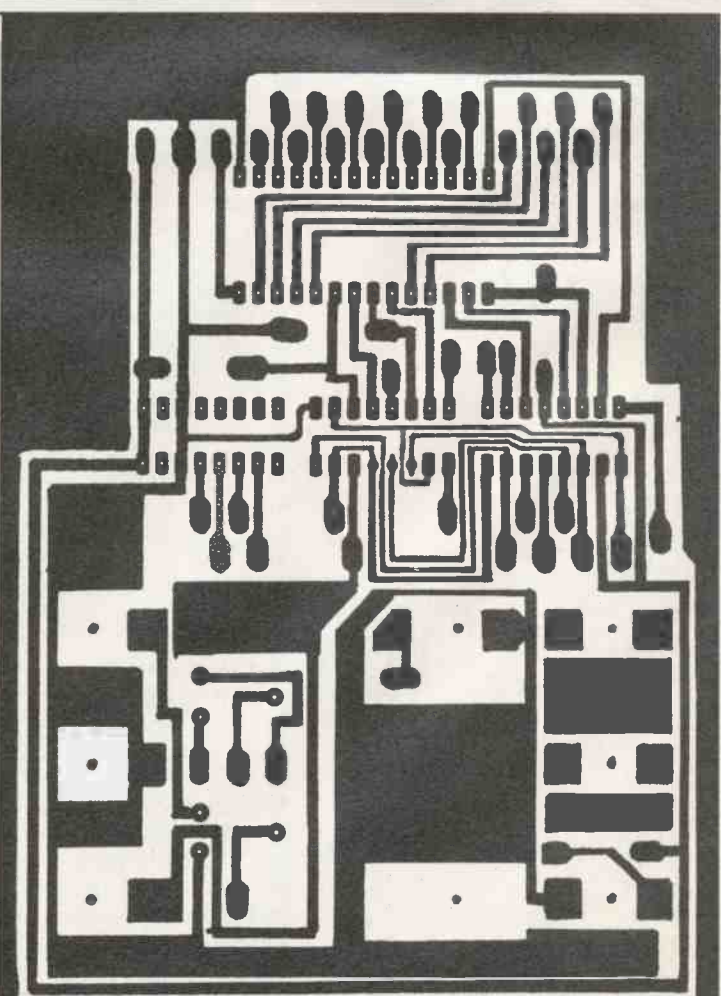
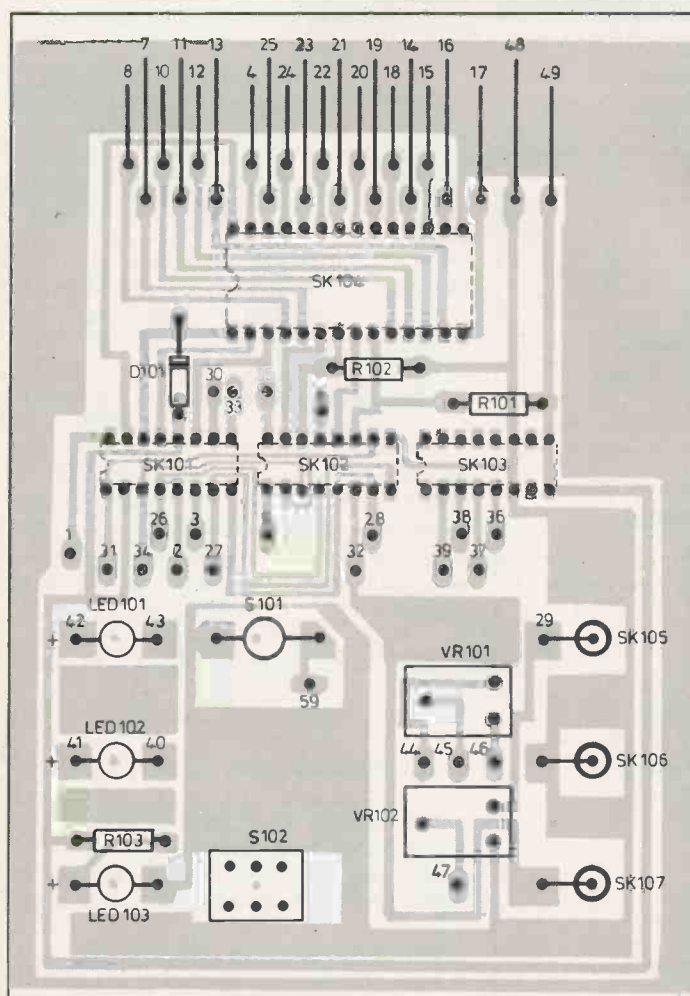
to 1200 baud. The green led (DTR) on the programmer should light. Any problems at this stage could indicate incorrect wiring or connections to the RS232 interface. (The programmer requires a valid DSR signal from the host computer before acknowledging with a DTR ready signal). Run a test program similar 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

EPROM POLY-PROGRAMMER



Figs. 13 and 14. Top pcb component and track layouts

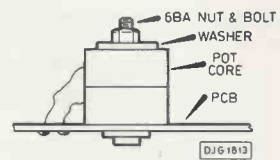
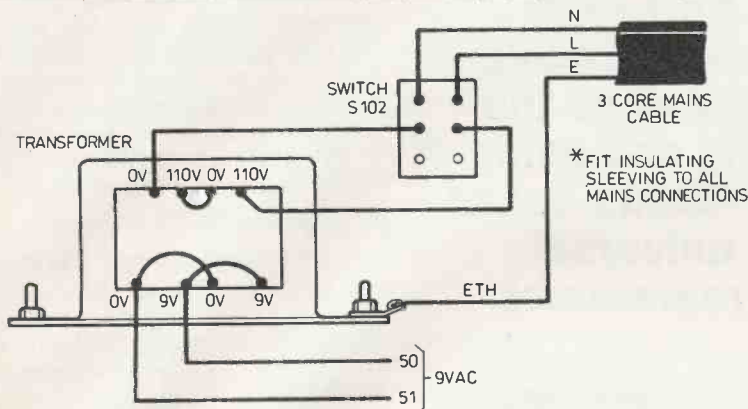
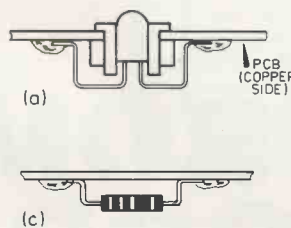
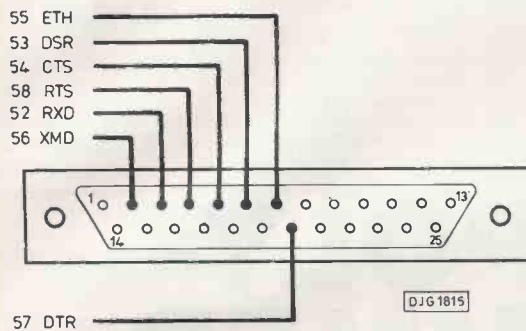


Fig 12 (above). Inductor L1 mounting
 Fig 15 (left). Mains power wiring.
 Fig 16 (bottom left). D-way socket wiring.
 Fig 17 (below). Top pcb component mounting.



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 eeprom programmer to undertake specific actions. A flowchart showing the typical command

sequence to program an eeprom 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 (D0 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 (D0 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.

Wire Number	Use
1 A15	Address
2 A14	"
3 A13	"
4 A12	"
5 A11	"
6 A10	"
7 A9	"
8 A8	"
9	- not used
10 D7	Data
11 D6	"
12 D5	"
13 D4	"
14 D0	"
15 D1	"
16 D2	"
17 D3	"
18 AO	Address
19 A1	"
20 A2	"
21 A3	"
22 A4	"
23 A5	"
24 A6	"
25 A7	"
26 PP	Prog Pulse
27 PP	Prog Pulse
28 PV	Read/write control
29 V1	Prog supply 1
30 V1c	Prog control 1

Wire Number	Use
31 V1sw	Prog supply 1
32 V2	Prog Supply 2
33 V2c	Prog control 2
34 V2sw	prog supply 2
35 -5	-5V supply
36 C3	Aux control 3
37 C2	Aux control 2
38 C1	Aux control 1
39 CO	Aux control 0
40	LED 102 -
41	LED 102+
42	LED 101+
43	LED 101-
44	VR101
45	VR101
46	VR101
47	VR101
48 ETH	common
49 +5	+5V supply
50 AC	Transformer
51 AC	Transformer
52 RXD	RS232 Pin 3
53 DSR	RS232 Pin 6
54 CTS	RS232 Pin 5
55 ETH	RS232 Pin 7
56 XMD	RS232 Pin 2
57 DTR	RS232 Pin 20
58 RTS	RS232 Pin 4
59	Reset S101

Fig 18. Wiring details.

8748 pin number 19 18 17 16 15 14 13 12	Error
0 0 0 0 0 0 0 0	Receive frame error (usually incorrect baud rate).
0 0 0 0 0 0 0 +5	Receive parity error.
0 0 0 0 0 0 +5 +5	Command length exceeds 4 bytes
0 0 0 0 0 +5 0 0	Hex data format error
0 0 0 0 0 +5 0 +5	Invalid command type
+5 X X X X X X X	Invalid command word (X = bits 0 to 6 of word)

Fig 19. Error codes.

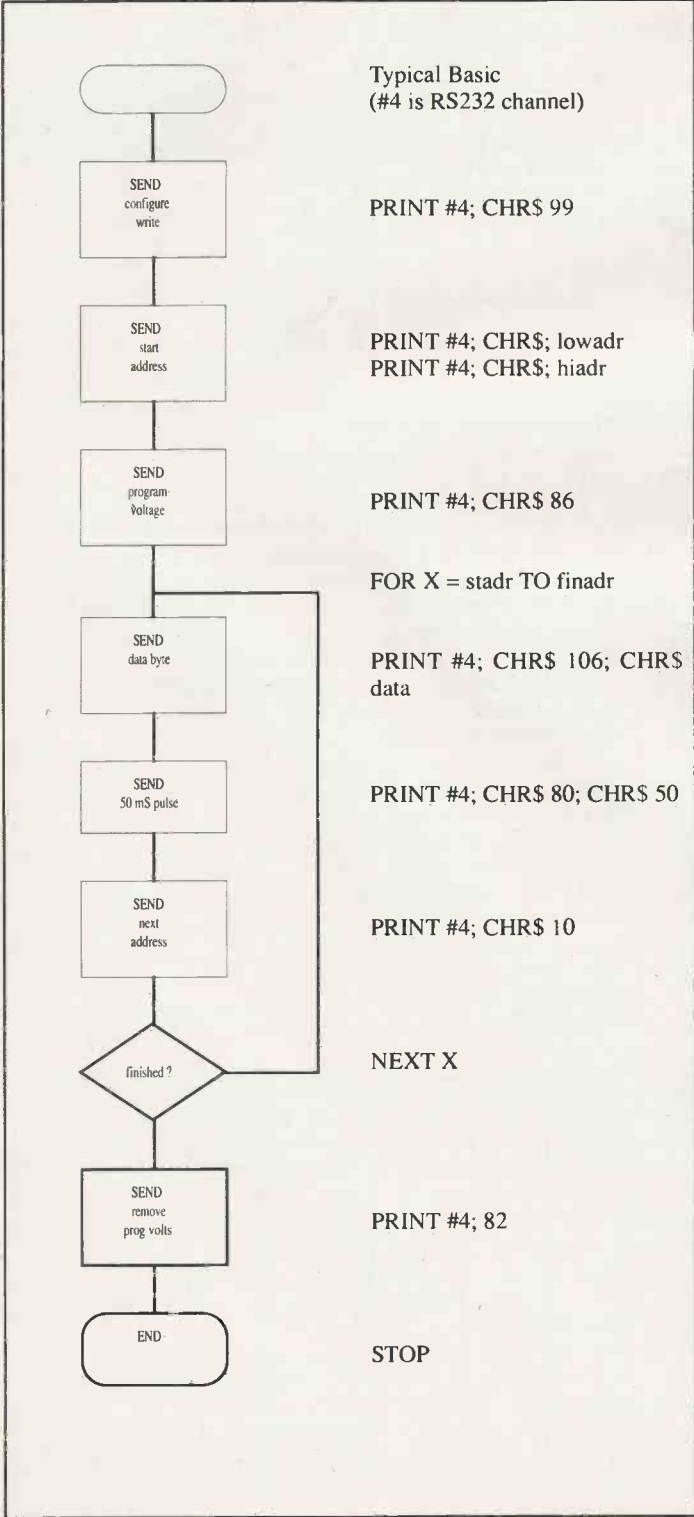


Fig 20. Typical programming sequence.

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 (D0 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 67 (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	b	Configures Programmer in the READ eprom mode, ie, the data lines (D0 to D7) are inputs. (Also sets all address and data registers to zero).
99	c	Configures programmer in the WRITE EPROM mode, ie the data (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	e	Re-configures programmer in the WRITE EPROM mode (Address and data registers are changed).
104xx	hxx	Set EPROM address lines (A8 to A15) to xx
105xx	ixx	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)
123))

[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.)]

Fig 21. 8748 E-programmer commands.

10 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 adrlo = adr - (256 * adrhi)
550 PRINT #4; CHR$ 104; CHR$ adrhi
560 PRINT #4; CHR$ 105; CHR$ adrlo
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 "Verifying Data" ,,,,
800 REM verify
820 PRINT #4; CHR$ 98
850 PRINT #4; CHR$ 104; CHR$ adrhi
860 PRINT #4; CHR$ 105; CHR$ adrlo

900 REM verify loop
910 FOR x = 0 to byte
920 PRINT #4; CHR$ 74 : INPUT #4; a$
930 GOSUB 2000
940 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

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.

```

Fig 22. Basic program.

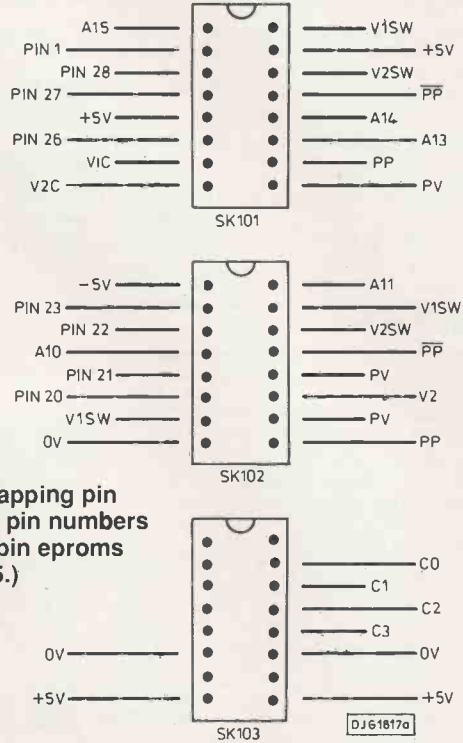


Fig 23. Strapping pin layout. NB pin numbers are for 28 pin eproms (see Fig 25.)

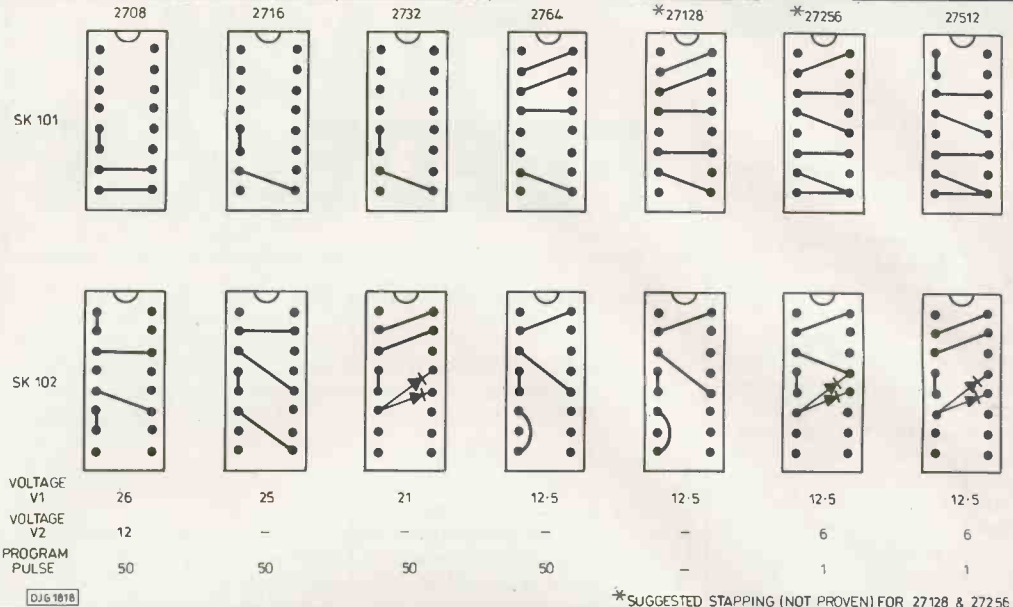
Fig 24. Strapping pin functions.

Pin	Use
V1sw	Programming supply voltage V1, switching controlled by pin V1c
V1c	Control input for switching programming voltage V1. (+5V= supply connected, 0V = supply not connected).
V2sw	Programming supply voltage V2, switching controlled by pin V2c.
V2c	Control input for switching programming voltage V2.
V2	Programming supply voltage V2 not switched
PP	+5 volt program pulse (software controlled duration)
PP	0 volt inverted program pulse (NOT)
PV	Read/Write eprom control line output. (+5V = write, 0V= read).
A x	Address output line from programmer pia chip. (x = Address line number 10-15).
Pin x	Eprom socket SK 4 pin number for 28 pin eprom, (x = pin number 1 to 28).
Cx	Aux control input/output lines. (x= 0, 1 or 2 for output only, x=3 input only).
+5	+5 V supply.
0V	0V supply.
5	-5V supply.

Below: Fig 25. 28 pin to 24 pin conversion.

28 pin no.	24 pin no.	28 pin no.	24 pin no.
1	-	28	-
2	-	27	-
3	1	26	24
4	2	25	23
5	3	24	22
6	4	23	21
7	5	22	20
8	6	21	19
9	7	20	18
10	8	19	17
11	9	18	16
12	10	17	15
13	11	16	14
14	12	15	13

Fig 26. 27xx series eprom strapping details.



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

0000	-	04	09	00	00	00	00	a5	93	b8	02	b9	3e	27	a0	18	-	(d5)	
0010	-	e7	0e	74	2e	09	53	60	af	d5	b9	25	b8	00	c5	74	6e	-	(16)
0020	-	25	14	45	c5	14	55	d5	b6	32	a1	19	18	23	19	37	68	-	(16)
0030	-	e6	23	f8	c6	23	c5	14	4a	14	55	b6	41	d5	a1	19	18	-	(14)
0040	-	c5	14	c0	04	21	23	10	74	45	83	23	10	14	4f	83	d5	-	(1b)
0050	-	00	4b	3a	ab	93	85	a5	b5	23	96	62	23	fb	55	46	65	-	(db)
0060	-	76	5e	95	65	83	65	62	55	27	14	95	c6	70	65	04	55	-	(31)
0070	-	be	08	27	14	95	ee	73	ad	ff	37	b2	87	27	14	95	ac	-	(8f)
0080	-	fd	14	ac	77	dc	96	8f	27	14	95	65	c6	91	fd	83	23	-	(64)
0090	-	01	95	74	39	83	a5	b5	76	97	97	a7	56	9e	97	67	bb	-	(18)
00a0	-	02	eb	a1	00	ac	65	23	f6	62	55	fc	83	be	08	85	f7	-	(30)
00b0	-	e6	b3	95	ee	af	ff	d2	b9	95	23	01	b6	be	07	85	83	-	(91)
00c0	-	14	d6	b6	c5	83	54	0f	14	fa	c6	d0	f0	43	80	74	39	-	(4f)
00d0	-	d5	f8	c5	96	c0	83	85	d5	f8	c5	96	dd	83	b9	25	b8	-	(0e)
00e0	-	20	aa	bb	04	f1	a0	d3	0d	96	ee	95	83	ca	fa	96	f1	-	(df)
00f0	-	83	19	18	eb	e4	23	03	74	39	83	b8	20	f0	53	78	77	-	(e3)
0100	-	77	77	03	05	b3	15	17	fd	fd	fd	fd	fd	fd	db	ec	2f	-	(b9)
0110	-	fd	78	5b	ad	c4	f0	83	f0	d3	0d	96	1d	83	f0	d3	0a	-	(87)
0120	-	96	2e	d5	1d	fd	96	28	1c	c5	23	01	54	31	27	83	23	-	(c8)
0130	-	50	d0	c6	3f	23	52	d0	c6	55	23	54	d0	c6	4f	83	54	-	(b8)
0140	-	5d	ae	23	04	74	45	fe	74	4b	23	04	14	4f	27	83	23	-	(ff)
0150	-	08	74	45	27	83	23	08	14	4f	27	83	f0	ae	54	5d	ad	-	(9f)
0160	-	23	98	6e	f6	66	83	ae	23	fc	5e	c6	6d	83	23	1c	6e	-	(96)
0170	-	a8	fd	a0	fe	54	3a	27	83	23	9e	60	f6	7e	83	be	03	-	(54)
0180	-	bc	02	c6	9f	07	c6	8e	07	c6	a3	07	c6	a4	83	23	80	-	(8a)
0190	-	d5	bc	00	bd	00	be	00	c5	54	54	fc	54	31	27	83	23	-	(c7)
01a0	-	89	cc	24	90	23	80	24	98	23	89	cc	24	98	f0	03	90	-	(1f)
01b0	-	ae	f6	b4	83	53	fc	c6	b9	83	23	1c	6e	a8	f0	54	b5	-	(7a)
01c0	-	54	f6	27	83	f0	03	88	ae	f6	cb	83	53	fc	c6	d0	83	-	(c9)
01d0	-	23	1c	6e	a8	f0	54	fb	54	f6	27	83	f0	03	be	c6	e4	-	(e3)
01e0	-	07	c6	e8	83	74	07	44	03	74	66	44	03	f0	03	b6	c6	-	(8a)
01f0	-	f5	07	c6	f9	83	74	07	44	09	74	66	44	09	23	05	74	-	(c9)
0200	-	39	27	83	54	b5	54	f6	27	83	54	fb	54	f6	27	83	d5	-	(f8)
0210	-	f8	c5	aa	23	25	a8	a9	f0	d3	0d	18	ca	96	17	fa	ab	-	(04)
0220	-	c6	28	f0	a1	18	19	ea	22	fb	d5	a8	c5	f9	d5	a9	c5	-	(35)
0230	-	83	ac	1c	fc	07	54	3a	ec	33	83	b8	1c	ae	68	a8	23	-	(33)
0240	-	03	de	c6	48	f0	54	54	83	d5	23	f8	5a	aa	c5	f0	53	-	(06)
0250	-	07	74	0f	83	ad	d5	fb	c5	4e	3a	fd	90	83	74	5d	54	-	(0c)
0260	-	7c	f6	76	74	60	c6	76	74	5d	54	7c	e6	72	23	04	74	-	(8c)
0270	-	39	83	c8	54	a2	83	74	60	96	6d	f0	83	97	b9	92	aa	-	(d3)
0280	-	bb	10	f9	a3	da	c6	8c	19	eb	82	a7	83	fb	07	37	53	-	(cf)
0290	-	0f	83	30	31	32	33	34	35	36	37	38	39	41	42	43	44	-	(a9)
02a0	-	45	46	f0	54	7c	47	ac	18	f0	54	7c	6c	83	00	b8	92	-	(4f)
02b0	-	68	a3	54	b5	83	ac	bd	ff	ff	37	d2	c2	fc	14	ac	43	-	(c8)
02c0	-	fe	ad	74	14	74	1f	97	a5	54	e0	ba	08	fc	67	ac	54	-	(5b)
02d0	-	e0	ea	cc	ba	03	fd	67	ad	54	e0	ea	d5	65	74	29	83	-	(dc)
02e0	-	23	20	76	e2	65	f6	eb	74	45	44	ef	00	00	14	4f	23	-	(53)
02f0	-	f6	62	55	a5	b5	83	23	0d	54	b5	83	a9	53	f0	47	54	-	(cd)
0300	-	ae	f9	53	0f	54	ae	83	d5	fb	c5	43	02	3a	80	83	d5	-	(7a)
0310	-	4a	aa	39	93	23	80	74	19	83	d5	37	5a	39	aa	93	ba	-	(09)
0320	-	64	0a	53	40	96	1f	ea	21	83	23	80	74	0f	83	d5	23	-	(e5)
0330	-	e8	39	aa	23	fc	3a	ab	c5	83	ae	74	2e	23	10	74	0f	-	(1d)
0340	-	fe	02	64	42	83	d5	37	5b	3a	ab	93	ad	a5	b5	23	f4	-	(26)
0350	-	62	00	55	76	53	65	be	05	ee	58	ed	4c	83	18	f0	83	-	(35)
0360	-	74	5d	d3	0d	c8	83	09	53	08	c6	6d	23	ff	83	0a	53	-	(95)
0370	-	80	96	6e	83	00	00	00	00	00	00	00	00	00	00	00	00	-	(07)

HARDWARE CONFIGURATION

In order to program a particular type of eprom various pins on SK104 have to be configured to match the particular eproms 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.

FINAL POINTS

- 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).
 3. Embedded Controller Handbook: detailed operations of the 8748 microcontroller. (Available from Intel, tel: 0793 696 000.

SEMANTIC GREENERY

Dear Editor,

Reading with great interest (as I always do) my PE for 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 of a component in his circuit?) We can usually cope with bad spellings and the like; their iz no danjer that we wil knot no wot waz ment, it just dozen't luck two nice!

Now we are three. *The Concise Oxford English Dictionary*, your very excellent wife, and myself, all agree: 'twenty-five' has a hyphen!

Your reply to Mr Long's letter says that you ran the text through your spellcheck (or did you mean 'spell-check'?) program, and 'twentyfive' failed the test. I presume this means 'twenty-five' passed, providing still more evidence against Mr Long's thesis. What intrigues me is this: where did he get the idea that 'twenty-five' was ever spelled without the hyphen? If he has documentary evidence let us see it, but if he just made up the idea out of his own head then why was he so cocksure he was right?

It is clear that you share my enthusiasm for English Orthography, but I should like to bring out a more sinister point: if people make up facts without any justification ("It must be right because I always do it that way"), then it shows that their thinking is becoming less and less clear.

In electronics and computing there is a lot of this about. As you know, our Interak system is Z80 based. We write control programs and the like for some of our professional clients, and it is always a source of amusement to us when the client 'knows', from what he has been told, that a Z80 can't do his job; it must be an 80286 and a megabyte of ram at the minimum. One example I have in mind eventually used about 2K of Z80 machine code, and outperformed his competitor's 16-bit monster, to the client's great delight. So how did he 'know' a Z80 couldn't do it? The same way we know 'all right' is spelled 'all right' and not the other way, which is 'alwrong', (and from which mercifully you and your spell-checker generally spare us in PE).

And how about 'its' and 'it's'? No, I shan't go on!

TRACK FEEDBACK

Thanks for a most enjoyable and high standard magazine.

David Parkins. B.Eng (Hons),
Greenbank Electronics,
Birkenhead, Merseyside.

Oh, yes, we indeed seem to be linguistically like-minded! Mind you, it is difficult on occasions when several thousand words have to be written to meet a particular press deadline, to stop the train of thought and typing in order to research every nuance of grammar and spelling. I know mine slips on occasion, but hopefully, as you comment, the meaning is still clear.

I feel that there is, also, the danger of the written word becoming dull if full 'conventional' regard is given to strict grammatical form. I favour a style which is more akin to the spoken form: more chatty, less pedantic, easier (hopefully) to understand. None-the-less, as one addicted to programming as much as to creating circuit ideas, I know the value of trying to use words which conform to standard conventions. With instructional texts in particular one tries to 'debug' ambiguities and avoid readers responding with their equivalent of the computational expletive of "Syntax Error in Line ..."

Thank you for the 'Oxford' extract - I don't how I missed researching that volume. The spell-check is, regrettably, American, and has its idiosyncrasies, especially on hyphens which it will accept happily in almost any circumstance. I wish computers were as tolerant of programming errors! Ed

RESTRICTING CHIPS

Dear Ed,

A JVC unit in my audio stack has a dead NE652 chip. Unable to locate a supplier, I contacted JVC. Their reply contained the following statement:

"JVC wish to be of every assistance to ensure that this item is restored to full working order with the minimum delay, however, in order to comply with British Safety Standards and current Safety legislation, the parts you require may only be supplied to an appointed JVC dealer or an authorised service department."

The answer came as a complete surprise as JVC have been very helpful with circuits, parts lists and components over the last 20 years. Though I admit I've had no dealings

with the UK branch until now.

I know we do have some odd habits in this country; most electronic equipment bought outside this country came with a circuit diagram; most bought inside it came without. This 'legislation' is completely new to me.

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 specialise in ics. Ed.

LAWFUL

Dear Editor,

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 Modem project. As far as I know, BT strongly disapprove of anyone connecting non-approved equipment to their phone lines.

Daniel Brook, Mill Hill,
London.

My cmos comments were intended to put minds at ease over static precautions; I've obviously had some effect. Good!

It is, quite naturally, my strict policy not to publish projects which fall outside the law, or are otherwise socially undesirable. For example, PE has no intention of publishing a

project to enable readers to decode the security signals which will ultimately be put out by Sky and BSB. To do so would be encouraging readers to view the coded satellite tv programmes without paying the obligatory fees. This would be tantamount to inciting readers to commit theft. I am aware of an internationally-distributed magazine which attempted to publish a project with a similar function. They were legally clobbered for their attempt; and quite right too.

As Kevin Kirk emphasised, the modem project has many applications other than those requiring the use of a phone line. As a design, it is technically capable of being used on some phone lines, but may not be legally connected to the public telephone network without approval. This situation is governed by law, as BT specifically state: "To protect you, the customer, and the BT network, the Government has made it unlawful for 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 capitulating and emigrating to Ireland, a neighbour suggested calling in the local sorceress and offered to contact her. A few days later an old lady arrived to "see to the moles". She refused hospitality and help, saying "I'd best do it alone". 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."

"Well said old mole! Canst work i' th' earth so fast?"

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

Ed.



TEACHER BASHING

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 preparedness 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 go on 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

MORE FEEDBACK

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.

You are indeed hauling 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 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 students and 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.

Ed.

LO-FI DEAF AIDS

Dear Ed,

I tried 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.

Howard also sent in a sketch of a combined stereo microphoned 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,

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 include a detailed description of how the key closure signals are unravelled by the microprocessor, and how the program for the eeprom 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.

STATIC CONDITION

Dear Mr Becker,

I endorse your comments on the handling of CMOS chips (PE Feb 90) but would add a fourth simple precaution.

This is to incorporate fabric conditioner in the final rinse when washing clothes, thus rendering even nylon and polyester much less prone to

developing electrostatic charge. Non-smelly versions are available from many supermarkets.

Henry Earle, Nottingham.

Thanks, I have not previously heard of this precaution, but whatever its merits, there is no substitute for maintaining frequent contact with a grounded item to ensure that you are completely free of static electricity when handling CMOS. Ed.

AIR YOUR VIEWS

ON ELECTRONICS, PE AND TECHNOLOGY. TELL US WHAT YOU THINK!

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



SPACE WATCH

BY DR PATRICK MOORE CBE

In space Galileo has encountered Venus, but in Chile astronomers have encountered tv interference with their supernova observations.

Left: Computer processed radar image of the Ishtar Terra highlands region in the far north of Venus.

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 PULSAR THAT WASN'T

Astronomers, like everyone else, are human; they can make mistakes - and an unfortunate one has just come to light. The outbreak of the Supernova 1987A in the Large Cloud of Magellan was one of the most important astronomical events of recent times. It was the first naked-eye supernova since 1604, and the progenitor star was known: it was a blue supergiant, whereas it had been generally believed that all supernovae were due to exploding red supergiants. The immediate problem was - What next? Would SN 1987A produce a pulsar, a black hole, or neither?

On 18 January 1989 it seemed that a pulsar had been found. J. Middleditch and T.P. Sasseen, using the 4-metre reflector at the Cerro Tololo Observatory in the Atacama Desert of Chile, detected flashes from the position where a pulsar might be expected, and the observations were continued for seven hours. The flashes were surprisingly bright, peaking at about magnitude 18. But even more surprising was the fact that they were very rapid. They indicated a pulsar with a

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 - 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

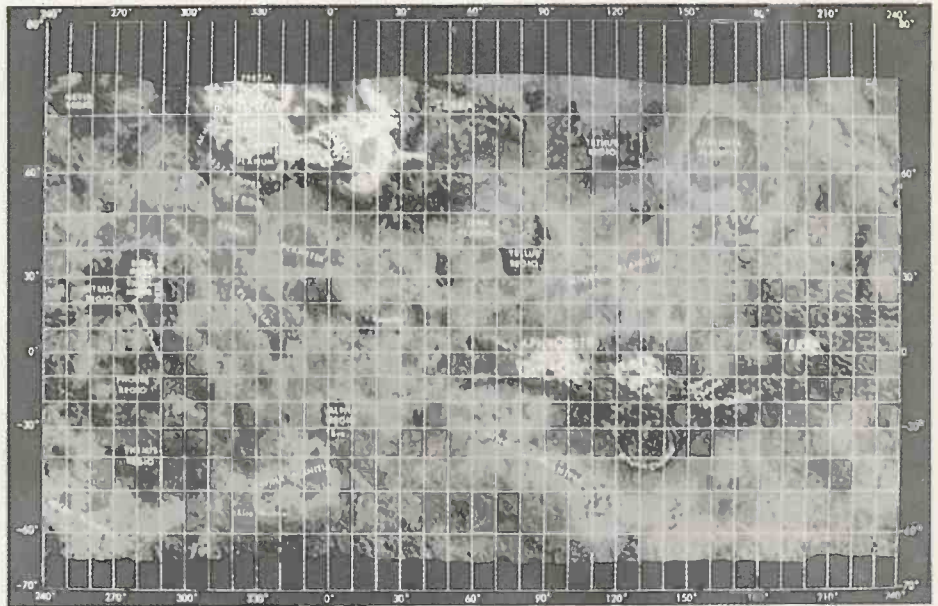
7. It is in Serpens - not one of the constellations of the Zodiac, but of course Pluto's orbit is much more highly inclined than those of the other planets. The magnitude is 14, so that a telescope of some size is needed to show Pluto at all. We have now lost most of the brilliant winter stars, though 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 Alpherat in Hydra, the Watersnake, which is as bright as the 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 SN1987A 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



Relief map of Venus's surface, showing elevations and depressions. It was constructed from data gathered using microwave radar. Both photos were taken by the NASA Pioneer/Venus Orbiter (1978-81) and provided by *Astronomy Now*.

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.

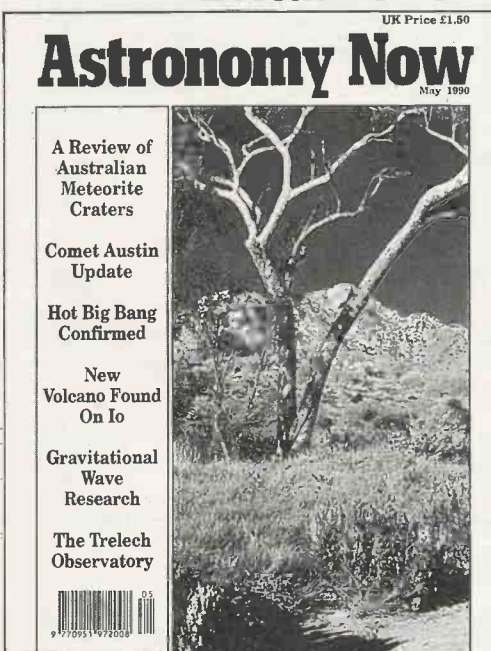
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BC109C	22p
BC184C	6p
BC212B	6p
BC239C	4p
BC307C	4p
BC548C	4p
BC558C	4p
ZTX300	17p

The above are a few examples from the 1000's of transistor types we have. We cover all ranges and types including JFET, SiPMOS, TMOS, TIP plastic & metal, FET & Darlington's.

REGULATORS

7805	5V @ 1.5A	30p
7812	12V @ 1.5A	30p
7815	15V @ 1.5A	30p
7905	-5V @ 1.5A	30p
7912	-12V @ 1.5A	30p
7915	-15V @ 1.5A	30p

CAPACITORS

Radial Aluminium Electrolytic 20% tolerance

10/16/25/35 Volt
4.7, 10, 22, 33, 47, 100 12p
220, 330, 470 20p
1000 30p
2200 48p
3300 65p
4700 85p

50/63/ Volt
0.47, 1, 2, 2.2, 3.3, 4.7, 10 12p
22, 33, 47 20p
100, 220 30p
470 50p
1000 90p

100 Volt
0.47, 1, 2, 2.4, 7 12p
10, 22 20p
47 30p
100 50p

Ultra miniature Aluminium electrolytic radial 20% tolerance

4 V
220 18p

6.3 Volt
22, 100 18p

16 Volt
10, 22, 47 18p

25 Volt
10, 22, 33 18p

35 Volt
4.7, 10, 22 18p

50 Volt
0.1, 0.22, 0.33, 0.47, 1, 2, 2.3, 3.3, 4.7, 10 18p

CAPACITORS

Disc Ceramic 5% tolerance 150Volt values in pF

15, 22, 33, 47, 68, 100, 150, 220, 330, 470 4p

100, 150, 220, 330, 470 6p

10% tolerance value in pF
220, 330, 470, 680, 1000, 1500, 2200 6p

1000, 1500, 2200, 3300, 4700, 6800 8p

+80% -20% tol. value pF
4700, 10000 6p

22000, 47000 9p

Tant. Bead resin dipped 20% tolerance value in uF

6.3 Volt
10, 22 15p
47 25p

10 Volt
3.3, 4.7, 6.8 15p
10, 15 25p
22, 33, 47 35p

16 Volt
2.2, 3.3, 4.7, 6.8 15p
10, 15 25p
22, 33 35p

25 Volt
1.2, 2.3, 3 15p
4.7, 6.8 25p
10, 15 35p

35 Volt
0.1, 0.22, 0.33, 0.47 15p
0.68, 1.2, 2.3, 3 20p
4.7, 6.8, 10 30p

CMOS

4000	17p	4106	34p
4001	17p	4160	40p
4002	17p	4161	40p
4008	37p	4162	40p
4007	17p	4163	40p
4008	37p	4174	37p
4011	17p	4175	40p
4012	17p	4194	42p
4013	25p	4501	27p
4014	37p	4502	40p
4015	37p	4503	37p
4016	28p	4504	120p
4017	37p	4506	76p
4018	37p	4508	90p
4020	37p	4510	37p
4021	37p	4511	37p
4022	37p	4512	37p
4023	17p	4513	90p
4024	35p	4514	85p
4025	17p	4515	80p
4027	34p	4516	37p
4028	37p	4517	90p
4029	37p	4518	37p
4032	56p	4519	26p
4034	95p	4520	37p
4035	44p	4521	85p
4038	66p	4522	44p
4040	37p	4526	44p
4042	37p	4527	44p
4043	37p	4528	44p
4044	37p	4529	50p
4046	47p	4530	90p
4049	27p	4531	44p
4050	27p	4532	80p
4051	37p	4534	240p
4052	37p	4536	120p
4053	37p	4538	54p
4060	37p	4539	45p
4066	20p	4541	60p
4067	90p	4543	54p
4068	17p	4544	130p
4069	17p	4547	130p
4070	17p	4549	400p
4071	17p	4551	85p
4072	17p	4553	120p
4073	17p	4554	320p
4075	17p	4555	60p
4076	37p	4556	50p
4077	17p	4557	120p
4078	17p	4558	120p
4081	17p	4559	440p
4082	17p	4560	110p
4093	27p	call sales for	
4094	48p	4500 series	
4097	90p	above 4560	
4099	48p		

DIODES

1N914 5p
1N4148 4p
1N4001 3p
1N4002/3/4/5/6 4p
1N5401 7p
1N5402/4/6/8 11p

Zener Diodes

500 mW
2.4, 2.7, 3.3, 3.9, 4.7, 5.1, 5.6, 6.2, 6.8, 8.2, 10.1, 11.2, 13.1, 15.1, 16.1, 20, 22, 24, 27, 30, 33, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91
All above voltages at 5p each

1.3 W
3.3, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1, 10.1, 11.2, 13.1, 15.1, 16.1, 18, 20, 22, 24, 27, 30, 33, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91
All above voltages at 16p each

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W03	25p
W04	30p
W06/08	35p
2A	200V 65p
2A	400V 72p
2A	600V 90p
6A	200V 78p
6A	400V 84p
6A	600V 99p

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BBC 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.

MODULE 1: DEF PROCexchange CLS PROCMESSAGE PROCREPLY	PROCLIGHT GOTO...
MODULE 2: DEF PROC manual-controls	
MODULE 3: DEF PROCfsrs CLS PROCFORWARD PROCREVERSE GOTO	MODULE 5: DEF PROCfsrs_left_right_beep CLS PROCFORWARD PROCREVERSE PROCBEEP PROCLEFT PROCBEEP PROCRIGHT PROCBEEP PROCRIGHT PROCBEEP PROCBEEP GOTO...
MODULE 4: DEF PROCfsrs_sound_light CLS PROCFORWARD PROCREVERSE PROCSOUND	

Fig 30. Main procedures.

Part 3 - in which Alan Pickard concludes Microbe 3.

SECTION 2

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

BUILDING A ROBOT CAR

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).

TITLE
MENU
MAIN PROCEDURES
1. PROCexchange 2. PROCmanual_controls 3. PROCfsrs 4. PROCfsrs_sound_light 5. PROCfsrs_left_right-beep 6. PROCcollision
SUB-PROCEDURES
EXCHANGE MOTION SOUND LIGHT COLLISION

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 for easy identification.

70,80 enable error conditions including ESC (code 17) to CLS

90,300 REPEAT...UNTIL (FALSE) loop keeps program running until exited

110,120 set up screen title in double height characters

130,190 prints out list of options on screen, under title

190 uses END to enable exit from program

200-290 REPEAT ... UNTIL loop enables menu to be accessed repeatedly

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 PROexchange, 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' 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 considerably 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 PROCfsfs_sound_light, is a variation on Module 3, but providing sound and led flash from MICROBE 3 between cycles.

Module 5, PROCfsrs_left_right_beep, demonstrates forward and reverse motion and also left and right turns. Changes in direction are signified at MICROBE 3 by the BEEP sound.

```

10 REM MICROBE 3.7
20 REM MENU-DRIVEN TEST PROGRAM
30 REM Alan Pickard 30 June 1989
40
50

```

```

60 REM MENU
70 ON ERROR GOTO 80
80 IF ERR = 17 THEN CLS
90 REPEAT
100 MODE 7
110 PRINT TAB(9,2) CHR$(141) "MICROBE 3"
120 PRINT TAB(9,3) CHR$(141) "MICROBE 3"
130 PRINT TAB(0,7) "1. PROCexchange"
140 PRINT TAB(0,9) "2. PROCmanualcontrols"
150 PRINT TAB(0,11) "3. PROCfsrs"
160 PRINT TAB(0,13) "4. PROCfsrs_sound_light"
170 PRINT TAB(0,15) "5. PROCfsrs_left_right_beep"
180 PRINT TAB(0,17) "6. PROCcollision"
190 PRINT TAB(0,19) "7. END - Exit Program"
200 REPEAT

```

```

210 INPUT TAB(0,23) "Enter number required: " option
220 IF option = 1 THEN PROCexchange
230 IF option = 2 THEN PROCmanualcontrols
240 IF option = 3 THEN PROCfsrs
250 IF option = 4 THEN PROCfsrs_sound_light
260 IF option = 5 THEN PROCfsrs_left_right_beep
270 IF option = 6 THEN PROCcollision
280 IF option = 7 THEN END
290 UNTIL option >= 1 AND option <= 7
300 UNTIL FALSE
310 END

```

```

320
330
340 REM MAIN PROCEDURES *****
350

```

```

360 DEF PROCexchange
370 CLS
380 PROCMESSAGE
390 PROCREPLY
400 ENDPROC
410
420 DEFPROCmanualcontrols
430 ?&FE62=&7F
440 ?&FE60=&05
450 *FX4,2
460 *KEY 11 ?&FE60=&05|M
470 *KEY 12 ?&FE60=&01|M
480 *KEY 13 ?&FE60=&0D|M
490 *KEY 14 ?&FE60=&00|M
500 *KEY 15 ?&FE60=&0F|M
510 *KEY 1 ?&FE60=&15|M
520 *KEY 3 ?&FE60=&35|M
530 *KEY 4 ?&FE60=&45|M
540 *KEY 5 ?&FE60=&55|M
550 *KEY 7 ?&FE60=&75|M
560 ENDPROC

```

```

570
580 DEF PROCfsrs
590 CLS
600 PROCFORWARD
610 PROCREVERSE
620 GOTO580
630 ENDPROC
640
650 DEF PROCfsrs_sound_light
660 CLS
670 PROCFORWARD
680 PROCREVERSE
690 PROCTONE1
700 PROCTONE2
710 PROCLIGHT
720 GOTO 650
730 ENDPROC
740

```

```

750 DEF PROCfsrs_left_right_beep
760 CLS
770 PROCFORWARD
780 PROCREVERSE
790 PROCBEEP
800 PROCLEFT
810 PROCBEEP
820 PROCRIGHT
830 PROCBEEP
840 PROCRIGHT
850 PROCBEEP

```

Program Listing 5. Complete menu-driven running program for Microbe 3.

```

860 PROCLEFT
870 PROCBEEP
880 GOTO 750
890 ENDPROC
900
910 DEF PROCcollision
920 CLS
930 PROCCOLLISION(PB7)
940 GOTO 910
950 ENDPROC
960
970 REM SUB-PROCEDURES *****
980
990 REM EXCHANGE:
1000 DEF PROCMESSAGE
1010 SOUND 1,-15,97,10
1020 SOUND 1,-15,105,10
1030 SOUND 1,-15,89,10
1040 SOUND 1,-15,41,10
1050 SOUND 1,-15,69,20
1060 FOR D = 1 TO 10000
1070 NEXT D
1080 ENDPROC
1090
1100 DEF PROCREPLY
1110 PROCTONE1
1120 PROCTONE2
1130 PROCTONE1
1140 PROCTONE1
1150 PROCTONE2
1160 PROCFLASH
1170 ENDPROC
1180
1190 REM MOTION:
1200
1210 DEF PROCFORWARD
1220 ?&FE60=&0F
1230 PRINT
1240 PRINT "FORWARD"
1250 SOUND 1,-12,20,1
1260 FOR M=1 TO 2000
1270 NEXT
1280 ?&FE60=&05
1290 PRINT
1300 PRINT " " STOP"
1310 SOUND 1,-12,20,1
1320 FOR M=1 TO 2000
1330 NEXT
1340 ENDPROC
1350
1360 DEF PROCREVERSE
1370 ?&FE60=&00
1380 PRINT
1390 PRINT " REVERSE"

```

```

1400 SOUND 1,-12,20,1
1410 FOR M= 1 TO 2000
1420 NEXT
1430 ?&FE60=&05
1440 PRINT
1450 PRINT "
1460 SOUND 1,-12,20,5
1470 FOR M=1 TO 2000
1480 NEXT
1490 ENDPROC
1500
1510 DEF PROCLEFT
1520 ?&FE60=&0C
1530 PRINT
1540 PRINT "LEFT"
1550 FOR X=1 TO 4000
1560 NEXT
1570 ?&FE60=&05
1580 FOR X=1 TO 2000
1590 NEXT
1600 ENDPROC
1610
1620 DEF PROCRIGHT
1630 ?&FE60=&03
1640 PRINT
1650 PRINT "RIGHT"
1660 FOR X=1 TO 4000
1670 NEXT
1680 ?&FE60=&05
1690 FOR X=1 TO 2000
1700 NEXT
1710 ENDPROC
1720
1730 REM SOUND:
1740
1750 DEF PROCTONE1
1760 ?&FE60=&15
1770 FOR S=1 TO 500
1780 NEXT
1790 ?&FE60=&05
1800 FOR S=1 TO 500
1810 NEXT
1820 ENDPROC
1830
1840 DEF PROCTONE2
1850 ?&FE60=&35
1860 FOR S=1 TO 500
1870 NEXT
1880 ?&FE60=&05
1890 FOR S=1 TO 500
1900 NEXT
1910 ENDPROC
1920
1930 DEF PROCBEEP
1940 ?&FE60=&35
1950 FOR X=1 TO 100
1960 NEXT
1970
1980 REM LIGHT:
1990
2000 DEF PROCLIGHT
2010 ?&FE60=&45
2020 FOR L=1 TO 1000
2030 NEXT
2040 ?&FE60=&05
2050 FOR L=1 TO 1000
2060 NEXT
2070 ENDPROC
2080
2090 DEF PROCFLASH
2100 ?&FE60=&45
2110 FOR L=1 TO 1000
2120 NEXT
2130 ?&FE60=&05
2140 FOR L=1 TO 1000
2150 NEXT
2160 GOTO 2100
2170 ENDPROC
2180

```

STOP"

Continued on next page


```

2190 REM COLLISION:
2200
2210 DEF PROCCOLLISION(PB7)
2220 ?&FE60=&0F
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
    
```

Program Listing 5.
(Continued from previous page).

```

EXCHANGE: PROCMESSAGE
          PROCREPLY

MOTION:  PROCFORWARD
          PROCREVERSE
          PROCLEFT
          PROCRIGHT

SOUND:   PROSOUND
          PROCTONE1
          PROCTONE2
          PROCBEEP

LIGHT:   PROCLIGHT
          PROCFLASH

COLLISION: PROCCOLLISION
    
```

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

IC1 Octal darlington driver with Rin RS 303 510
 IC2 NE555 timer
 TR1,TR3 BC182 (2 off)
 TR2 MPSA12

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)

MISCELLANEOUS

25 way D-type plug
 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.

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.

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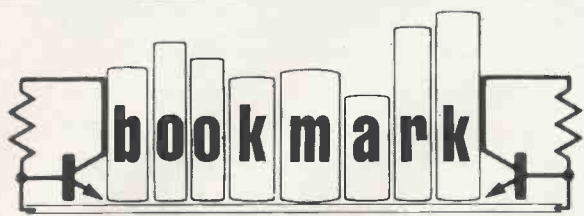
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Your Ed looks at some of the new books recently received.

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 ttl and 4000 cmos series, including functional descriptions and a selection of pinouts. It covers memory maps, Karnaugh maps, cpus and memories, conversion tables for Ascii, hex, binary, octal, 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 developing a microprocessor-based system, as well as to be of interest to anyone 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, 8-bit processors, 16/32 bit processors. RISC processors are discussed, together with single chip computers. Serial and parallel input/output parameters and protocols are presented. Multifunction 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 that 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 scrs. 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 Apple. £16.30. ISBN 0-8306-2982-3. **Learning Electronics Theory and Experiments with Computer-aided Instruction for the IBM.** £13.20. ISBN 0-8306-9382-3. 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, background 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 valuable even 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

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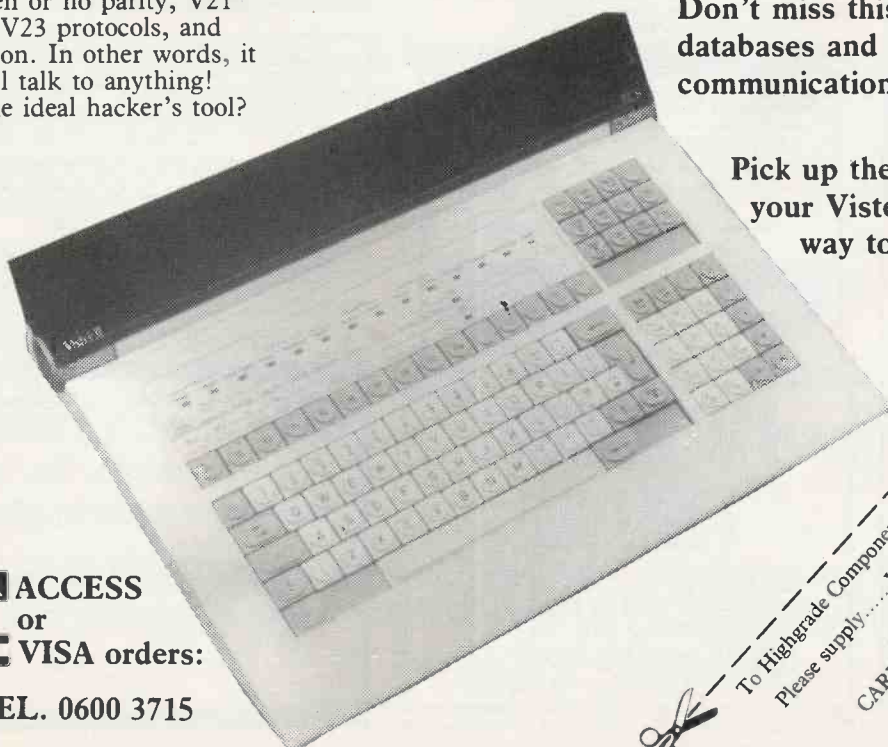
INDEX 3 A Swedish bulletin board for the adventurous, and for those with no worries about running up outrageous telephone bills. Dial: 010 46 42138 476.

HAWK'S CASTLE An interesting bulletin board which often has numbers for yet more bulletin boards. Who knows where you might end up? Dial 0344 411621.

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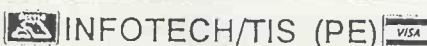
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Electronic engineers have always complained that their industry is far too much under control of accountants and lawyers. They cite examples of wrong decisions being made in the boardroom and imply that if engineers had been in charge these mistakes 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 industrial performance in the UK.

INDUSTRY



NOTEBOOK

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

CARDBOARD AND CUCKOO CITY

SHORT-TERMISM

The root of the trouble, according to this body of informed opinion, is financial short-termism. The share capital of British public companies is owned largely by financial institutions like pension funds and insurance firms rather than by individuals. These bodies control about £450 billion of investment in total. Always seeking the highest immediate returns, these organizations are constantly switching their funds around. Whenever they sense trading difficulties in a company - real or imagined - they sell their shareholding as quick as a flash and put the money somewhere else. They have no long-term interest in or knowledge of the companies or industries they are investing in. One firm is as good as another as long as it produces a fast buck.

As a result the managements of the electronics and other industrial companies are constantly worried by the instability of current funding. They are always looking over their shoulder at the share price and other indicators instead of devoting their full energies to producing and selling. If the share price falls, and hence the capital value of the company, they fear a takeover and start making defensive moves. They are reluctant to invest in R&D and training because the expenditure reduces immediate profits, and the financial markets reflect this by lowering the share price. Yet it's notorious that short-term share price fluctuations often have little to do with the real economic position of a company.

Overall the effect is that the directors and managers of the industrial companies become excessively concerned about what the financial markets want instead of what their customers want.

By Tom Ivali

Does the self-serving 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 dud 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 ISCgroup 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

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 bird 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.

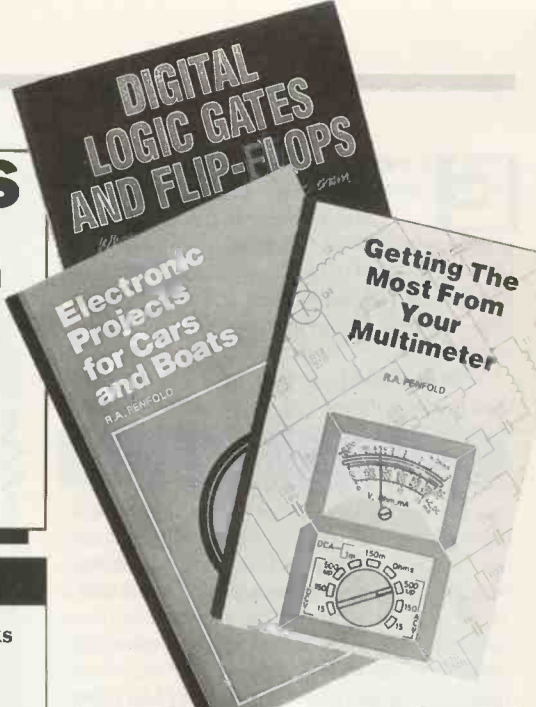
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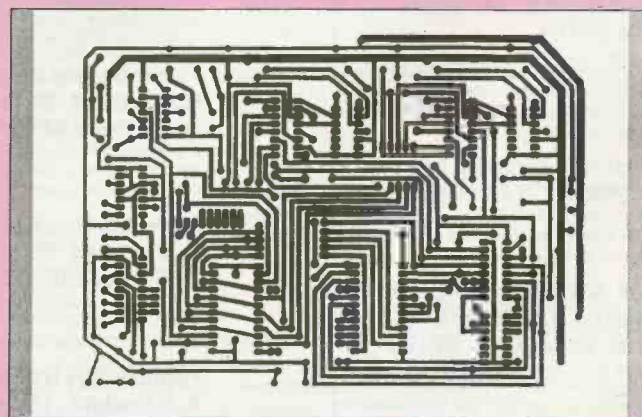
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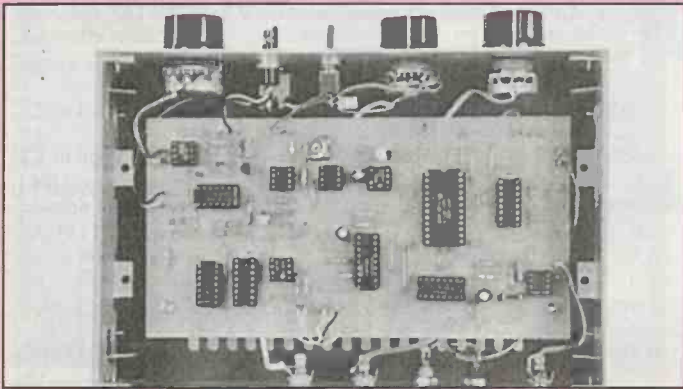
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TOOLS

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.

ASSEMBLING THE PCB

Authors will sometimes offer their own advice on the order of assembly, but as a general guide, it is usually easier to assemble parts in order of size. Start though with the integrated circuit sockets. Please use them where possible, they make life much easier than if you solder the ics themselves - with sockets you can just lift out an ic if you want.

Then insert and solder in order of resistors, diodes, presets, small capacitors, other capacitors, and finally transistors. Clip off the excess component leads after you have soldered them. Now use a magnifying glass, ideally one that you can hold to your eye, and take a good look at the joints, checking that they are satisfactorily soldered, and that no solder has spread between the pcb tracks and other joins. Be really thorough with visual checking since errors like this are the most likely reason for a circuit not working first time.

SOLDERING

Bring the tip of the iron into contact with the component lead and the pcb solder pad, then bring the end of the solder into contact with all three, feeding it in as it melts. Once sufficient solder has melted to fully surround the pad and the lead, remove the solder, and then the iron. Now allow the join to cool before touching it, otherwise the solder may set unsatisfactorily. If it does move, just reheat the join once more.

WIRING

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.

TESTING

Now you are ready to test and use the project as described by the author. Components can occasionally fail, but these days it is extremely uncommon, and if you have followed the instructions, been careful with your joins, and bought the parts from a good supplier, you will have the enormous satisfaction of having built an interesting and working unit. It really can be easy if you do it with care.

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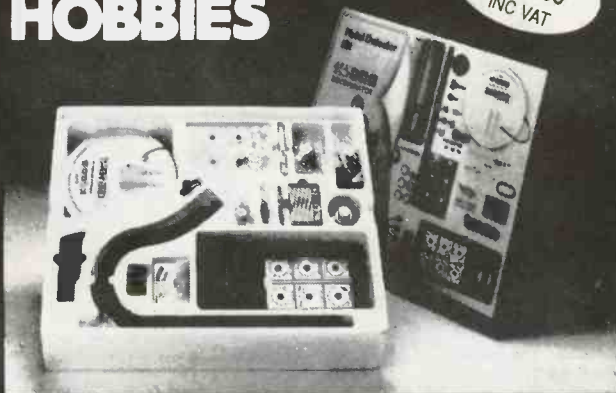
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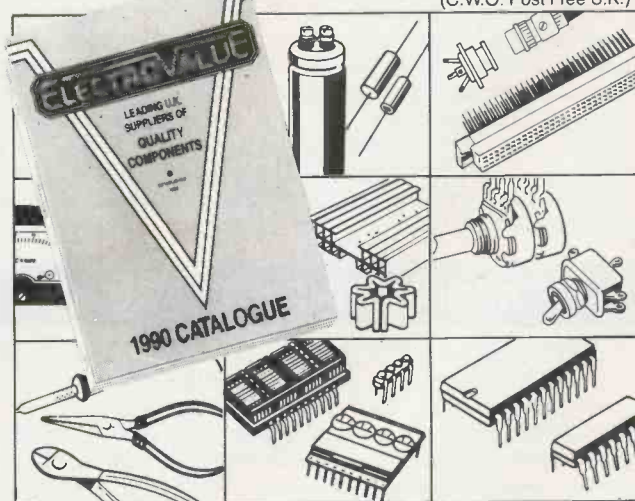
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OVP POWER AMPLIFIER MODULES-TURNABLES-DIMMERS-LOUDSPEAKERS-19 INCH STEREO RACK AMPLIFIERS

OVP POWER AMPLIFIER MODULES

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OVP POWER AMPLIFIER MODULES Now enjoy a world-wide reputation for quality reliability and performance at a realistic price. Four models available to suit the needs of the professional and hobby market i.e. Industry, Leisure, Instrumental and Hi-Fi etc. When comparing prices. NOTE all models include Toroidal power supply, Integral heat sink, Glass fibre P.C.B. and Drive circuits to power compatible Vu meter. Open and short circuit proof.

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NEW SERIES II MOS-FET MODULES



OMP/MF 100 Mos-Fet Output power 110 watts R.M.S. into 4 ohms. Frequency Response 1Hz - 100KHz - 3dB. Damping Factor, >300. Slew Rate 45V uS. T.H.D. Typical 0.002%. Input Sensitivity 500mV. S.N.R. -125dB. Size 300 x 123 x 60mm. **PRICE £39.99 + £3.00 P&P.**

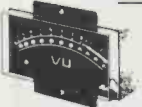


OMP/MF200 Mos-Fet Output power 200 watts R.M.S. into 4 ohms. Frequency Response 1Hz - 100KHz - 3dB. Damping Factor >300. Slew Rate 50V uS. T.H.D. Typical 0.001%. Input Sensitivity 500mV. S.N.R. -130dB. Size 300 x 155 x 100mm. **PRICE £62.99 + £3.50 P&P.**



OMP/MF300 Mos-Fet Output power 300 watts R.M.S. into 4 ohms. Frequency Response 1Hz - 100KHz - 3dB. Damping Factor >300. Slew Rate 60V uS. T.H.D. Typical 0.0008%. Input Sensitivity 500mV. S.N.R. -130dB. Size 330 x 175 x 100mm. **PRICE £79.99 + £4.50 P&P.**

NOTE - MOS-FET MODULES ARE AVAILABLE IN TWO VERSIONS. STANDARD INPUT SENS. 500mV BAND WIDTH 100KHz. P&P PROFESSIONAL EQUIPMENT COMPATIBLE. INPUT SENS. 775mV BAND WIDTH 50KHz. ORDER STANDARD OR PEC.



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 - 10" 50 WATT EB10-50 DUAL IMPEDENCE. TAPPED 4 & 8 OHM BASS. HI-FI, IN-CAR. RES. FREQ. 40Hz FREQ. RESP. TO 5KHz SENS. 99dB **PRICE £12.00 + £2.50 P&P.**
 - 10" 100 WATT EB10-100 BASS. HI-FI, STUDIO. RES. FREQ. 35Hz FREQ. RESP. TO 3KHz SENS. 96dB **PRICE £27.50 + £3.50 P&P.**
 - 12" 60 WATT EB12-60 BASS. HI-FI, STUDIO. RES. FREQ. 28Hz FREQ. RESP. TO 3KHz SENS. 92dB **PRICE £21.00 + £3.00 P&P.**
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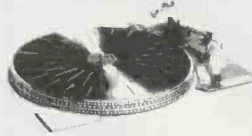


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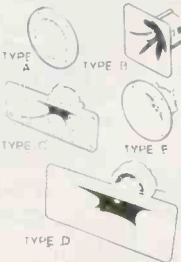
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PIEZO ELECTRIC TWEETERS-MOTOROLA

PIEZO ELECTRIC TWEETERS — MOTOROLA

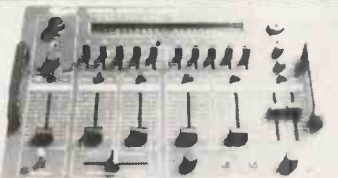
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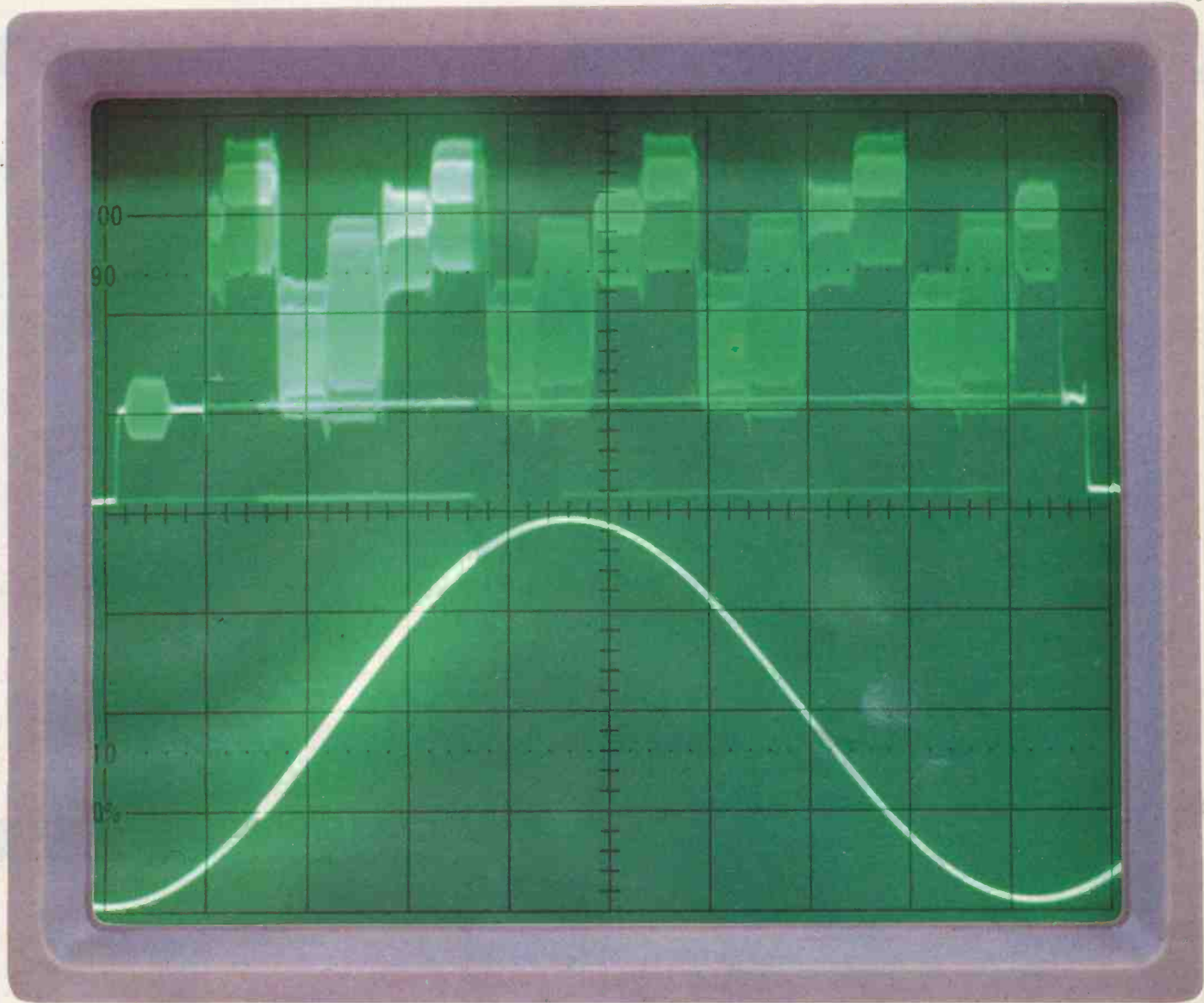


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