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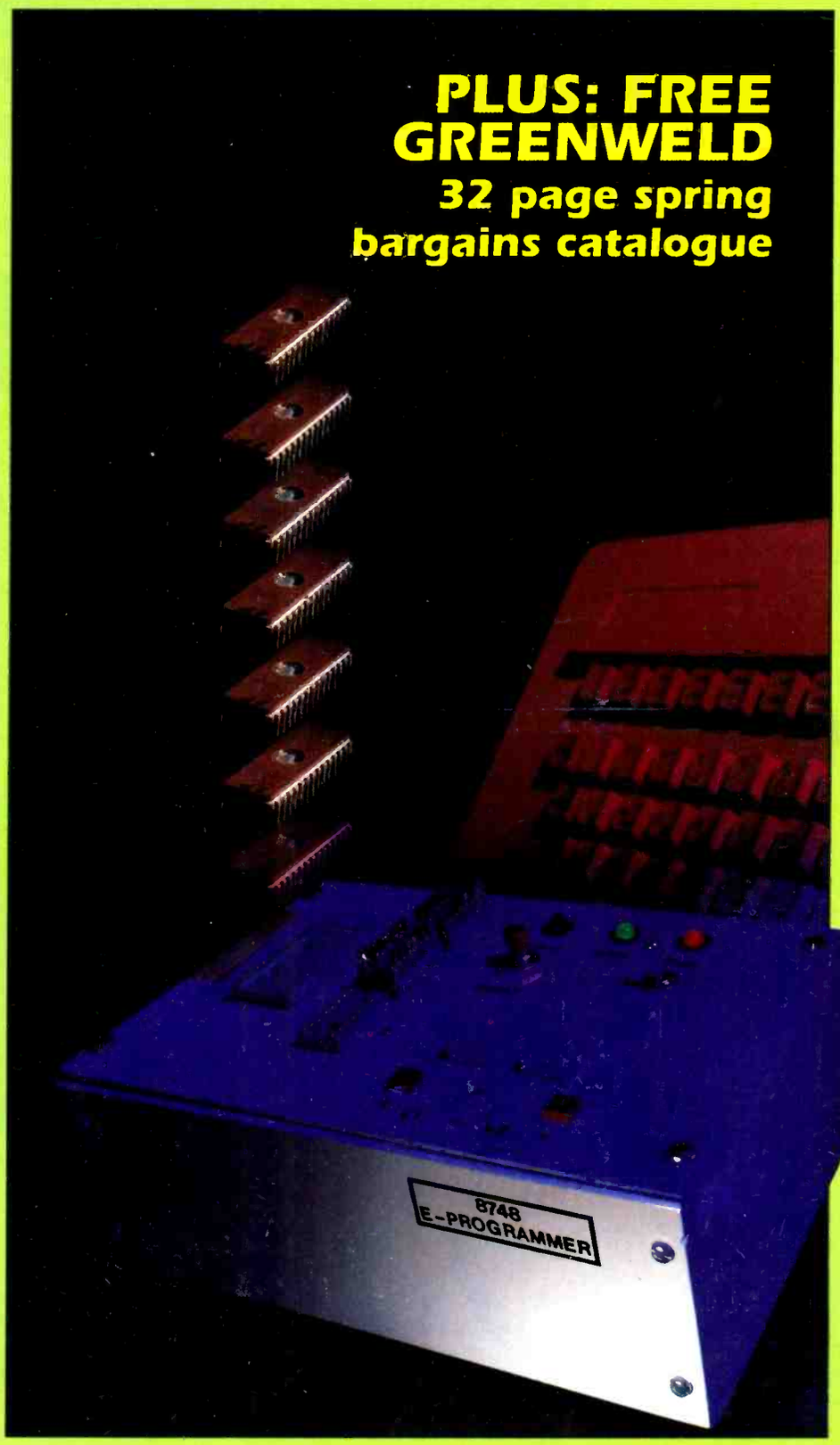

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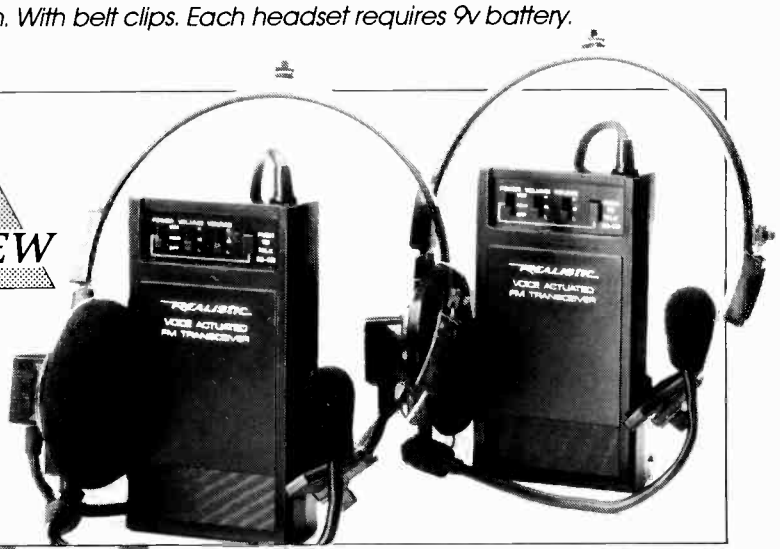

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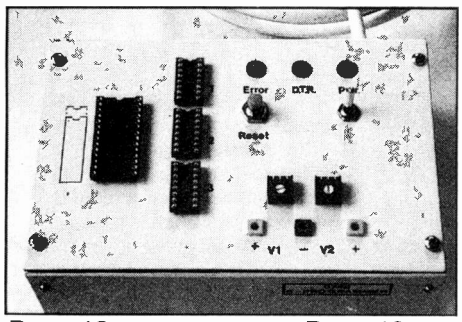

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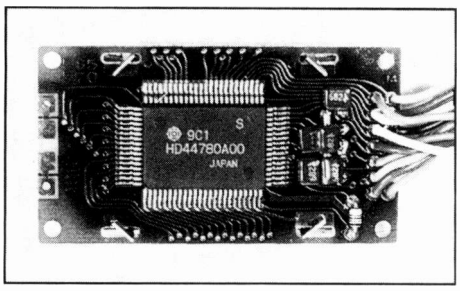

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NEXT MONTH

We put display theory into practice showing you how to build and use an 80 character alphanumeric Message Maker with the intelligent lcd module described this month. Communications buffs can breath a sigh of relief: the baud rate converter we had hoped to bring you this month (sorry, lack of space prevented it) will be in next month's issue, offering you greater inter-computer talk-back facilities. We'll have more on robot car control circuits and software, and enlighten you even further with another episode in the Basic Electronics series. We've other great offerings in preparation, plus, of course, our usual top-line features.

★ SUMMER IS A-COMING IN

★ AND SO'S OUR WELL-SEASONED JUNE 1990 ISSUE

★ ON SALE FROM FRIDAY MAY 4TH DON'T MISS IT!

PRACTICAL ELECTRONICS

VOL 26 NO 5 MAY 1990

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PE TAKES TECHNOLOGY FURTHER - BE PART OF IT!

NEWS

BAZOOKA BOOM-BOOM

Are Philips taking the ghetto-blaster concept to new martial extremes? That must surely depend on your viewpoint, but it seems like they have gone on to a war footing with their Bazooka sound blaster.

When the Bazooka was first launched last summer it was camouflaged in battle-ship grey. At that time it was sold as part of Philip's Moving Sound range, and was an enormous success. Now coming more firmly on to the attack, Philips have relaunched this stereo radio cassette recorder as an active unit in its own right, and given it a new coat of paint - deep space star-wars black.

Code named the AW7192, the Bazooka derives its title from its decidedly wacky shape, which to many observers resembles a military bazooka. For ease of portability among the armies of street-wise kids, the Bazooka has a soft padded handgrip and padded base. It has a formidable music power-punch output of 20 watts.

The dual cassette deck has marching orders which include high speed dubbing, continuous play, pause facility, and automatic recording level control. The three-band fm -stereo/lw/mw tuner has automatic frequency control on fm, an fm stereo led indicator and automatic mono/stereo switchover. Dynamic bass boost (DBB) emphasises bass tones, contributing warmth and richness to the sound, especially at low volume levels. Sound quality is further enhanced by the end-mounted speakers which produce superb in-phase stereo from both sides of the machine.

Equipped for either mains or battery operation, the versatile Bazooka also boasts slider volume/tone controls, built-in condenser microphone, and a headphone socket. Weighing in at 2.9kg and measuring 518 x 200 x 160mm the Philips AW7192 retails at £69.99.

We wonder what other weaponry shapes music machines might assume. How about a neat line of cut-down stereo Cruise missile music makers, we understand there might be quite a few going spare which could be put to more useful and peaceful (?) use.

Challenge your local audio dealer about his retailing battle plans for the AW7192 Bazooka. Tell him that when it comes to music, the Philips Arsenal rules, ok!

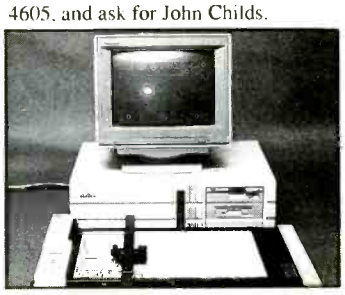
WHITE HOUSE PLOTTING

You don't need to be called Nixon, North or even Fawkes, to now have access to plotting facilities. White House Systems have announced that they have launched an HPGL plotting service aimed at the serious amateur and small professional users of CADD (computer aided drafting and design) who do not have their own plotting facilities.

The plotting service uses top quality film and inks, and other media are available on request. Plot sizes of up to A1 are offered. HPGL files can be sent on either 3.5 inch (720K or 1.44M) or 5.25 inch (360K or 1.2M) discs, and most HPGL formats can be plotted.

Prices start from only £5 (including post and packing), and all plot designs will be despatched by first class post within 24 hours.

So whatever you're plotting, enlist the help of **White House Systems**, 48 South Terrace, Esh Winning, Durham, DH7 9PS. Tel : 091 373 4605, and ask for John Childs.



CATALOGUE DATABASE

Our browse through recently received literature

Eskan have sent us copies of their publicity material. This company recognises that as electronic and computing equipment is becoming more sophisticated, so many people are realising the necessity for effective security, both in their work and personal lives. Eskan was formed to provide the advice and essential equipment necessary to give you the confidence and security that you need. Their **wide range of security products** is mainly related to communications security in various forms. They have telephone monitors, both of the conventional monitoring variety, and of the 'bug' transmitter type which enable any telephone conversation to be picked up using a receiver. Into similar categories fall their room monitors. Associated products include vhf transmitters whose signals can be picked up on standard fm radio or airband receivers, both of which Eskan can supply. If security or counter surveillance is your concern, Eskan can probably supply advice and the goods. **Eskan Electronics Ltd**, 172 Caledonian Road, London N1 0SG. Tel : 01-278 1768.

On another page we have publicised the BAEC. Another club well worth while supporting if you're interested in electronic music is the **EOCS, the Electronic Organ Constructors Society**. Their latest magazine has arrived and as usual it's full of interesting ideas and circuits, as well as readers' comments and suggestions. Also included are reports on local meetings, plus a 'for sale' section. **This club, too, would love to have more new members joining.** Why not write to them for membership details? A.T. Hawkins is in charge of subscriptions and new members. He can be contacted at 23 Blenheim Road, St Albans, Herts, AL1 4NS.

Digisound can probably help you if you're looking for parts to build anything from a very basic monophonic synthesiser to an extremely versatile and ever **expanding polyphonic modular system**. Their nicely-produced glossy 8-page catalogue has recently been received and it describes the full range of kits available. Tim Higham's the man to contact at **Digisound**, 16 Lauriston Road, Wimbledon, London SW16 4TQ. (Tel number not quoted.)

TMK's latest catalogue is fully illustrated in colour. The company specialise in **test instruments**, which they have been designing and manufacturing in the UK for more than 25 years. The majority of instruments are meter-related and include clamp meters, thermometers, cable testers, milliohm meters, **analogue multimeters, and digital multimeters** of many varieties. They also have a speed probe and a flat mini chart-recorder. The company is the test equipment division of Harris Electronics (London) Ltd. **TMK Instruments**, Unit 3, GEC Estate, East Lane, Wembley, Middx. HA9 7PJ. Tel : 01-908 3355.

Miles Gordon Technology have been regularly sending in literature relating to their **Sam Coupe micro-computer**. Much of the information has been of a highly specific technical nature, but to summarise: the Sam Coupe micro-computer is a **second generation machine** with a Z80B microprocessor running at 6MHz. The heart of the machine is an ASIC (application specific ic) which contains 3066 gates, which is the equivalent of about 130 ordinary chips. It has fitted on-board 256Kb of memory upgradable to 560Kb. 32Kb of rom contains Sam Basic, disk bootstrap, and Bios. The machine utilises video memory mapping, has a 64-colour palette, a six channel stereo sound synthesiser and a Midi interface. MGT are obviously very proud of their new machine and would be pleased for you to ask for literature on it. **Miles Gordon Technology Plc**, Lakeside, Phoenix Way, Enterprise Park, Swansea, SA7 9EH. Tel : 0792 791100.

NEWS

CLUB MEMBERS WANTED

The British Amateur Electronics Club is urgently looking for new members. It fears that if it doesn't find them, it may be forced to close. On behalf of the Club, we appeal to all PE readers to consider joining this very worthwhile nationwide club.

The club was founded in 1966 (two years after PE began) by Cyril Bogod. It started in Penarth, South Wales, but soon expanded its activities by recruiting members throughout the British Isles and even overseas. The mainstay of the club is the quarterly newsletter, which contains articles on a variety of electronic topics, mainly of a practical nature. It offers a forum for members to exchange information, and provides advice for beginners, who can take their problems directly to more experienced members. Sections covering help wanted, sales and exchanges have also helped many members.

We have frequently publicised the BAEC's quarterly newsletter, but were unaware of the club's declining membership until we recently received a letter from a senior committee member, Herbert Howard. In his letter, Herbert advised us that Cyril Bogod was in poor health and felt that he could no longer carry on as Chairman. Herbert, previously the joint editor of the newsletter, had now taken over as Chairman.

Herbert's letter continued: "I have agreed to do this on an interim basis, as the production of the newsletter is the mainstay of the Club and I have edited the last two issues. It would be unrealistic for me, at the age of 76, to see this as a continuing commitment. What is needed is a member - or better, a small group of members - preferably young and enthusiastic, who could continue and extend the activities of the Club in the foreseeable future.

"It seems to me that the Club is at the crossroads. Membership has declined; those who have been members from the start or joined a few years ago are not now able to play a very active part. Indeed, we have a number of members who, like me, joined after retiring from full-time work. It is true that there is a number of younger members as well, and I believe all of us would like to see the Club continue.

"With such a diversity of membership it is not easy to produce a newsletter which can interest everyone. It cannot compete with published electronic magazines, nor should it attempt to do so. But it does provide what these magazines cannot do, which is to offer personal contacts between members, often leading to continuing friendship."

In addition to hoping that many new members will be encouraged to join the Club, Herbert hopes that people will tell him what sort of material they would like to see in the newsletter (the latest one is 30 A4 pages long). Herbert's own preference is for practical articles, but he goes on to say: "Details of readers' experiences, successes and failures, views on component suppliers - mail order and retail, inexpensive sources of components, members' sales and wants and requests for information, and reviews of books or magazine articles would all, I believe, have a general appeal."

Readers, this is a club that can give you great benefit and a lot of pleasure from electronics. It should not be allowed to go into decline through lack of new membership. You're all interested in electronics - you wouldn't be reading PE if you were not. Don't be apathetic, get out your pens and write to Herbert saying that you want to join the BAEC. A year's membership costs only £7.00 if you live in the UK or Eire. Overseas subscription is £8.50 if you live Europe or want your newsletter sent by surface mail. If you live outside Europe and want the newsletter sent by airmail, the rate is only £12.50. Boost the Club's numbers up and gain the rewards from a worthwhile two-way relationship in electronics.

Write now to Herbert Howard, BAEC, 41 Thingwall Park, Fishponds, Bristol BS16 2AJ. And tell him John, PE's Editor recommended you!

GLOBAL VILLAGING

The term 'Global Village' goes some way to describing the fluency of communication that is afforded by increasingly sophisticated technology. But the basic irony about the whole welter of gadgetry that surrounds us in business and domestic life is that, rather than making matters simpler, it can tend towards making it more confusing and, indeed, more costly.

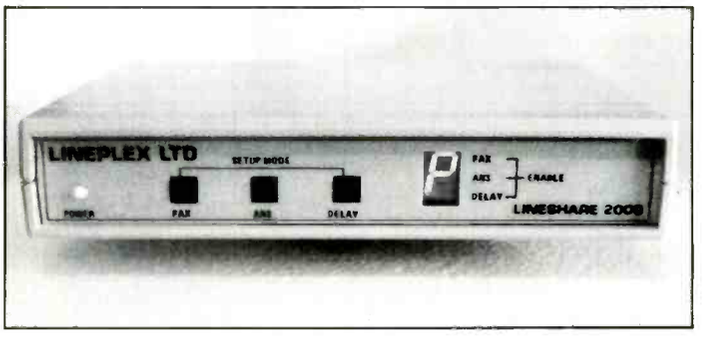
A new BABT-approved product, which is also compatible with Mercury, promises to take some of the strain off your pocket and the phone lines.

The brainchild of Lineplex, the Lineshare 2000 enables a fax, an answerphone, a modem and one or more phones to share just one phone line. The cost saving implications are obvious. For those who wish to work at home or have a limited small business budget, the product opens new possibilities.

As an added bonus, the micro-processor controlled box offers phone management facilities and is able to take a fax message as part of a phone call. There is no need to redial since the unit continually listens for the fax tone.

Undoubtedly a streamlined solution to problematic technological hang-ups. And the price will keep you solvent too, it's only £195 plus vat.

For further information contact **Lineplex Ltd**, Barn House, White Horse Lane, Ripley, Woking, Surrey. GU23 6BJ. Tel/fax : 0483 211632.



EVENTS DIARY

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.

Apr 4-5. Drives, Motors, Controls. New Century Hall, Manchester. 0799 26699.

Apr 9-11. Cable and satellite exhibition and conference. Olympia, London. 01-486 1951.

Apr 24-26. British Electronics Week. Olympia, London. 0799 26699.

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.

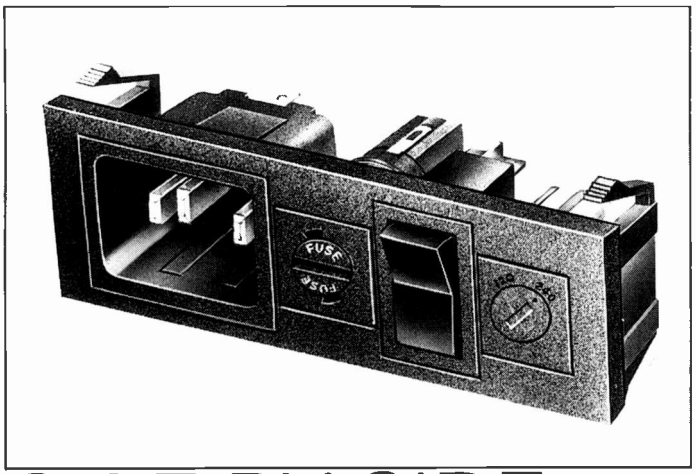
Jun 26-28. Infrared Technology. Wembley Conference Centre. 0799 26699.

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.

NEWS



SIDE BY SIDE

A new Polysnap power inlet module has been introduced by Bulgin and which facilitates the assembly of components in a side by side configuration, unlike most modules in which a vertical configuration is more usual.

When panel space is at a premium, such as in instrumentation, the added versatility afforded by the new horizontal format Polysnap should be particularly helpful in giving the option of alternative layouts, says the company.

The new side by side format offers an integral BS4491 inlet, a 5 x 20mm fuseholder, a single or double pole switch and a voltage selector as standard. However, the selector and fuseholder may be replaced with an optional neon indicator or blanking plate if preferred.

The addition of this new module means there will be a choice of more than 300 different Polysnap snap-in combinations. The line of products is one of a broad range of electronic and electromechanical products manufactured for world markets at Bulgin's Barking factory.

For further information contact **A.F. Bulgin and Co Plc**, Bypass Road, Barking, Essex, IG11 0AZ. Tel : 01-594 6913.

CABLING PROGRESS

Several times a month I receive information from the Cable Authority concerning recent developments regarding the introduction of cable tv. Most of these relate to applications for new franchises, and by which organisations they are being made.

So far the Authority has awarded 56 franchises across the country. Another 50 franchises are currently in the pipeline, either with applications being considered by the Authority or with areas already advertised and applications awaited.

We have recently also received information which should be gladly received by franchised operators, and which should ultimately be of value to subscribing viewers. The Authority has reduced its licence fees substantially for 1990, the first year since it was set up five years ago that the Authority has not found it necessary to increase its fees.

The annual licence fee for the average franchise has fallen from £18,000 to £7,500. This reduction reflects the enormous growth in the cable industry which is currently taking place, enabling the Authority to spread its costs across a much increased number of licensees.

John Davey, the Authority's Director General, said recently, "The extent of the boom in cable is such that we expect these lower fees still to generate higher total revenues in 1990 than the fees delivered in 1989."

The Cable Authority is required by law to be self-supporting from the fees that it charges to its licensees. It is non-profit making and in its early years it was funded by loans from the Government. Partly as a result of the regulatory light touch pioneered by the Authority, and now expected to be followed by the new Independent Television Commission, it has kept its costs low and, even after five years of existence, has just achieved its financial break-even.

CABLED WITHDRAWAL

With all the fuss about what should and should not be transmitted into our homes by the plethora of tv channels spring from the sky and underground, it's good to know that at least one organisation has the teeth to enforce its barks. The Cable Authority has withdrawn its approval for the carriage of the German-language channel RTL Plus on cable tv and SMATV systems in the UK.

RTL Plus had recently shown a number of programmes during the daytime that appeared to be aimed at an 'adult' audience. In particular, a film containing scenes of nudity, adult situations and 'bad' language was shown at lunchtime, in breach of the Cable Authority's programme codes and guidelines, which place specific time constraints on the screening of such material. (Quite right too - it'd be enough to take anyone's concentration off their meat and pudding!)

It appeared to the Authority that the nature of RTL Plus, and its scheduling philosophy had changed materially since it was originally approved for carriage on UK cable some years ago, and that it was no longer acceptable by British standards.

Since March 1st, the Authority has placed new restrictions on channels whose programming is aimed at adult audiences. These channels, including Home Video Channel and the United Pay-Per-View channel, may not be carried in the basic package of cable channels, but can be made available only to viewers who have specifically requested them.

RTL Plus may still be viewed directly by home dish owners who receive transmissions from the Astra satellite.

It's perhaps pertinent to quote figures just released by the Independent Broadcasting Authority (IBA) concerning audience's perceived response to the main tv channels. The following tables were published in the winter issue of *Airwaves*, the IBA's quarterly journal (no mention was made of cable tv):

TABLE 1
The nature of offensive programme content

	1986 %	1987 %	1988 %	1989 %
ITV				
Not offended by channel	65	64	69	65
Offended by				
Bad language	22	21	18	20
Violence	16	21	16	15
Sex	14	18	12	12
BBC1				
Not offended by channel	69	69	71	69
Offended by				
Bad language	19	18	15	18
Violence	15	17	14	12
Sex	13	15	10	10
BBC2				
Not offended by channel	88	88	87	81
Offended by				
Bad language	6	7	8	10
Violence	5	5	7	6
Sex	5	5	7	6
Channel 4				
Not offended by channel	83	81	81	73
Offended by				
Bad language	11	12	13	15
Violence	8	9	9	9
Sex	8	11	9	10

Respondents could name more than one type of offensive material, percentages based on all television viewers

TABLE 4
Perceptions of satellite television channels

	1988	1989	
	%	Not seen satellite %	Seen satellite %
Better quality than present TV	31	20	35
Same quality as present TV	27	16	23
Worse quality than present TV	30	36	32
Don't know	13	28	9

Base All those who had heard of satellite TV

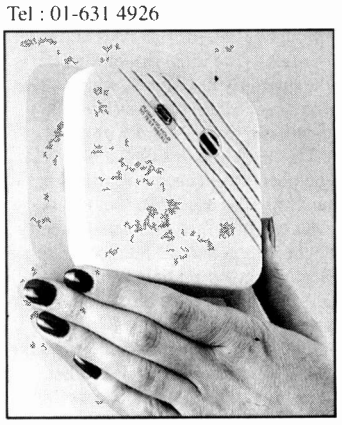
NEW SMOKE ALARMS

Black and Decker have introduced a new range of smoke alarms which are much more compact and have been completely restyled to a more appealing design.

The alarms have a test button, an led power indicator, and are battery powered. The basic alarm is suitable for use all around the home. The kitchen alarm is suitable for any room where cooking takes place, and has a temporary silencer to stop it from reacting to cooking vapours by reducing its sensitivity level for 15 minutes. The escape route alarm is for siting in hallways and landings, and has an additional feature, high intensity intermittent beam which, when activated, indicates the escape route.

The three alarms are priced at £9.99, £12.99 and £14.99, respectively.

For further information contact your local **Black and Decker** stockist, or Barbara Attenborough Associates, Dumbarton House, Oxford Street, London W1N 9LA. Tel : 01-631 4926



INVENTION COMPETITION

For the third successive year Toshiba is sponsoring the national Year of Invention competition which offers prizes valued in excess of £100,000. Administered by the Design Council, the competition aims to encourage and stimulate new inventions, talent and ideas which will result in long term benefits for Britain.

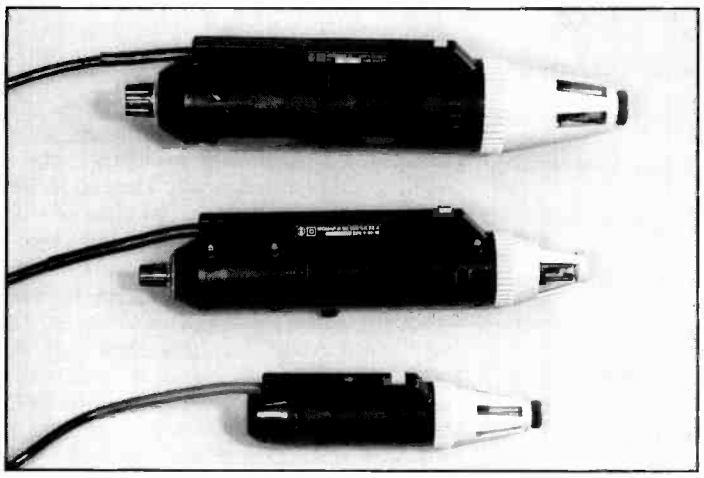
For further information telephone Catherine Miller, Nelson Bostock Communication on 01-229 4400.

POINTS ARISING

Modem (Feb 90)

The author has clarified a number of points that have arisen. Please send an sae for the list of answers.

NEWS



SPEEDY STRIPPING

Ideal for any small business which caters for electronic assembly is the new range of wire strippers from Series 4.

The Isomap range of strippers will strip both enamelled and thermoplastic insulations and can be hand held or bench mounted as required. The tools utilise a precision balanced rotary blade stripping head with a finite depth adjustment to strip thermoplastic, teflon and fibreglass insulations up to 14mm outside diameter, and round enamel insulation up to 9mm outside diameter. A wire brush head attachment is also available for the largest unit in the range to strip rectangular enamel wire.

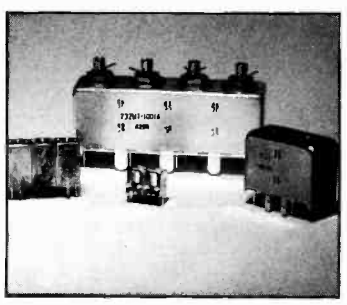
The two larger units have a built in speed control so that they can be plugged directly into a mains supply. All units are available in both 110V and 240V.

For further information contact **Series 4 Ltd**, PO Box 112, Southampton, Hants, SO9 7NN. Tel : 0703 474581.

VERSATILE FILTERS

As the frequencies of vhf, uhf and microwave equipment have increased, so the demand for higher frequency filters has grown.

Conventional l/c filters are restricted by the low capacitance and inductance values necessary, while the relative inflexibility of piezo-electric devices makes them similarly impractical.



Overcoming these restrictions is a versatile selection of Toko helical filters now being marketed by Cirkit. Their design incorporates a single layer helix winding on a low-loss former enclosed in a highly conductive shield, with one end of the winding terminated to the shield (grounded) and the other end open circuit. Models range from 100MHz to 1.5GHz, all combining low insertion loss and excellent tunability, in a choice of low-profile 5mm units which are ideal for portable equipment, and 7mm CB/HR ranges which offer superior flexibility.

A comprehensive selection of frequencies are available, with many values held in stock for immediate delivery. All helical filters are also available custom made to individual user requirements, subject to minimum quantities.

For further information contact **Cirkit Distribution Ltd**, Park Lane, Broxbourne, Herts, EN10 7NQ. Tel : 0992 444111.

FRIENDLIER TELECOM

The final link in a unique computer system was recently put in place in London. The system is the largest of its kind in the world and is designed to give a friendlier and speedier service to British Telecom customers throughout the UK.

BT's Customer Service System (CSS) is a fully integrated, screen based system which gives staff who deal with customer orders, billing or fault enquiries, access to a much wider range of information than before. It means that even complex enquiries can usually be dealt with while the customer is still on the line. In time, customers will deal with just one unit for the majority of their telecoms needs, improving response time and quality of service.

The opening of the CSS centre at Ealing brought the last of 27 district CSS centres officially into operation, completing the nationwide implementation to give all BT's 24 million customers a better and faster service.

CHIP COUNT

NEW FLIP-FLOPS

The term *metastability* may be an unfamiliar one to some readers, but its effects can cause considerable problems for designers of asynchronous systems. Philips have now released four new integrated circuits which are immune to the condition.

Metastability is phenomenon which occurs usually in asynchronous systems when set-up or hold times for a flip-flop are violated. When this occurs the flip-flop will settle in a 'metastable' state somewhere between the two stable states (logic high and logic low). It will stay like this until knocked up or down by noise. While the flip-flop is metastable the output 'glitches', a major problem for designers of high performance systems.

The first two flip-flop types from Philips are the 74F5074 and 74F50109. They are metastable-immune versions of the popular D-type and JK flip-flops 74F74 and 74F109. They are also considerably faster with an F_{max} of 150MHz.

The other new types are dual D-type flip-flops, 74F50728 and 74F50729. In the 74F50728 the flip-flops are cascaded, whilst the 74F50729 is a metastable-immune version of the popular 74F5074 with clocked Set and Reset.

All four ics have a guaranteed output-to-output skew of less than 1.5ns. They represent a considerable technical advance which will not only simplify system design but will also lead to greater improvements in reliability.

ULTRA-LOW POWER SRAMS

The static random access memories (sram) in the new FCB61C65 series are the first of their type to be offered by Philips. They feature ultra-low power consumption of only 1uA, both in the 5V standby mode and the battery back-up mode, while in the active mode the power consumption is 70mA. (PE wishes that manufacturers would find ways of reducing the active mode power consumption of rams as well: 70mA from a small battery in handheld equipment is a severe penalty.) The family comprises normal and low power variants as well as versions offering speeds of 70ns and 55ns.

Double-metal 1.2um technology, together with cmos 6-transistor memory cells, accounts for the new sram's very low standby power consumption, stability at low supply levels (under 2V), low sensitivity to alpha particles and wide temperature range.

All devices in the FCB61C65 family operate from a single 5V power supply and have inputs and outputs that are ttl and cmos compatible. Two chip enable pins are provided to give maximum flexibility, easy memory expansion and control in the standby mode.

The address activated devices feature combined data input and output interfaces and can also be tri-state controlled with a separate output-enable pin.

MINI STAND-UP POWER RESISTORS

The new miniature wirewound SMW02/3/5 series resistors from Philips are supplied in a 'stand-up' configuration which gives them a high heat dissipation factor for their size. Their power ratings are 2W, 3W and 5W respectively, and resistance values are 0.1 ohm to 560 ohms in the E24 series.

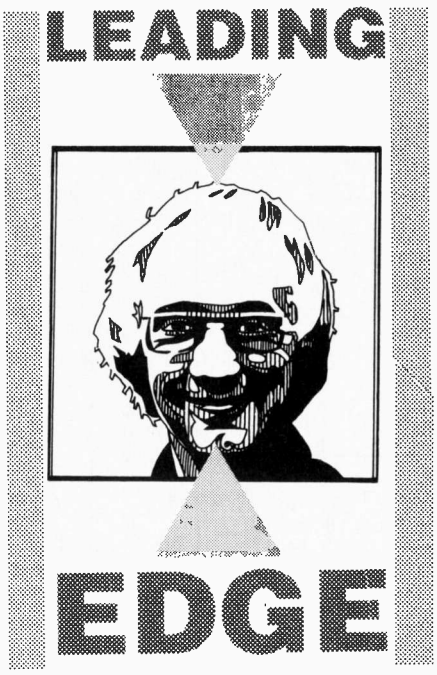
The core of these new stand-up resistors is a single layer wire winding on a ceramic rod. Metal end caps with copper-clad iron leads complete the basic construction. This entire assembly is then encapsulated in a rectangular ceramic base which is non-flammable and will not melt, even at high overloads. The encapsulating material is also resistant to most cleaning solvents.

The short pins are spaced at 5mm centres. The resistors are all marked with type, power dissipation, resistance value, tolerance and production week code.

MANUFACTURER'S ADDRESS

Philips Components Ltd, Mullard House, Torrington Place, London WC1E 7HD. Tel : 01-580 6633.

CONSUMING JAPANESE



BY BARRY FOX
Winner of the
UK Technology Award

Despite widespread automation, the Japanese consumer industry is beginning to feel the pinch.

Automated production is the key to success in the consumer electronics industry. When tuned to perfection it reduces costs and ensures consistent quality. I wonder how many people fully appreciate the extent to which Japanese industry has automated the mass production of precision electronics, and mechanics.

At JVC's factory at Yokohama a row of 63 robots assembles video camcorders. Each robot has arms that take just eight seconds to carry out two quite separate operations before the parts move on a conveyor belt down to the next robot. Humans are employed to run up and down the conveyor belt, freeing any jams that occur, for instance when a robot arm misses its target - thereby sounding an alarm and red light. Only one human being is employed to sit on the production line, and work alongside the robots. She adjusts variable component settings. She has such sensitive fingers that JVC has not yet been able to devise a machine to do her job.

Both JVC and its rival TDK make video tape cassettes, with virtually nothing touched by human hand. Anyone who has tried to take a video cassette apart and re-assemble it will recognise the challenge of fully automated assembly. In each company's factory robot trucks follow electric control tracks buried in the floor to transport the parts from one workstation to another and more robots assemble the cassettes. Almost nothing is touched by human hand.

JVC's parent Matsushita (maker of Panasonic and Technics equipment) has factories which are arguably the most automated in the world. Japanese television station NHK recently made a documentary about automation, taking Matsushita's new factory complex at Sendai as the model example. Sendai is where Matsushita builds and experiments with robots on the production line. When the technology is proven, more of the same robots are built and sent to other factories around the world - Matsushita has 69 factories in 28 countries outside Japan. On the NHK programme, a Matsushita manager made a significant admission.

"We have built factories in countries like Singapore, where labour is cheap. But now labour costs are rising. So we have to export equipment to automate the production line if we are to remain competitive".

In Matsushita's factory at Ibaraki near Osaka eight production lines each make up to 1000 tv sets a day. Most of the lines are staffed entirely by machines, with articulated arms which do the job of human hands. Human supervisors stand to attention watching the machines work, ready to run across the factory floor whenever a red light flashes the alarm that a machine has a developed a fault, usually by fumbling the insertion of a component into a socket. Between 75% and 80% of the factory processes are now fully automated. It remains cheaper for humans to handle large and awkwardly shaped components.

Mitsubishi's tv and video factories at Kyoto are similarly automated. Over the factory floor, a large sign encourages the humans employed to tend the machines to "Respond quickly with all our hearts to achieve our targets".

Matsushita's video factory, in the mountains near Okayama, can produce 110,000 "table top" video recorders and 150,000 camcorders every month. There are now around 3,000 components in a table-top video recorder, and 4,000 in a camcorder. The factory has automated machines to make the high precision video head drums needed by every recorder, selling them also to other companies around the world.

The drum is made from aluminium and is machined to size, with 2 micrometre accuracy, completely automatically. Other machines make the tiny video heads and fit them to the drums, again completely automatically. All these machines run 24 hours a day, unattended during two shifts. The only workers on site then are security staff who are forbidden to touch the machinery, other than to turn it off in an emergency. Together the machines make a million video heads a month. The coil for the head is wound by machine, 24 turns of wire 40 microns thick, thinner than a human hair.

The fly in the ointment is that even the ever-obliging Japanese consumer is now rebelling against the obligation to buy for the sake of buying. In 1970 35% of the production from the Japanese electronics industry was aimed at the consumer; in 1975 it was 31%, in 1985 it was 26%, in 1988 it was 22% and last year was dipping to near 20%.

There is no clear sign yet of any home entertainment product which will fill the gap left by saturation of the market for home video.

This is why Japanese consumer electronics companies are diversifying. It was Matsushita which coined the new phrase, "human electronics" to cope with the blurring line between consumer and industrial products. Mass production and integration of complex circuits onto microchips brings the price of computers and facsimilie machines down and makes them small enough to find space in the home. Western computer companies are now obliged to sub-contract the manufacture of portables to Japan. No Western manufacturer makes fax machines.

By moving deeper into the production of raw components, especially integrated circuits, the consumer companies win a stranglehold over the West. The Japanese production lines in the West import components from home base, pleading the inadequate quality of local supplies. Chips are now incorporated in everything from toasters to bombs; there is a semiconductor in every piece of electronic equipment.

When Akio Morita, founder of Sony recently helped write a Japanese-language tract, *The Japan That Can Say No*, he upset the US public only by stating the obvious - that the Pentagon's missiles rely on Japanese microchips for their guidance systems.

Those with foresight are asking whether the West has any place in the future of electronic manufacture, other than as production line fodder.

The dark truth is that Japanese manufacturers have so far built only factories in the West, and exported low grade production line work. Western governments live in hope that Japan will start to export research facilities, and thereby create job opportunities for graduate scientists and engineers. This is likely to remain a cuckooland dream.

PE

It seems likely that if I were to take a poll of those who read the cautionary feature regarding electric blankets, later on in this issue, I would find very mixed reactions, from downright alarmed to highly sceptical.

For many years, of course, we have been aware of the possibility of health problems arising from close and extended exposure to powerful electromagnetic fields. The CEGB has been researching that situation since 1978. I must admit, though, that at present I side with the sceptics, and doubt the immediacy of having to rearrange my life to exclude proximity to low power magnetic fields.

If there is validity to the assertion of some American researchers, we shall eventually hear more about it. Maybe then we shall need to make changes, but in the meantime, I can't believe that a bit more exposure to the magnetic fields we have been living with for decades can do much more harm. Perhaps, though, the Curies said the same about x-ray emissions, and we all know how wrong that assumption was proved to be. I suspect I can also hear cries of indignation from some quarters: "But you're not very young, nor very old, nor very sick, nor very pregnant!" True, and I accept that we must always cater for those more frail than the majority, but I believe that, in general, life is more robust than fragile.

PRACTICAL
ELECTRONICS

BLISS OR BLIGHT?

There are several levels on which the American research allegation should, perhaps, be judged. First, the consumer law in America is far more stringent than that in Britain. US manufacturers and suppliers are under far more risk of prosecution for defects or hazards relating to their products and services. The financial penalties involved can be huge. It's therefore incumbent upon American companies to ensure that they minimise the risk of being accused of negligence. Thus, at the merest hint of something becoming potentially a danger to the public, and however remote the possibility, action has to be taken and the situation fully publicised. There have been many instances of hazard alarms being raised in America over things which have subsequently turned out to be benign. It's true, of course, that the opposite has also been the case, to the benefit of society once the situation was known and remedied.

I have also formed the impression that, perhaps because of the above, American researchers test products to excessive limits, well beyond those which other researchers might consider to be appropriate to normal circumstances. Maybe if anything is tested to extreme limits it can be proved to be harmful. There are circumstances in which even oxygen, without which we would suffocate, can be a breathing hazard, as any trained diver will tell you. There will always be differences of opinion between experts on what constitutes normal and excessive circumstances. We each should be aware of the opposing opinions and draw our own conclusions on risk potentials.

Over the last few years we have been made aware of many areas of

Continued on page 41

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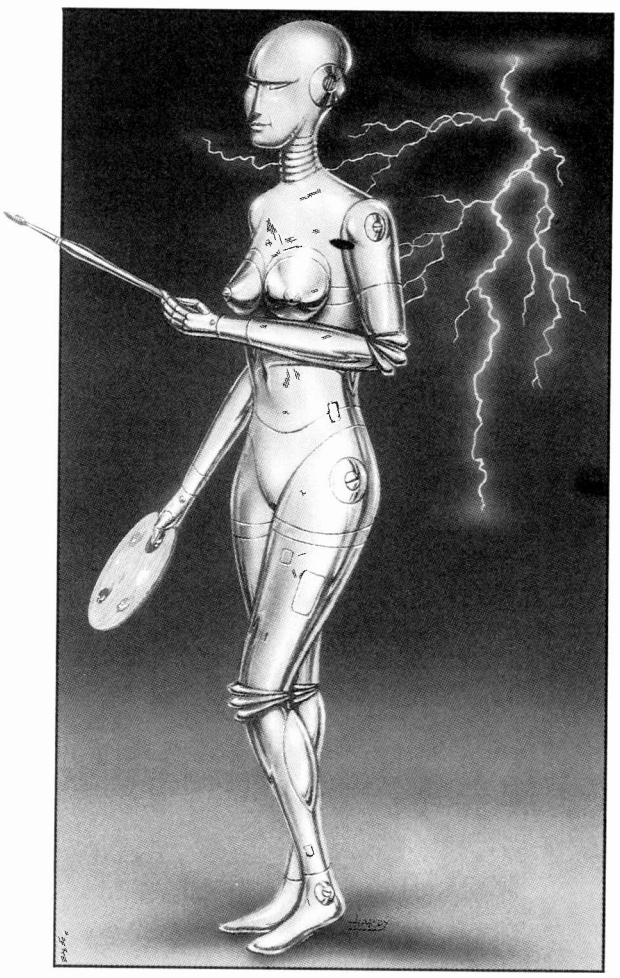

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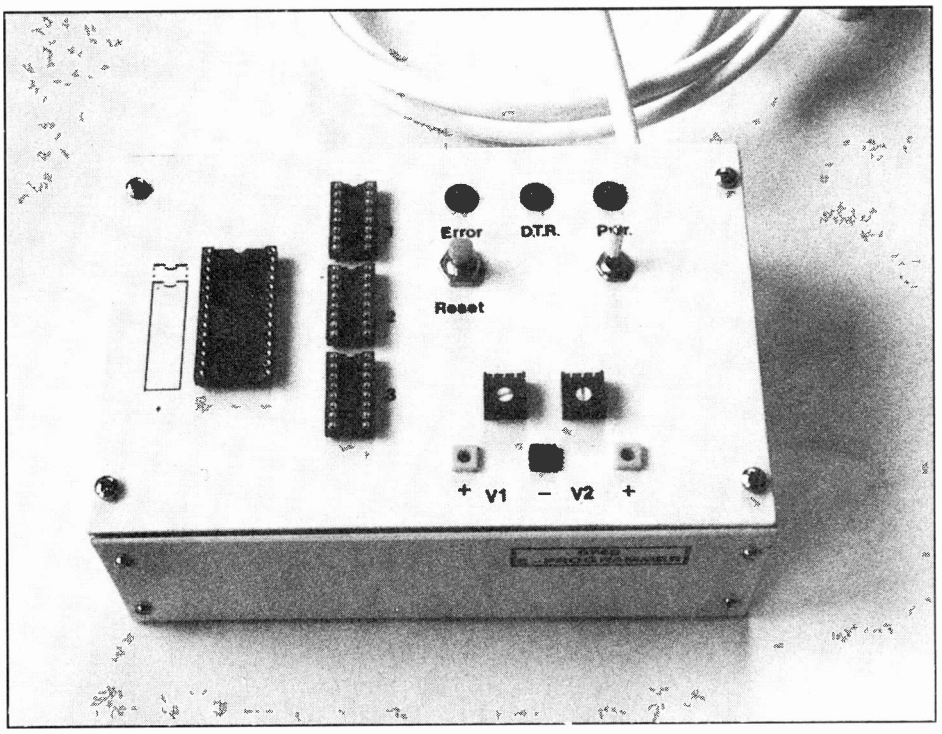
Kevin Browne presents an RS232 universal eprom programming unit based around an 8748 microcontroller.



The author's prototype eprom programmer.

EPROM POLY-PROGRAMMER

The basic facilities of the eprom programmer unit described here are as follows:

1. Compatibility with any type of computer.
2. Totally self-contained, requiring no power from the host computer.
3. The ability to program many different types of eprom including eprom microcontrollers such as the 8748.
4. The host computer software is kept as simple as possible.
5. The ability to program a single byte as well as an entire eprom.

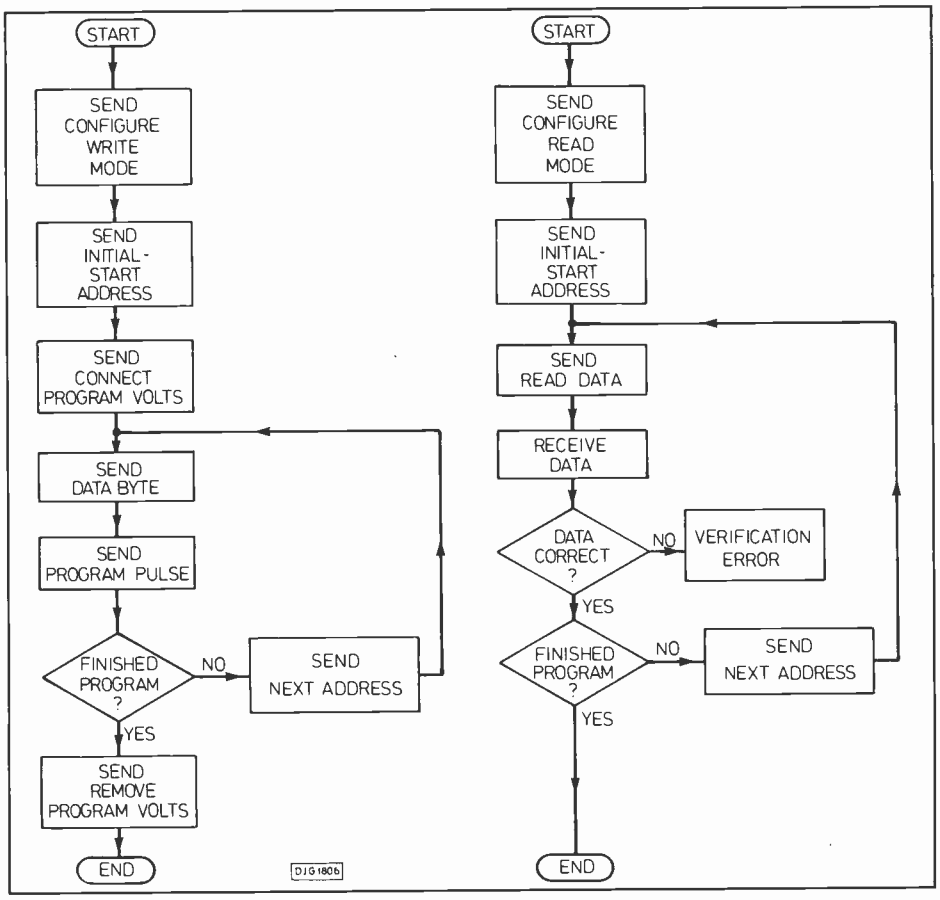


Fig 1. Typical programming sequence.

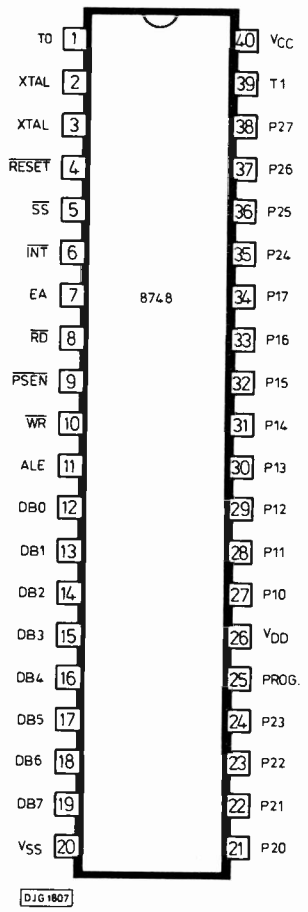
To provide these facilities, I designed the programmer to look, at least as far as a computer is concerned, like a printer. That is, for it to be connected to the printer port of the computer and to 'print' data to the eprom device. I chose the RS232 type interface as opposed to the Centronics type for two basic reasons. Firstly, most computers have an RS232 interface fitted as standard, and secondly, only seven connections are required to the host computer for full RS232 working, therefore the programmer can be connected to the computer with a standard printer lead.

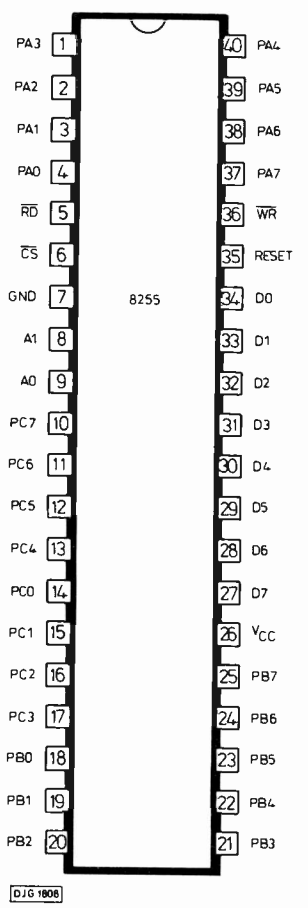
SYSTEM OVERVIEW

The internal operation of the unit is controlled by an Intel 8748 single chip microcontroller. This ic is responsible for receiving the RS232 data, decoding the information received and setting the appropriate address and data lines for the eprom being programmed. It is then responsible for connecting the programming voltages, timing the programming sequence and finally reading the programmed eprom and sending data back to the computer in RS232 format for verification.

A typical programming sequence is shown in Fig. 1.

Figs 2 and 3. Microcontroller 8748 and PIA 8255, respectively.





8748 MICROCONTROLLER

Microcontroller chips are complete microprocessor systems, consisting of ram (random access memory), rom (read only memory), cpu (central processing unit), i/o (input and output ports) and timer circuitry all contained in one integrated circuit.

The 8748 microcontroller chosen for this project has 64 bytes of ram, 1024 bytes of rom, 27 i/o lines and an integral timer. Its pin-outs are shown in Fig. 2. The microcontroller has to be programmed with the software program I've written especially for the project.

8255 PERIPHERAL INTERFACE ADAPTOR

To program eprom devices a large number of i/o lines are required. For example, a 27512 eprom requires 16 address lines, 8 data lines and a number of miscellaneous control lines. The 8748 microcontroller has only 27 i/o lines, insufficient to implement the RS232 interface (6 lines) and other miscellaneous functions. So a second ic, the 8255 pia (peripheral interface adaptor), which has a further 24 lines of i/o is added to the system. This is connected to the 8748 microcontroller by an 8 bit data bus and two address control lines. This brings the total i/o lines available to 41, of which 40 are actually used (ie. 8255 = 24, 8748 = 27 less 10 to control the 8255).

Fig. 3 shows the pin-outs and Fig. 4 tabulates the port allocations.

CIRCUIT OPERATION

A block diagram of the system is shown in Fig. 5 and the circuit diagrams are shown in Figs. 6 to 8.

1. System Start up/ Reset

When the programmer is first switched on, R1 and C6 provide delayed reset pulses. This allows time for the power supply to stabilise before initialising the microcontroller and the pia. IC7b buffers this reset pulse to provide a clean pulse to IC5, IC7a inverting the pulse for IC6.

Switch S101 is a non-locking push-to-make type which can be used to re-initialise the system, by momentarily discharging capacitor C6.

2. Option Switch Setting

The baud rate for the RS232 interface is fixed at 1200 baud, though a choice of parity checking protocols is available. The setting of the two dil switches S1 and S2 indicates to the cpu the parity option required. These switches are connected to port inputs P15 and P16, the state of which is tested by the cpu on system initialisation. The ports have internal pull-up resistors, so the cpu reads logic 1 when a switch is open and logic 0 when a switch is closed. Fig. 9 details the various parity options available.

3. The RS232 Interface

An RS232 interface uses two voltage levels for transmission, +12V and -12V. These

Fig 4. Tabulated port allocations for the 8748 and 8255.

8748 PORT ALLOCATION

Port 1			Port 2		
0	(27)	Aux control 0	0	(21)	8255 address 0
1	(28)	Aux control 1	1	(22)	8255 address 1
2	(29)	Aux control 2	2	(23)	Prog pulse 0 = pulse
3	(30)	Aux control 3	3	(24)	Prog mode 0 = prog
4	(31)	Error led 1=on	4	(35)	RS232 DTR
5	(32)	Option switch S2	5	(36)	RS232 XMD
6	(33)	Option switch S1	6	(37)	RS232 CTS
7	(34)	RS232 RTS	7	(38)	RS232 DSR

Bus		T1		
(12-19)	8255 data bus	T1	(39)	RS232 RXD

8255 PORT ALLOCATION

Port A			Port B			Port C		
0	(4)	A8	0	(18)	AO	0	(14)	DO
1	(3)	A9	1	(19)	A1	1	(15)	D1
2	(2)	A10	2	(20)	A2	2	(16)	D2
3	(1)	A11	3	(21)	A3	3	(17)	D3
4	(40)	A12	4	(22)	A4	4	(13)	D4
5	(39)	A13	5	(23)	A5	5	(12)	D5
6	(38)	A14	6	(24)	A6	6	(11)	D6
7	(37)	A15	7	(25)	A7	7	(10)	D7

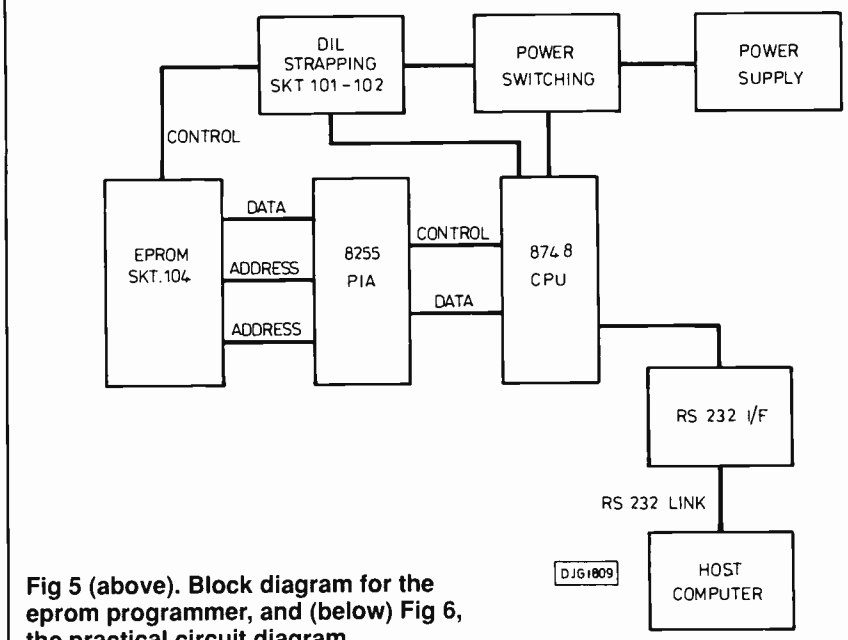


Fig 5 (above). Block diagram for the eprom programmer, and (below) Fig 6, the practical circuit diagram.

voltages are nominal, however, and any voltage between 3V and 15V is acceptable. The signal levels have to be converted to the more usual ttl logic levels of +5V and 0V for use by the 8748 microcontroller. IC8 converts the three RS232 input signals to ttl levels similarly, the three outputs are converted from ttl levels to a nominal by IC9.

One of these signals, the dtr (data terminal ready) is also used to control LED 102 via TR2 to provide a visual indication that the programmer is ready.

4. Clock Circuit

A 6.144 MHz crystal is used to provide the clock frequency for the operation of the cpu. It is also used to control the baud rate timing for the RS232 interface via the internal software program of the 8748 microcontroller.

5. 8255 PIA

The 8255 pia is formatted under software control from the microcontroller to provide three 8 bit i/o ports (used to provide the address and data bits for the eprom to the programmed). The microcontroller can

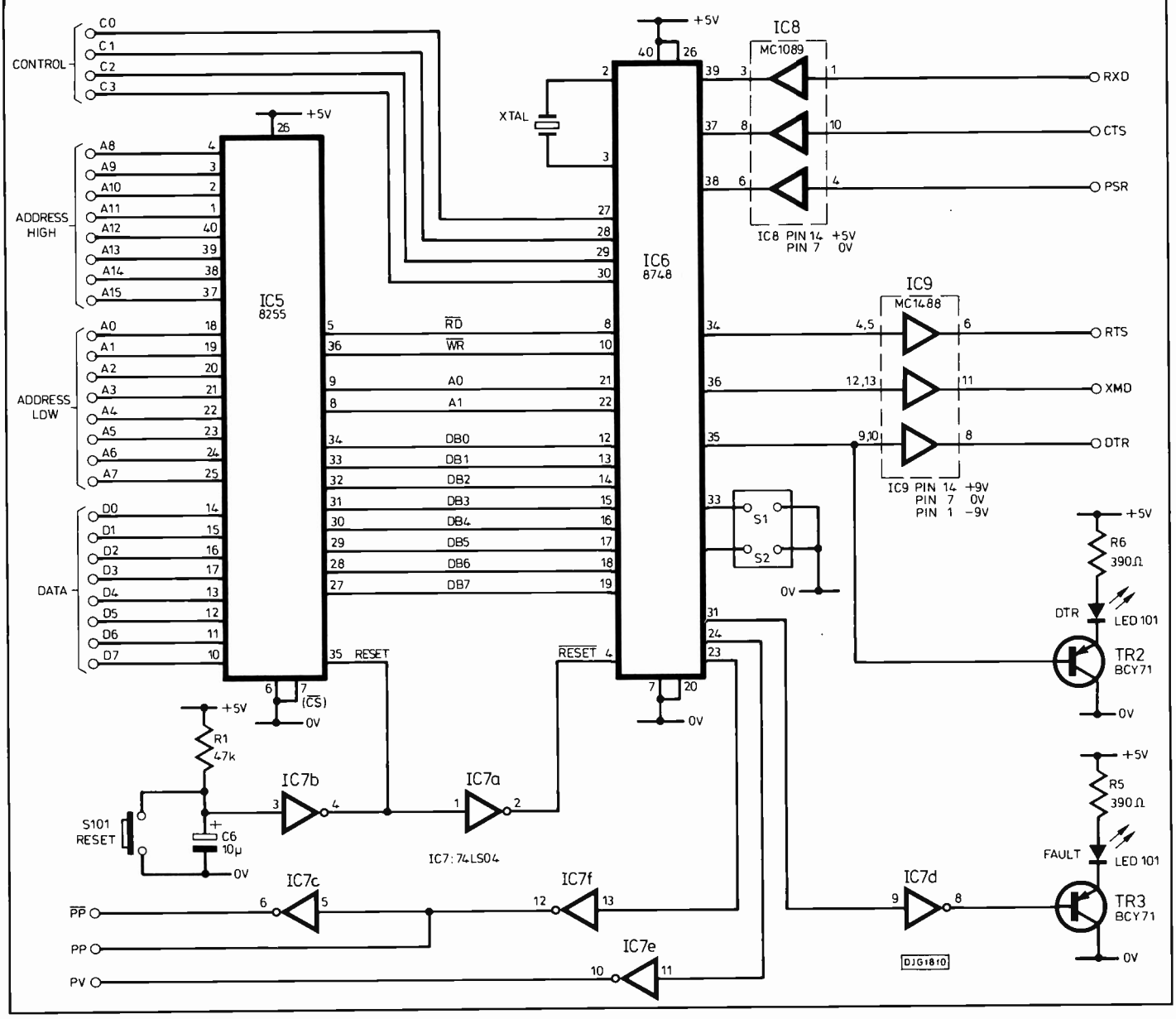
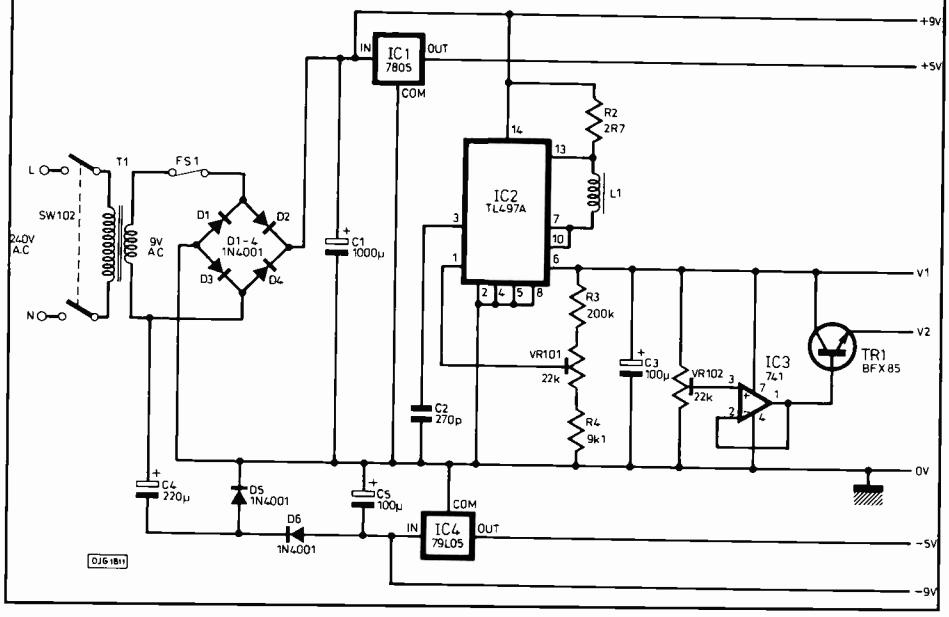


Fig 7. Power supply circuit.



address each port individually using two of its own i/o port bits (P20 and P21). The setting of these two bits, in conjunction with the read and write lines, control the flow of data between the pia and the microcontrollerr over the 8 bit interconnecting data bus.

6. Miscellaneous I/O Lines

A number of miscellaneous functions are provided by various i/o lines of the 8748 microcontroller:

Port P14 (pin 31) of the 8748 is used via IC7d and TR3 to control LED 101. This is the fault/error led used to provide indication of a system malfunction.

Port P22 (pin 23) of the 8748 is used as a programming pulse for the eprom. The duration of the pulse is variable between 1 and 255ms, controlled by software. IC7f provides a buffer, and IC7c inverts the pulse to provide the negative-going transition required for some eprom types.

Port P23 (pin 24) of the 8748 via IC7e is used as read/write control for the eprom being programmed.

Ports P10 to P12 (pins 27 to 29) provide three user controllable outputs. These signals are NOT buffered. They provide a high impedence logic a (80k) and source only 40uA. However, the logic 0 is of lower impedence and can sink up to 1mA. These outputs are provided for use as extra control signals to program such devices as single chip microcontrollers. Take care, when using these outputs, not to damage the microcontroller within the programmer.

Port P13 (pin 30) provides a user readable input line, and has an internal pull-up resistor of 80k. When using this port, further care must be taken not to damage the microcontroller with the programmer.

7.Power Supply

Transformer T1 provides 9V ac from the mains power. Diodes D1 to D4 form a bridge rectifier and in conjunction with capacitor C1 provide an unregulated voltage of +9V to +12V. This voltage is used directly to supply the RS232 interface driver chip, and via IC1 to provide a regulated +5V for all the other logic functions within the programmer.

The unit has two variable programming voltage supplies (V1 and V2) for the various eprom types to be programmed. Voltage V1 is a variable 9V to 30V supply generated by the switched mode circuit formed around IC2. VR101 is used for adjustment of this voltage, with R3 and R4 presetting the upper and lower limits. This voltage is then fed via TR4 which, in conjunction with TR5 allowing the eprom programming voltage to be set by the microcontroller. The actual control for this switch can be obtained from a number of different sources, depending upon the strapping arrangements of SK101 and SK102.

A second programming voltage supply, V2, is made available by regulating voltage V1 by means of IC3 and TR1. The voltage is adjustable between zero and V1 by VR102. V2 can be used directly by the eprom or taken via a second logic switch formed by TR6 and TR7, also depending upon the strapping of SK101 and SK102.

A -9V supply is required for the RS232 interface and is supplied via C4, C5,D5 and D6.

The regulated -5V supply is obtained from C4. The only use for this voltage is in the programming of 2708 eproms.

CONSTRUCTION

1. The Main Circuit Board (Figs 10, 11)

Start with the smaller components, resistors, diodes, erc, and work through to the larger components. Sockets should be used for all the integrated circuits, but do not fit the ics into their sockets until after some preliminary testing. Inductor L1 is a home wound device. Twenty five turns of 22 swg enamelled copper wire must be wound tightly and neatly on to the coil former. The former, once placed inside the two sections of the pot core, can be secured to the pcb with a 6BA nut and bolt. Place a large washer on top of the inductor (see Fig.12) and clamp firmly to the pcb. The two coil ends can then be soldered in place.

2. Top Circuit Board (Figs 13, 14)

I have made the upper pcb in such a way as to form the top of the project box. The pcb track and component layouts will be shown next month. I recommend that this board be made from fibre glass for added strength. Before assembly of the board, I painted it with four or five coats of white cellulose spray paint, of the type used to touch up cars. Allow the paint to dry for 24 hours and then apply rub-down panel markings as shown in the photo. Ensure these are well rubbed-down and then apply two coats of clear cellulose lacquer, as used on metallic painted cars. Allow to dry for a further 24 hours.

Carefully fit and solder in place SK101 and SK104. SK104 should ideally be of the zif (zero insertion force) type; these sockets are expensive, but if you intend doing a lot of eprom programming are well worth the investment.

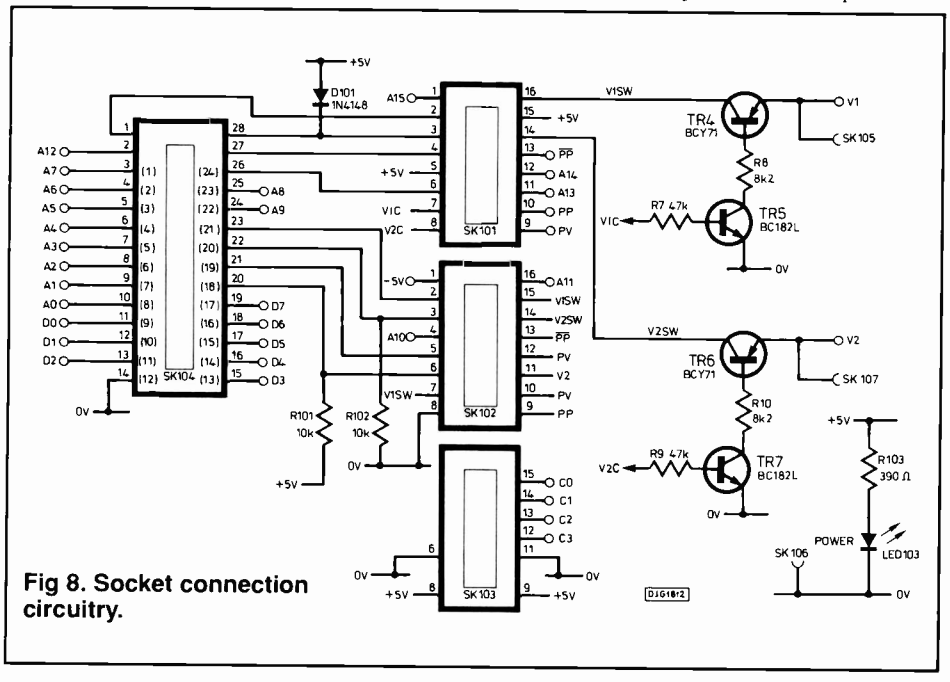


Fig 8. Socket connection circuitry.

	Switch S1	Switch S2
8 bit No Parity	X	0
8 bit Even Parity	1	1
8 bit Odd Parity	0	1

Fig 9. Option switch setting. 1=switch open, 0=switch closed, X=don't care. All transmission is 1200 baud, one or two stop bits.

Next, mount VR101, VR102, S0101, S102, SK105, SK106 and SK107. The three leds should be clipped in place and leads carefully bent as will be shown in Fig.17 next month. R101,R102, R103 and D101 should also be mounted on the copper side of the pcb.

3. The Project Box

The box I used for the project was a low cost aluminium box measuring 6in x 4in x 2in. The top of the box should be removed and cut to accommodate the top pcb. The rear section should also be cut to mount the 25-way D type socket and a hole provided for the mains cable entry, large enough to accomodate a protective grommet. Check the assembly of all parts of the box, and then paint it. Once the paint is dry apply a layer of plastic insulating tape around the top edges of the box top prevent the aluminium flanges from short circuiting any tracks on the pcb. PE

To be continued next month.

COMPONENTS

RESISTORS

R1, R7, R9	47k (3 off)
R2	2R7
R3	200k
R4	9k1
R5, R6, R103	390R (3 off)
R8, R10	8k2 (2 off)
R101, R102	10k (2 off)
VR101, VR102	22k enclosed horizontal preset (2 off)

SEMICONDUCTORS

D1-D6	IN4001 (6 off)
D101	IN914 (or IN4148)
IC1	7805 1A regulator
IC2	TL497A Switching reg
IC3	741 op amp
IC4	79L05 100mA regulator
IC5	8255 PIA
IC6	8748 programmed
IC7	74LS04
IC8	MC1489 RS232 receiver
IC9	MC1488 RS232 driver
TR1	BFX85
TR2 - TR4, TR6	BCY71 (4 off)
TR5, TR7	BC182L (2 off)
LED101, LED103	red 5mm (2 off)
LED102	green 5mm

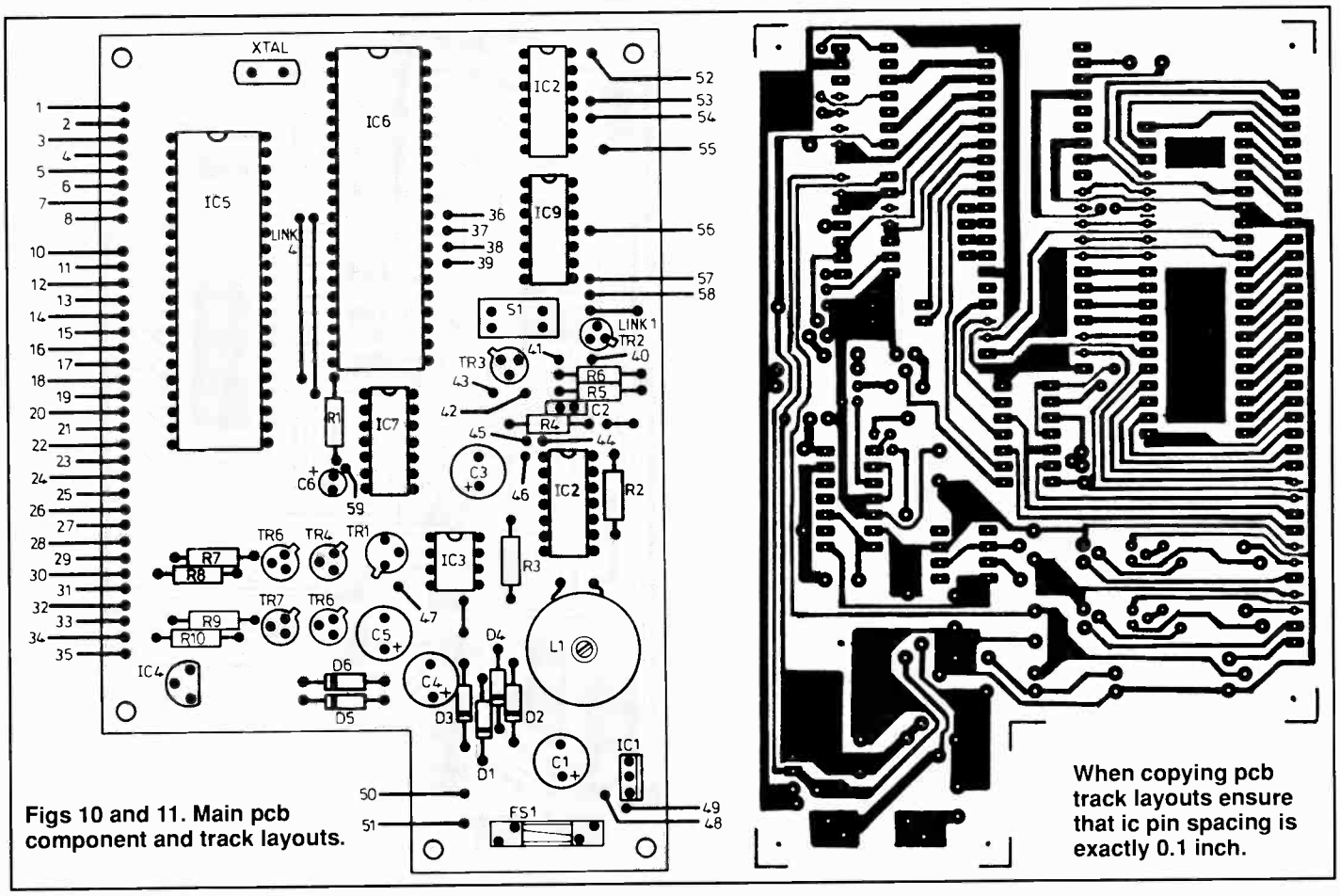
CAPACITORS

C1	1000µ 16V electrolytic single ended
C2	270p ceramic plate
C3, C5	100µ 63V electrolytic single ended (2 off)
C4	220µ 16V electrolytic single ended
C6	10µ 50V electrolytic single ended

MISCELLANEOUS

XTAL 1	6.14 MHz crystal
S1, S2	spst dil switch (dual)
S101	Push-to-make switch
S102	dpdt 250V ac rated toggle switch
T1	9V 6VA transformer (STC 12614H)
Aluminium box	6 in x 4 in x 2 in
SK106	Wanda Type 2mm, Black
SK105, 107	Wanda Type 2mm (2 off)
RS232 connector	25-way female D connector
Fuse clips	(2 off)
Fuse	20mm 500mA anti surge
LED clips	5mm (3 off)
IC Sockets	40 way (2 off)
	14 way (4 off)
	8 way
SK 104	28 way zif socket
SK101-103	16 way (3 off)

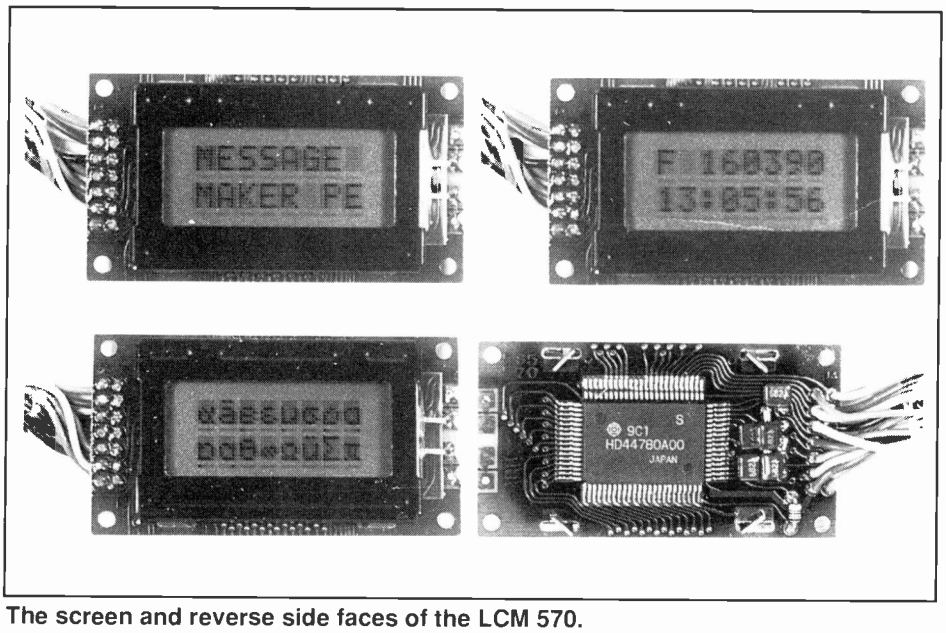
L1 25 turns 22 swg on a Philips Ferroxcube FX2238 18mm dia core (STC 52704H), former DT2178 (STC 52329X).



Figs 10 and 11. Main pcb component and track layouts.

When copying pcb track layouts ensure that ic pin spacing is exactly 0.1 inch.

Recognising the importance of the wider availability of Sanyo LCM lcd modules, John Becker applies linguistic and technological analysis, showing you the simple route to greater display sophistication.



The screen and reverse side faces of the LCM 570.

INTELLIGENT LCD MODULES

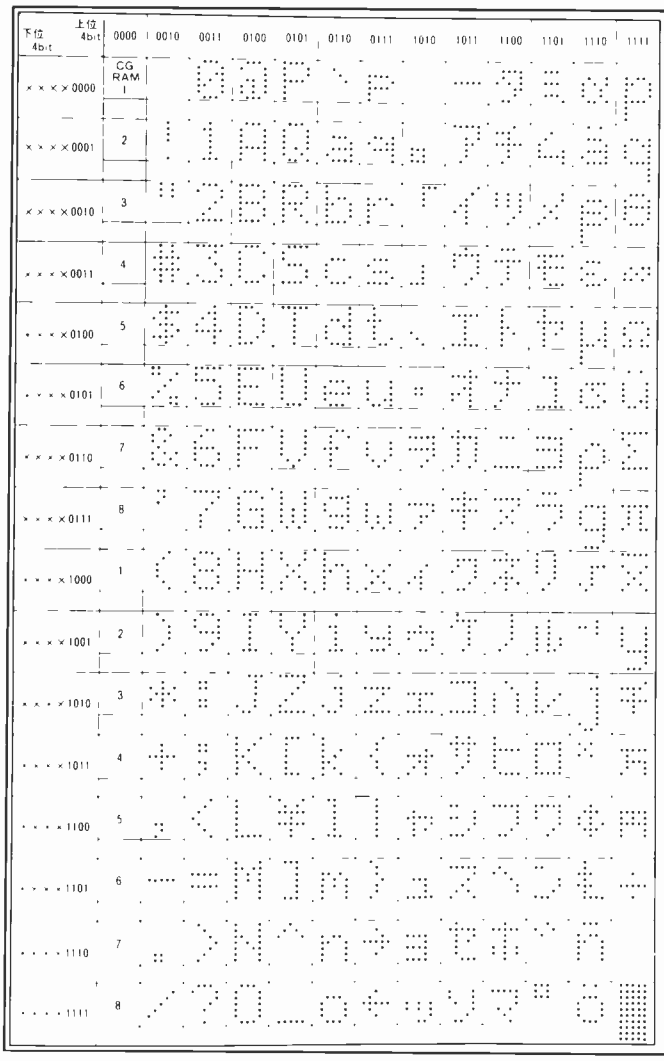


Fig 1. The complete character library held within the Sanyo LCM series liquid crystal display modules. There are 160 characters conforming to the JIS standard. Conventional alphanumeric characters are included, plus a selection of Kana and Greek symbols. Eight locations are available for programming in your own patterns.

The Sanyo LCM series of intelligent alphanumeric liquid crystal display modules has recently become more widely available in Britain. These modules offer constructors the opportunity to readily design and build projects which are capable of displaying a wide variety of detailed and sophisticated visual information. They may be used with or without a microprocessor and offer display opportunities virtually unobtainable with discrete led devices.

Although alphanumeric lcd module technology has been in existence for some time, the LCM series is the latest from Sanyo to become more available to the amateur market. Its principle features are that the modules are compact and lightweight, have low power consumption, have wide viewing angles and high contrast, utilise on-board control LSI, can be interfaced to either 4-bit or 8-bit controllers, and are available with electro-luminescent (EL) and led backlighting options. They contain 160 alphanumeric characters allowing detailed messages or patterns to be displayed. Additionally, users can also program in their own characters or symbols.

TONGUE TIED

Recognising many applications to which these displays can be put, it was obvious that I should investigate them. However, having obtained a data sheet for them, it then became apparent that this examination was not going to be as straightforward as I had expected. Sanyo, as you know, are a Japanese company, and quite naturally, the Japanese tend to think

and write in Japanese! One would have expected, though, that any document intended for a market which does not similarly appreciate the linguistics of Eastern Enterprise would be *comprehensibly* translated into the tongue of the intended recipient. We've all come across quaint wordings associated with consumer product imports, haven't we? Regrettably, I found that the translation I received reminded me, heavily, of those other literary masterpieces.

PROSPECTUS

My aim here, therefore, is two-fold. To show you how to use the major aspects of one the devices in the range, the LCM 570, and to explain the functions in more comprehensible English, and in such a way that you will feel confident to use and vary them to suit your own needs. The examination falls into four parts, each of which can be treated independently, though by following each one, you will build up a wider picture of the capabilities and versatility of the lcd modules. The basic information is relevant to other modules in the Sanyo LCM series.

In this first part I shall discuss in detail the control options available. Next month I shall present a practical constructional project which illustrates the primary functions in conjunction with a simple computer program written in Basic. The program generates control codes which may, in real time, be used to display messages or patterns on the LCM 570 screen via the interface circuit. The program has been written in such a way that you can readily modify it and experiment with the various LCM commands. The circuit design can also be used with an eeprom to allow messages to be stored and displayed, either with or without a computer. As such, the design is a working Message Maker which can be used in its own right as well as being a tutorial and evaluation test example.

Two further articles will show how the modules can be used in two other applications. One of these will be a semi-intelligent Morse Decoder capable of decoding morse signals direct from radios, tape recorders, computers, or a morse key. The second will be an lcd readout extension for the Rugby clock in which the entire transmitted calender and time data are simultaneously displayed on the screen, using alpha characters as well as numerics.

CHARACTER LIBRARY

The LCM 570 has a character generator rom which contains a library of 160 alphanumeric characters, as shown in Fig.1. These conform to the JIS standard (a bit like the Ascii standard) and consist of the normal punctuation marks, mathematical symbols, numbers 0-9, plus the alpha characters A-Z in upper and lower case. Additionally, the library contains characters from the Japanese 'alphabet' (Kana symbols), several Greek characters as used in maths, and a few

32	blank	48	0	64	@	80	P	96	\	112	p
33	!	49	1	65	A	81	Q	97	a	113	q
34	"	50	2	66	B	82	R	98	b	114	r
35	#	51	3	67	C	83	S	99	c	115	s
36	$	52	4	68	D	84	T	100	d	116	t
37	%	53	5	69	E	85	U	101	e	117	u
38	&	54	6	70	F	86	V	102	f	118	v
39	'	55	7	71	G	87	W	103	g	119	w
40	(	56	8	72	H	88	X	104	h	120	x
41	)	57	9	73	I	89	Y	105	i	121	y
42	*	58	:	74	J	90	Z	106	j	122	z
43	+	59	;	75	K	91	[	107	k	123	{
44	,	60	<	76	L	92		108	l	124	
45	-	61	=	77	M	93	]	109	m	125	}
46	.	62	>	78	N	94	^	110	n	126	
47	/	63	?	79	O	95	_	111	o	127	

Fig 2. Address codes for commonly used characters. Refer to Fig. 1 for the characters at locations 92, 124, 126 and 127.

continental European letters.

The library has 256 address locations, 0-255, of which only 160 are pre-programmed, leaving 96 locations basically unused. Via the CG ram, eight of these, locations 0 to 7, can be programmed by users with patterns of their own choice. These patterns are also accessible by addressing locations 8 to 15, ie, if you read address 8 you will get the pattern in address zero, similarly addressing 15 will get the pattern at address 7. You cannot program patterns directly into addresses 8-15. Nor can you program patterns into the other unused addresses at 16-31 and 128-159, which all contain the 'blank' character.

The characters held at locations 32-127 closely follow those associated with one variation of the Ascii code, as shown in Fig.2. Other useful symbols are shown in Fig.3.

224	α	alpha
226	β	beta
227	ε	epsilon
228	μ	mu
229	σ	sigma
230	ρ	rho
242	τ	theta
243	∞	infinity
244	o	omega
246	ζ	zeta
247	π	pi
253	÷	division

Fig.3. Address codes for other commonly used symbols.

DISPLAY ASPECTS

Before examining the control commands it's necessary to understand several principle aspects of the screen display and its data display (DD) ram.

The original data sheet had me well confused for some time concerning how one caused the characters to be displayed on the lcd screen. The sheet referred to a 'character generator ram' (CG ram) and to a 'data display ram' (DD ram). My first assumption was that characters had to be 'taken' from the CG ram and transferred to the DD ram, and the assumption was reinforced by various statements regarding reading and writing from and to the different rams. This was a wrong interpretation on my part, and a lot of time was spent experimenting with many permutations of commands before the meaning became clear.

The DD ram of the LCM 570 has 80 memory locations into which messages can be written. It is the contents of the DD ram that are then available for displaying on the screen. The screen display has 16 character positions shown as two lines each of eight characters. You can choose to display the characters on just the upper line, leaving the lower line blank, or to display data on both screen lines. When using just one screen line any eight consecutive characters held in the DD ram can be displayed. You can write directly to the locations which appear to be actually on the screen, or to any of the other 72 locations to the 'left' or 'right' of the screen. In the single line mode all 80 locations are available.

EXAMPLES

In essence, if you want to store "A" at location 1 in the DD ram, you send the address command for location 1, and then send the command for 65, the code number for A. As far as you, the user is concerned, these commands are entirely handled by the DD ram and you neither read from nor write to the CG ram in order to perform them.

In order to view the characters from locations in the DD ram other than those already on screen, you just tell the module to shift the whole lot left or right as many times as necessary until they appear on the screen.

If the two-line mode is selected, line 1 has its data stored at DD ram addresses decimal 0-39 (hex 0-27), a total of 40 character locations. Line 2 also has 40 locations available, but these are at decimal 64-103 (hex 40-67). In this mode, any eight consecutive characters from addresses 0-39 can be displayed on line 1, line 2 will then show eight consecutive characters from the same corresponding addresses in the 64-103 group. For example, if you display the character sequence from DD ram locations decimal 10-17 on line 1, line 2 will automatically display the character sequence held at locations decimal 74-81.

Curiously, in the two-line mode, if you write to DD ram locations between decimal 40 and 63, the data will be accepted but when displayed it will appear on line 2. You will also notice that, in effect, the DD ram in the two-line mode appears to have more than 80 (40 x 2) available addresses. When you've built the test circuit, you can experiment with this aspect.

The only time the CG ram is used is when programming in your own patterns or characters (discussed later). Although in that situation you need to write to up to 256 CG ram locations in order to program-in up to the eight new patterns allowed, the patterns are subsequently accessed as though they are part of the normal character library. Suppose you

want, for example, pattern 2 stored at DD ram location 3, you simply send the code for location 3 and then the command for 2, similar to the way "A" was sent, above.

All this was obvious, once I understood it. Why couldn't the data sheet have been more explicit? (I hope have made it clearer for you!)

COMMANDS

There are eleven main groups of commands which can be sent to the module, many of which have groups of sub-commands:

1. Clear display
2. Return home
3. Entry mode set
4. Display and cursor on/off
5. Display and cursor shift
6. Function set (control bits, lines and fonts)
7. Set CG ram address
8. Set DD ram address
9. Write data to CG or DD rams
10. Read data from CG or DD rams
11. Read 'busy' flag and address

Two of these groups, numbers 10 and 11, are associated with examining the contents of the module and I shall be discussing them only briefly since in most instances most users will not require the facilities. I shall discuss in detail only the first nine command groups which concern the principle display functions.

CONTROL LINES

The module has 11 control lines and three power lines, as shown at the end. Eight of the control lines, D0-D7, are dual purposed and can convey either data or control commands. Three control lines, E, RS and RW, are purely for control commands. All 11 lines are used when in 8-bit control mode. In 4-bit control mode, only seven control lines are needed, E, RS, RW and D7-D4.

Line RW sets the module into read or write mode. Logic 0 on this line is the level you will normally use, allowing you to send (write) data to the lcd screen ram (DD ram). Logic 1 puts the module into read mode, allowing the ram contents to be examined.

Line RS tells the module whether the data on D0-D7 is to be treated as a ram address (RS = logic 0), or as a character to be stored in the screen ram (RS = logic 1).

ENABLE LINE 'E'

Line E, the enabling line, may be regarded as the external clock input line which triggers the module to carry out each instruction. It needs to be taken high (logic 1) prior to, or simultaneously with the command being presented to the module on the other control lines. Then, leaving the command control lines unchanged, E is brought low (to logic 0). It is the action of the transition from high to low (negative-going transition) which triggers the module into its internal cycle to perform the command given. Leaving E low will have no further affect upon the chip. The new command data may be presented to the chip almost immediately following the negative-going transition (taking into account the execution time referred under the Busy Flag command).

LINE	RS	RW	D7	D6	D5	D4	D3	D2	D1	D0	DECIMAL
1. CLEAR DISPLAY	0	0	0	0	0	0	0	0	0	1	1
2. RETURN HOME	0	0	0	0	0	0	0	0	1	*	2
3. ENTRY MODE SET	0	0	0	0	0	0	0	1	ID	S	4-7
4. DISPLAY, CURSOR, BLINK ON/OFF	0	0	0	0	0	0	1	D	C	B	8-15

CONTROL GROUPS

Let's examine each of the control groups in turn. The decimal code column shows the decimal equivalent of the binary number represented by lines D7-D0. 'A' = address, 'D' = data, and an asterisk '*' indicates that it doesn't matter whether 1 or 0 is in that position; the related decimal number is that for * = 0. You will notice that it is always the first '1' occurring between D7 and D0 which sets the principle mode, the subsequent logic then dictates the sub-mode.

1. CLEAR DISPLAY

Implementing this command clears the entire DD ram contents, writing character code decimal 32 (hex 20) into each location. It sets the address counter to zero, returns the display to its primary position (ie, displaying the contents of DD ram addresses 0-7 and, if in two-line mode, the contents of DD ram addresses 64-71 - in this instance, all blanks). The cursor location is reset to the top left hand side of the screen (but will only be seen if previously turned on).

2. RETURN HOME

This command sets the DD ram address counter to zero, and returns the screen display to the primary position (displaying the contents of DD ram addresses 0-7 and, if in two-line mode, DD ram addresses 64-71). The cursor location is reset to the top left hand position on the screen (but will only be seen if previously turned on).

3. ENTRY MODE SET

There are four modes under control here, depending on the logic of ID and S.

'ID' determines whether the DD ram address increases by 1 (ID = 1), or decreases by 1 (ID = 0) each time a character code is written into or read from the DD ram. When increased by one, the cursor or blinking character moves to the right by one place. When decreased by one, the cursor or blinking character moves to the left by one place. The same applies if it is the CG ram instead of the DD ram that is being accessed.

'S' controls the shifting of the entire display. If S = 1 the display will shift by one place in the direction set by ID, though the cursor remains in the same location. The data sheet states that the display will not shift when examining (reading) the data in the DD ram, though I have not verified this. If S = 0 then the display will not be shifted when reading from or writing to the CG or DD rams. The control options are thus as follows :

D7-D0	DEC	RAM	CURSOR	DISPLAY
00000100	4	Decrease x1	left	none
00000101	5	Decrease x1	left	left
00000110	6	Increase x1	right	none
00000111	7	Increase x1	right	right

4. DISPLAY, CURSOR AND BLINK ON/OFF

Eight functions are controllable here, as set by the logic of D, C and B.

'D' sets the display on (D = 1) or off (D = 0). When D = 0 it is only the screen which is turned off and the data remains in the DD ram. On setting D to 1 the data at the preset addresses in the DD ram is immediately displayed.

'C' sets the cursor on (C = 1) or off (C = 0). The cursor consists of five dots displayed on a separate screen line below the character. The function of ID in the Entry Mode Set is not affected by the setting of the cursor control C.

'B' sets the 'blink' control on (B = 1) or off (B = 0). The blink affects just one character, the one in the same location as the cursor. Consequently, it is necessary to move the cursor in order to select which character should be seen blinking. However, it is not necessary to be able to see the cursor before moving its position.

The data sheet here makes reference to the rate at which the blinking occurs. It is apparently related to the oscillation rate of the module's internal clock, believed to be approximately 250kHz. However, no indication is made of how the internal clock rate can be changed and so the information seems irrelevant. Suffice to say, it appears, that the blink rate is internally set at about 0.4 second intervals.

These are the eight sub-commands:

D7-D0	DEC	DISPLAY	CURSOR	BLINK
00001000	8	off	off	off
00001001	9	off	off	on
00001010	10	off	on	off
00001011	11	off	on	on
00001100	12	on	off	off
00001101	13	on	off	on
00001110	14	on	on	off
00001111	15	on	on	on

5. DISPLAY AND CURSOR SHIFT

Only four functions are controllable here, as set by the logic of SC and RL. When SC = 0 only the cursor shifts, but when SC = 1 the cursor and the display shift together. RL controls the direction of shift; it's to the left when RL = 0, and to the right when RL = 1.

These functions allow the cursor, or the entire display including cursor, to be independently shifted left or right by one place at a time. It is not necessary to write to or read from the display data in order to use the functions. One use for the display shift functions is to scroll data to the left or right so that messages of more than eight characters can be repeatedly shown. The functions can also be used when searching for particular characters or information in the displays. The latter could be put under computer control, in conjunction with the 'read' function, to search out and correct specific characters or locations without direct visual observation of the screen. I have not experimented with this latter aspect, though.

When the entire display is shifted in the two-line mode, both lines will shift simultaneously. It should also be noted that when shifting the cursor on its own in the two line mode, once it has passed the 40th position it will drop down to the next equivalent position in the lower line. However, similar oddities don't occur when shifting the entire display: the data in the first line doesn't drop into the second at the 40th position. This allows for a two line message to be repeatedly looped backwards or forwards across the screen just by repeatedly using the shift control.

D7-D0	DEC	DISPLAY	CURSOR	COUNTER
00010000	16	none	left	decrease x1
00010100	20	none	right	increase x1
00011000	24	left	left	unchanged
00011100	28	right	right	unchanged

6. INTERFACE LENGTH, FONT AND LINE MODE SET

Just six functions are controllable here, but they are the most important functions that usually need to be set before the module can be used, and are determined by the logic of DL, N and F.

LINE	RS	RW	D7	D6	D5	D4	D3	D2	D1	D0	DECIMAL
5. DISPLAY AND CURSOR SHIFT	0	0	0	0	0	1	SC	RL	*	*	16-31
6. INTERFACE, FONT, LINE SET	0	0	0	0	1	DL	N	F	*	*	32-63
7. SET CG RAM ADDRESS	0	0	0	1	A	A	A	A	A	A	64-127

The module, as we are seeing, has eight data/address lines, D7-D0. Cleverly, the manufacturers have given users the option of controlling the module either via all eight of these lines, in 8-bit mode, or by just using only four of them, D7-D4, in 4-bit mode. We shall see in a moment how the data is split and allocated in the 4-bit mode.

At switch on, the module automatically puts itself into a 'reset' cycle routine which clears the DD ram by writing blanks into each location, resets the counter and display locations, sets itself for 8-bit control, and into a single display line mode using a 5 x 7 dot character font. The reset cycle does not appear to set the CG ram to blanks and random patterns are set into this ram at switch on.

Following the reset cycle, which takes about 15ms after switch-on, we can if we want, set the module's display as one or two lines, and its control as 4-bit or 8-bit. If setting for single line display mode, we can additionally select for the character font to be generated as characters with a 5 x 7 or 5 x 10 dot matrix. With two-line mode, we can only use the 5 x 7 dot matrix font.

'DL' sets the module under 8-bit control (DL = 1), or 4-bit control (DL = 0).

'N' sets the number of display lines to one (N = 0), or two (N = 1).

'F' selects the 5 x 7 dot font (F = 0), or the 5 x 10 dot font (F = 1).

One point that should be noted is that the screen contrast is affected by the choice of font and line quantity. It is highest when a single line with the 5 x 7 dot font is selected, and lowest when in two-line mode. However, the contrast can be adjusted by means of a preset control inserted into the negative power line feeding to the module. The contrast change appears to be due to the multiplexing control within the module, affecting the frequency duty cycle factor. The data sheet quotes this as 1/8 for single line 5 x 7 dots (NF = 00), 1/11 for single line 5 x 10 dots (NF = 01), and 1/16 for two line 5 x 7 dots (NF = 1*) (* = don't care).

D7-D0	DEC	INTERFACE	LINES	FONT
00100000	32	4-bit	1	5 x 7
00100100	36	4-bit	1	5 x 10
00101*00	40	4-bit	2	5 x 7
00110000	48	8-bit	1	5 x 7
00110100	52	8-bit	1	5 x 10
00111*00	56	8-bit	2	5 x 7

(Codes 44 and 60 have the same effect as 40 and 56 respectively.)

7. SET CG RAM ADDRESS

Before data can be written into or read from the CG ram, the module must first be told which CG ram address you want to access. Lines D5-D0 hold the address, and there are 64 options available. In the 5 x 7 dot mode, each complete pattern needs to have eight codes programmed into separate consecutive CG ram addresses. Each code determines the dot pattern at that address. When the pattern is required to be displayed via the DD ram, all eight codes are accessed to build up the pattern. For example, when you tell the DD ram to show the pattern associated with DD ram code 0, the chip copies the data from CG ram address 0 and it becomes the top line (line 0) of five dots of the pattern being transferred to the DD ram address previously specified. CG ram address 1 then provides pattern line 1, CG 2 = line 2, CG 3 = line 3, CG 4 = line 4, CG 5 = line 5, and CG 6 = line 6. The eighth CG ram address, CG 7, provides the data that goes into the cursor line (line 7). The contents of the CG ram remain unchanged when copying into the DD ram.

A similar principle applies with DD ram character codes 1 to 7. The relationships between the DD ram codes and CG ram addresses are thus:

DD RAM CODE	CG RAM ADDRESSES
0	0 - 7
1	8 - 15
2	16 - 23
3	24 - 31
4	32 - 39
5	40 - 47
6	48 - 55
7	56 - 63

When in the 5 x 10 dot mode, the relationship between the DD ram codes and CG ram addresses changes and only four patterns can be generated, each requiring 10 CG ram addresses. The 11th address is the cursor line, while the 12th to 16th addresses are unused in the pattern. The four patterns are accessed via DD ram codes 0, 2, 4 and 6. The DD to CG ram relationships thus become:

DD RAM CODE	CG RAM ADDRESSES
0 (hex *00*)	0 - 10
2 (hex *01*)	16 - 26
4 (hex *10*)	32 - 42
6 (hex *11*)	48 - 58

You will notice that bits 3 and 0 of the DD ram hex codes are asterisked. This means that DD ram codes decimal 1 and 9 (hex 0001 and 1001) will each access the first pattern ostensibly held via DD ram code 0. A similar principle applies to the other three DD ram codes.

It's also interesting to note that only five bits of the CG ram data are used in the pattern (D4 - D0). This means that imaginative designers could make use of the three unused CG ram bits, numbers 5 to 7, as 3-bit data storage areas for other purposes.

I shall describe how you set about programming the patterns later on (though not how you can use the spare three bits).

8. SET DD RAM ADDRESS

The module usually (though not always, as we shall see presently) must be told at which DD ram address a particular character is to be written and held ready for display. It looks at first sight that 128 addresses are available, however, as we saw earlier, data should only be placed at locations 0-79 for single line mode, and locations 0-40 and 64-103 for two-line mode. For interest, once you've built the control circuit, you can try writing to the 'invalid' addresses and see what happens.

Before *reading* data from the DD ram, the address at which the data is to be accessed must also be specified by first using the above control code.

9. WRITE DATA INTO CG RAM OR DD RAM

Once the CG or DD ram address has been specified, data can be written to it using the ninth control format. This is the first of two occasions on which the RS line is set to logic 1.

You have the full choice of all 256 data numbers to write to the relevant ram. The tables in Figs.1 and 2 given earlier show the characters that will be stored in the DD ram in respect of each number. For example, code 65 stores character A at the previously specified DD ram address, 66 stores B, 90 stores Z, etc.

When writing to the CG ram for pattern generation, you will normally only use lines D4-D0, so having a binary range of 00000 to 11111 (decimal 0-31). You *can* use numbers between 32 and 255, but the final three bits will be ignored by the pattern generator, so still limiting you to decimal 0-31.

Now an additional factor comes into play. Each time data is written to, or read from either the CG or DD ram, a program counter is updated, depending on the setting of ID in the Entry Mode function. With ID = 1 the counter is increased by one, with ID = 0 it is decreased by one.

The implications of this are particularly significant when a consecutive sequence of reads or writes is involved since the address location only needs to be set once, at the beginning of the sequence. Thereon, because the address counter is incremented (or decremented) automatically with each data read or write, you do not need to respecify the address between each data item. This is especially valuable where speed or eprom control memory space is at a premium.

LINE	RS	RW	D7	D6	D5	D4	D3	D2	D1	D0	DECIMAL
8. SET DD RAM ADDRESS	0	0	1	A	A	A	A	A	A	A	128-255
9. WRITE INTO CG RAM OR DD RAM	1	0	D	D	D	D	D	D	D	D	0-255
10. READ DATA FROM CG AND DD RAMS	1	1	D	D	D	D	D	D	D	D	0-255
11. READ 'BUSY' FLAG AND ADDRESS	0	1	BF	A	A	A	A	A	A	A	128-255

The action of writing to the DD and CG rams also triggers the display and cursor shifting, as set by S in the Entry Mode command, and SC and RL in the Display and Cursor Shift command.

10. READ DATA FROM CG AND DD RAMS

With RS and RW both set at logic 1 the contents of the CG and DD rams at the previously specified address can be read by a controlling computer or microprocessor. (This facility, though, is not allowed for on the control circuit to be described next month.) The CG or DD ram address is specified as in function 7 or 8, in same way as though data were to be written to that address. Then, instead of writing data, the computer or microprocessor reads the data presented on lines D7-D0 while RS and RW are both at logic 1, and following the negative-going transition of Line E. Under this control, any data deliberately stored in CG ram bits D7-D5 can also be read, and acted upon (as discussed above).

Note that, unlike *writing* to CG or DD ram, *reading* the data does not cause the display to shift, irrespective of the Entry Mode settings.

11. READ 'BUSY' FLAG AND ADDRESS

Another function for which a computer or microprocessor controlled circuit can be designed to read is set by the status of RW and BF. The operations of the module are governed by an internal clock. Each time a new instruction is triggered externally, the chip goes through a cycle of events controlled by the clock. The chip cannot act upon a further new instruction until the cycle has been completed. The status of the cycle is signalled by a 'busy' flag generated within the module and accessible on line D7 (BF). When BF = 1 the internal operation is still in progress and the next instruction cannot be accepted until BF returns to 0. On a slow-speed circuit the rate at which the cycle is performed is likely to be much faster than the rate at which new data can be presented to the chip. Therefore, under slow control command, the reading of BF should not be necessary. However, under high speed control, it is vital to read BF and allow it to go low before sending the next instruction. The data sheet is unclear on the timing associated with BF, but it is related to the complexity of the previous command. With the internal clock functioning at 250kHz, says the data sheet, the Clear Display command takes 1.64µs (the slowest command) whereas the majority of the remaining commands take 40µs to complete. Setting up to read BF apparently takes only 1µs.

It seems likely, therefore, that if the Clear Display command has to be used the maximum external control rate that be used without reading BF is in the region of 600Hz. Otherwise, assuming an execution time of 40µs, it seems reasonable to suppose that 25kHz is about the maximum rate of command control without reading BF.

Once the previous command has been executed and BF = 0, the value of the address counter can be read, a factor which may affect what the next command given should be.

The control circuit to be described next month does not allow for reading the busy flag and address counter.

4-BIT CONTROL MODE

When the lcd module is set to operate as a 4-bit device, lines D3-D0 are not used. It is not clear from the data sheet whether they need to be grounded, though I have assumed that it is preferable that they should be, as with any unused input pins of a cmos device. (If you intend to read from the module when in 4-bit mode, it may be advisable to take D3-D0 to ground via a buffer resistor, of 1k or 10k for example.

In the 4-bit control mode lines D7-D4 have to do all the work previously carried out by all eight lines, D7-D0. So that 8-bit data can be sent to and from the module, it is split into two blocks, each of four bits, and each block is sent separately. Line E, the enable line, has to be taken up and down with each block. The data is sent as the higher order block first, then the lower-order block. In other words, the left hand half of the 8-bit code is sent first, then the right hand half.

However, a modification to the data value has to be carried out by the external controlling circuit. This is a very simple procedure and simply requires that each half of the code is first treated as a 4-bit code in its own right, and it is the value of that code which is sent along D7-D4. Lines RS and RW need to be set to their required values for each of the two 4-bit blocks.

Let's give you an example (I wish the data sheet had given me some!).

Suppose we want to set the DD ram

address to 70 (binary 1000110), and we want to place letter C at that address (C = 67 decimal, 1000011 binary).

Under 8-bit control the two commands would be established as follows (remember that we actually use 11 control lines, E, RS, RW and D7-D0, and that line E must be toggled up and down with each command) :

SET DD RAM ADDRESS TO 70 (D7 at logic 1 = 128)

RS	RW	D7	D6	D5	D4	D3	D2	D1	D0	DEC
0	0	1	1	0	0	0	1	1	0	198

WRITE DATA INTO DD RAM:

RS	RW	D7	D6	D5	D4	D3	D2	D1	D0	DEC
1	0	0	1	0	0	0	0	1	1	67

Under 4-bit control the DD ram address binary code is split from 11000110 to 1100 and 0110. The character data is split from 01000011 to 0100 and 0011. (Note that we now need only seven control lines, E, RS, RW and D7-D4.) The sequence becomes:

SEND DD RAM ADDRESS LH BLOCK
SEND DD RAM ADDRESS RH BLOCK
SEND CHARACTER DATA LH BLOCK
SEND CHARACTER DATA RH BLOCK

THUS:

LINE:	RS	RW	D7	D6	D5	D4	DEC
	0	0	1	1	0	0	12
	0	0	0	1	1	0	6
	1	0	0	1	0	0	4
	1	0	0	0	1	1	3

If all these data were to be sent on the first seven data output lines of a computer, we could allocate each of the lcd module lines to the computer lines as follows:

LCD LINE :	E	RS	RW	D7	D6	D5	D4
CPU LINE :	D6	D5	D4	D3	D2	D1	D0

By taking Line E (bit 6, decimal 64) high at the same moment the data is first presented, then taking it low again, the full sequence of codes would be:

BINARY	DECIMAL
1001100	78 (64 + 12)
0001100	12
1000110	70 (64 + 6)
0000110	6
1100100	100 (64 + 36)
0100100	36
1100011	99 (64 + 35)
0100011	35

In other words, in order to place letter C at location 70, the computer would send a sequence of eight decimal numbers: 78, 12, 70, 6, 100, 36, 99, 35.

CG RAM PATTERN PROGRAMMING

Patterns and characters are made up of dots and spaces. In the 5 x 7 bit font mode each line has five dots, and there can be seven lines. An eighth line, the cursor line, can also be used, though in most instances only seven lines will be needed.

When programming a new CG pattern, you first draw a 5 x 7 dot matrix on paper, draw the pattern you want on the matrix, after which you allocate 1s to the dots that the pattern crosses, and 0s to the dots that it doesn't. The pattern thus becomes represented by eight binary numbers, the decimal equivalents of which are stored in consecutive CG ram locations associated with the character code number you prefer (from 0 to 7). Suppose we want to program a sterling pound sign (£) for accessing as character code number 3, the sequence could be as follows (squint your eyes to make out the pound symbol made up of 1s) :

LINE	MATRIX	SYMBOL	BINARY	DEC
0	. . . . .	. . 1 1 .	00110	6
1	. . . . .	. 1 . . 1	01001	9
2	. . . . .	. 1 . . .	01000	8
3	. . . . .	1 1 1 . .	11100	28
4	. . . . .	. 1 . . .	01000	8
5	. . . . .	. 1 . . .	01000	8
6	. . . . .	1 1 1 1 1	11111	31
7	. . . . .	. . . . .	00000	0

Character code 3 has its equivalent CG ram locations at 24-31. In an 8-bit control mode we first set the initial CG ram address to location 24 (note that D6 at logic 1 represents decimal 64) :

RS	RW	D7	D6	D5	D4	D3	D2	D1	D0	DEC
0	0	0	1	0	1	1	0	0	0	88

Assuming that the Entry Mode code ID has been set for 1 (increment ram address by 1), we now send each of the pattern line codes consecutively, toggling Line E up and down each time :

RS	RW	D7-D0	DECIMAL
1	0	00000110	6
1	0	00001001	9
1	0	00001000	8
1	0	00011100	28
1	0	00001000	8
1	0	00001000	8
1	0	00011111	31
1	0	00000000	0

The pattern is now stored in CG ram and can be accessed as though it were in the fixed character library, as character number 3. The pattern will remain where set until the Clear Display command is called, or the power is switched off, or another pattern is programmed in to replace it.

POWER SUPPLY

The LCM 570 needs three power lines, +5V, 0V and -5V. The chip's logic is controlled by the +5V, and its lcd screen is controlled by -5V via a potential divider which is adjusted to vary the lcd contrast, as described next month.

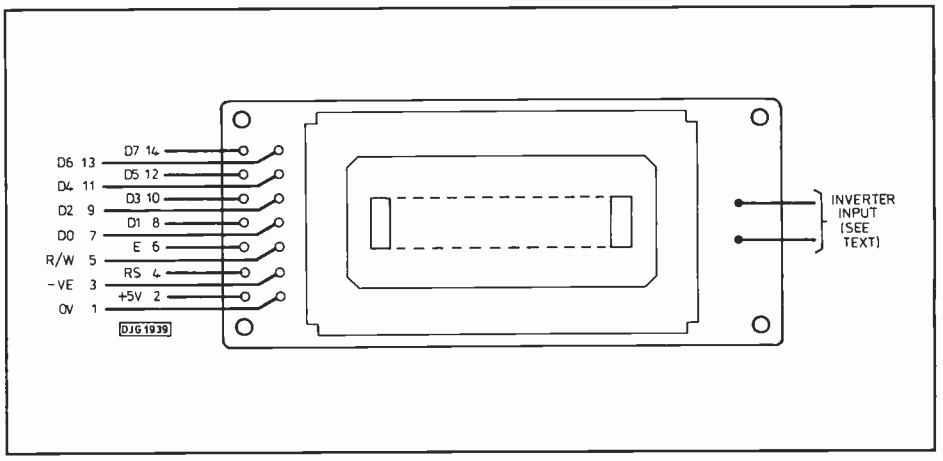
BACKLIGHT FACILITY

A normal drawback of lcds is that they need to be illuminated before their data can be seen, unlike led devices which provide their own light. The problem has been overcome on the LCM 570 by providing it with its own separate internal lighting, known as the EL, or electro-luminescent source. This illumination source requires a separate power supply, available from the manufacturers and their suppliers as an accessory module. Known as an inverter source, the module generates a voltage of about 100Vac at a frequency of 400Hz. This is taken to pins 15 and 16 on the right hand side of the module. It does not matter to which of these two pins the inverter is connected. (Some modules in the LCM series use led back lighting which does not need an inverter, running from the normal +5V supply.)

NEXT MONTH

Next month I'll describe the simple, but very useful Message Maker circuit that can be used as a test and real-time evaluation-board, and as a practical message display medium. A complete computer program listing performing and illustrating the principle modes of control and their effects will form an important part of the next article. Alternative devices to the LCM 570, which use similar control codes but have varying line counts and lengths, will also be given.

We are grateful to Tempatron and RS Components for their assistance and data supplied relating to the lcd module LCM 570 and the equivalent Electromail device RS 585-006. PE



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HOME-BASE

Ian Burley hosts this month's column. He's had a good look round the Winter Consumer Electronics Show in Las Vegas and tells us about a variety of new and interesting products for the domestic and office scenes.

Every January and June the consumer electronics community in North America up and leave home for a few days to meet up in Las Vegas and Chicago respectively to see and show the latest goods. These shindigs aren't modest affairs. It's difficult to know where to start when you're confronted with your first Consumer Electronics Show (CES), after all at Winter CES'90 some 100,000 show goers went to see about 1,400 companies spread around nearly a dozen exhibition sites in dazzling Las vegas Nevada.

CES has to be the ideal example I'd use to explain the meaning of "diverse" to an alien. Virtually anything remotely associated with leisure products powered by electricity can be found at CES, from home computers and video games, hifi and in car audio, all manner of video and tv equipment, batteries, calculators, telephones and home automation and office technology, to mention but a few. There's also audio and video software media, watches of all shapes and sizes and even a separate section dedicated to adult video.

Although CES is really a domestic trade event for the American and Canadian consumer electronics market, companies often use the show platform to reveal new products and innovations for the global market.

Main themes this year were expected to be high definition tv (hdtv), home automation, home theatre, dat vs analogue tape and the latest in home video game consoles.

DOLBY S

Starting totally at random, Dolby managed to persuade four respected hifi names, Teac, Denon, Harman Kardon and Pioneer, to show prototype cassette decks incorporating the latest tape noise reduction system, Dolby S. Besides offering audiophiles even better cassette recording quality, Dolby S was heralded at the show by the American pundits as the last nail in dat's consumer coffin market coffin.

Dolby S is a refinement of Dolby C, which has been around for several years. The problem with C is that it's not very compliant with a range of different tapes. Dolby claims that S is much more compliant and will exhibit considerably less distortion on a wide range of tapes. While Dolby C failed to take over from Dolby B as the de facto noise reduction standard for cassette tape, Dolby thinks S will finally achieve this goal. Dolby is currently reducing its prototype S chip count for mass production and we should see Dolby S equipped decks in the shops by the end of the year.

Proponents of dat as a home hifi leisure medium were very depressed about the Dolby S revelation because there is now a school of thought which thinks the trusty compact cassette can now virtually match dat for quality in the majority of homes. dat hardware and software will always be more expensive and the all important record companies are more likely to embrace Dolby S than dat even though they're supposed to have agreed to start producing for the latter.

HDTV

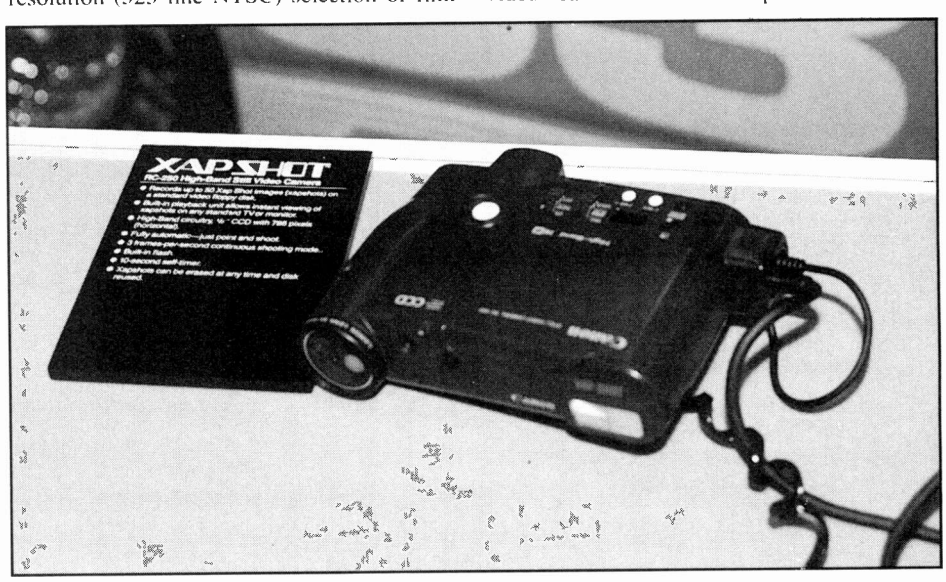
Pre-show blurb heralded CES as the event to see hdtv. I managed to sit in on a marvellous hdtv demo courtesy of Barco Inc., a respected manufacturer of video projection systems but, very disappointingly, nobody else showed hdtv technology. The Barco demonstration was all the more impressive because it was projected. The demo started with an impressive enough standard resolution (525 line NTSC) selection of film clips and half way through the hdtv projector was switched in. The assembled viewers gasped with amazement and in typical American enthusiasm promptly applauded. Coupled with an impressive stereo surround sound backing, the Barco demo was perhaps the highlight of the show for me.

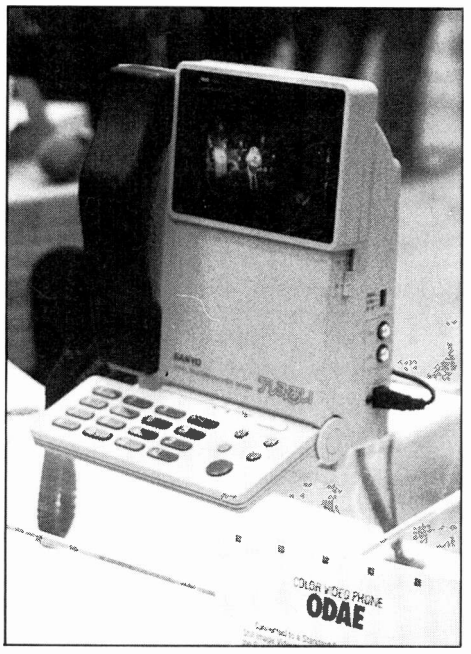
However, hdtv is still some years away from being a commercial reality.

All the big names in tv and video virtually refused to acknowledge the existence of hdtv on their show stands. Instead, the US trend is for bigger tvs - up to 35 inch tubes, and even video projectors, which leads us on to the perception of another American growth market, home theatre. Stereo tv broadcasts are now well established in the States and coupled with suitable decoders, like Dolby's Surround and Pro Logic systems, and huge screen tvs or projectors, more and more homes are being equipped with dedicated viewing rooms, or home theatres. Videos are also getting better with, for example, Sharp unveiling an amorphous nine head vcr. Sharp also exhibited an lcd based video projector.

XAPSHOT

Remaining on the subject of video, Canon invested in a large display for its Sony Mavica based Xap-Shot still video camera. In fact Canon has developed a whole range of still video cameras for both professional and





leisure use. These cameras all use the same Sony developed tiny 2 inch Mavica floppy disc to record up to 50 still frames according to the resolution used. Sony's own Mavica camera for the consumer market has an audio option which lets you record about 10 seconds of sound instead of a picture. Oddly enough Canon representatives were rather dismissive of this feature and somewhat smugly reminded me of Sony's decision not to show the Mavica at CES. It's all very well being able to take pictures on a camera which will replay them on a tv, but what about prints? Canon showed a hard copy device which produces 5 inch colour prints of surprisingly good quality. The idea is that Canon dealers will have one or two of these devices in their shops to cater for the odd snap shot a Xap-Shot owner wants printed. Prints are said to cost about $1 (60p) each and I'd equate quality to that of a good 110 print in terms of sharpness but without the annoying graininess of conventional film. Another potentially important use for the still-video technology is for image capture in computer applications like desktop publishing. An Apple Macintosh was on hand to demonstrate this, though quality was a bit disappointing as a fairly basic analogue to digital interface box was being used. Canon Xap-Shot cameras start at about $995 and the European PAL compatible version is just starting to appear here in the UK, but called the Canon Eon, priced £500.

DIGITAL PHONES

Telephones in the States aren't the somewhat boring and taken for granted everyday necessities we often take them for here. Digital exchanges started to appear in America and Canada several years before the UK and subsequently many advanced new features provided by the new exchanges have started to appear. These are CLASS, or Custom Local Area Service System features.

One of the most exciting and already controversial has been the limited introduction of a facility known as Caller ID. Already available in many office pabx systems, CID lets the phone call recipient know the phone number of the caller on a small lcd screen - even before he or she has to pick up the phone to answer it. Several states have blocked the introduction of CID because of complaints concerning a perceived erosion of "civil liberty." The phone companies feel that CID is an ideal way to deal with the problem of malicious callers and "heavy breathers." Others argue that they have a right to contact people on the phone regardless of who they are.

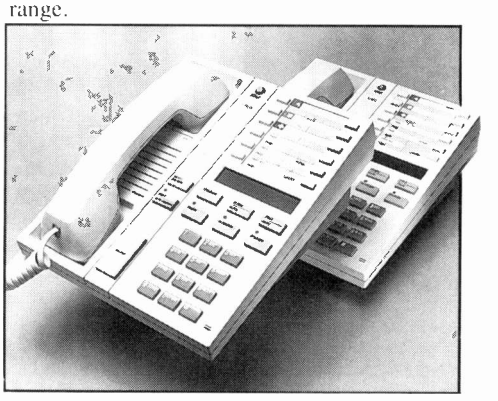
CID adapter boxes, which you add to an existing phone, have been available for about a year now. Telecomms manufacturer, Northern Telecom, launched the world's first phone with integral CID at CES with the help of celebrity William Shatner, better known as Captain Kirk from Star Trek. The Northern Telecom "Maestro" phone can also remember the phone numbers of callers who missed you if you were out and there's even a facility to include a black list of numbers you don't want to get through to you. The Maestro costs $136 or about £80 and is just a hint at what's to come telecomms-wise. Other CLASS facilities include multiple lines on the same phone number, call diverting, and distinctive ring patterns to indicate who the call is for.

VIDEO PHONES

Talking of phones, Sharp showed its colour video phone system at CES. These are actually on sale in Japan, though probably only to those who succumb to flashy gimmicks. The Sharp videophone does sport the latest technology colour lcd screen, but frame refresh is at best only every few seconds and can't, by any stretch of the imagination, be called real time! Still, the phone itself looks good and you don't need dozens of lines like some of the more ambitious prototypes which have been seen. Of course, you can only use the picture facility when phoning another Sharp videophone.

SPEAKER PHONES

One of the largest US phone companies, AT&T, made a couple of interesting announcements at CES. Following an accelerating overall trend, AT&T has taken a facility already offered to the business community and offered it to the householder. This time it's a network of versatile phones, called Intercom Speakerphones, in your own home, complete with paging and an intercom facility, but without the need to rewire the installed phone lines. AT&T also announced improved reception quality on its range of cordless phones using an enhancement system called Clarity Plus. The claim is that static noise and interference has been virtually eliminated, even near the limits of reception range.



Not surprisingly, there was no sign of any of the new digital cordless phone technology which has started to appear this side of the Atlantic - in other words Telepoint. Supporters of Telepoint in the UK say that there is considerable Stateside interest in the CT2 technology being developed by Ferranti, Shaye and Plessey. Perhaps we'll see Telepoint making its mark in future CES shows.

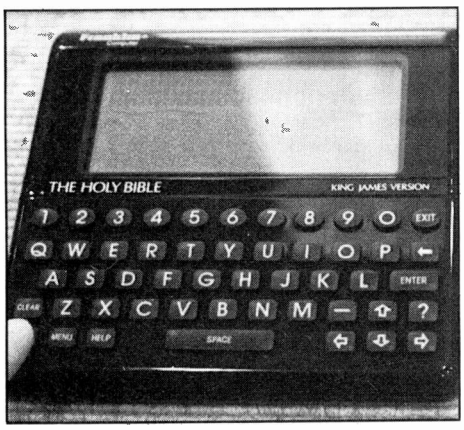
The trend towards working from the comfort of your own home is no more evident thanin the States. CES is a show for products aimed at the home, so perhaps it's no surprise that fax machines and compact photocopiers were much in evidence at CES, as were personal computers - especially the new

generation of notebook and pocket sized computers and advanced "electronic organiser" calculators.

CASIO BOSS

Casio introduced a new BOSS (Business Organiser Scheduling System) electronic organiser at the show, called the SF-9000. The compact unit offers a Sinclair ZX81 reminiscent flat QWERTY keyboard coupled to 64K of ram and a 32 column by 6 line lcd display. The SF-9000 can be linked to either an Apple Macintosh or a PC with optional link packs and plug in software comes in the form of credit card sized memory expansion cards. More ambitious software offerings are also being supplied on disc for use with the BOSS to PC links. The BOSS range starts at $300.

Meanwhile, Sharp released some new applications cards for its established IQ personal organiser, known as the Wizard in the States. Another American firm making a name for itself by packing incredible things into very small calculator like cases is Franklin Computer. Its biggest claim to fame so far has been to offer a dedicated calculator sized computer containing the entire new and old testaments of the Holy Bible, King James version. A small QWERTY keyboard gives



you access to a search system which instantly finds you favourite quotatations and passages. The Franklin hand held Bible sells for $329. The company also makes a range of pocket sized language translators (including speaking versions), spelling checkers and a thesaurus. That originator of all electronic pocket organisers, the Psion Organiser, is an established product in the States and much in evidence at CES. Much interest was shown in Psion's new range of A4 sized Mobile Computers or MC laptops.

Another popular pocket sized computer at CES was Atari's Portfolio Pocket PC.

HOME AUTOMATION

So onto one of the adopted themes of the show; home automation. To be honest, like the much heralded hdtv, there wasn't an abundance of home automation systems on show, but what there was proved interesting. Californian firm, Mastervoice, exhibited its Butler in a Box appliance control system, complete with a

voice command option. The main control unit can remotely switch on or off up to 28 lights and or relayed appliances through the house's normal electrical wiring. Inventor of the Butler in a Box is Gus Searcy, an ex-professional magician. He claims the idea to build the device, which he paternally refers to as "Sidney," came from joking from friends that as a magician he should be able to switch things on or off around the house through "magic." With a voice recognition option, based around a $150 NEC voice recognition chip, it might as well be magic. A less expensive infra red remote control is also available.

CES also saw the announcement of a Home Automation Standard devised by the Electronic Industries Association in Washington DC. Basically the standard envisages common inter-communication between controllable appliances through telephone, electricity and cable tv cabling as well as rf and infra red links. One scenario put forward would be when a home owner could check his or her home security system before retiring for the night, in other words all the doors could be locked, non essential lights switched off and the central heating or air conditioning thermostat turned down all from a bedside panel or remote control, not to mention via voice command. Imagine 2001's HAL in your home... Appliance adjustments could also be made simply by phoning home from the office too. Exactly what chance the ideas proposed by the EIA have of being adopted by the consumer electronics industry as a solid standard remains to be seen, but that vision of an automated future looks very attractive.

BATTERIES

Finally, on to a few odds and ends which caught the eye at CES. Duracell has come up with a novel way for customers to reassure themselves that batteries they have just bought are fresh. An electrolytic battery test indicator is printed on the battery blister pack. The only problem is that you have to open the pack to test the batteries. But still, it's an excellent idea and one which will hopefully cross the Atlantic to the UK soon. Sticking with batteries, Duracell announced developments in Zinc/air battery technology while Gates Energy unveiled a new range of Millenium Nicad rechargeable batteries. Milleniums have a life time guarantee and a claimed 30% improvement in charge life.

Sony showed its first "one-bit" High Density Linear Converter (hdlc) portable cd player. The new Sony Discman is one of the first portables to incorporate the latest one-bit digital sound processing circuitry only recently introduced to top end hifi cd players.

NEVADA BLASTING

Outside under the bright Nevada desert sun, in car stereo systems were blaring out at full blast - you could feel the bass inside neighbouring exhibition halls. The main innovation here was a new digital signal processor (dsp) based sound field enhancer system from Pioneer. DSP heads, as they're known in the car hifi trade, aren't very new, but Pioneer is the first company to have brought pricing down well below $1,000.

That's all from the CES Show for now. Look out for our coverage of the Summer CES in Chicago this June.

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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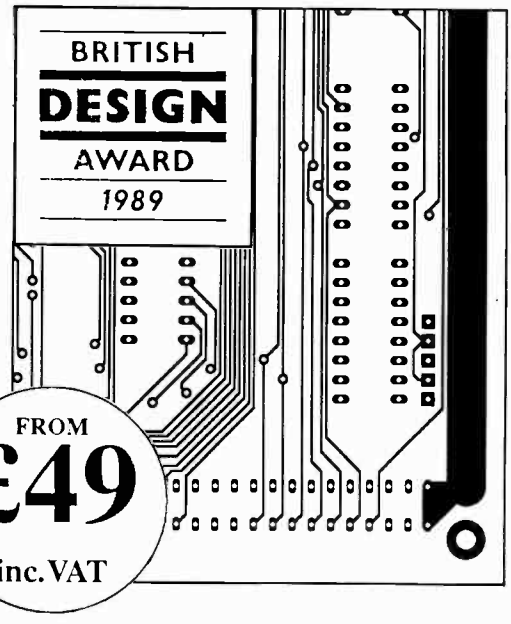

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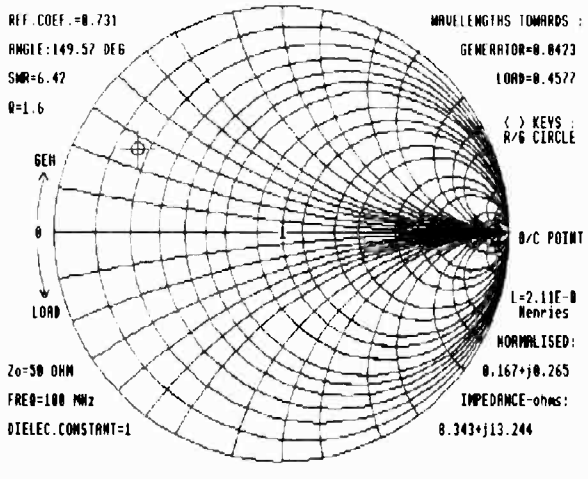
For IBM, PC/XT/AT and clones inc. Amstrad 1512 and 1640 and BBC B, B+ and Master.



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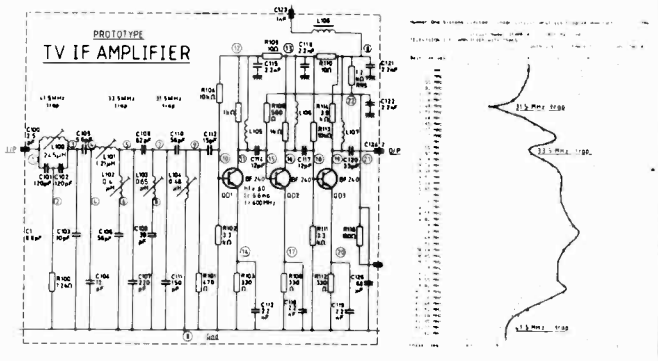

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BUILDING A ROBOT CAR

In part two, Alan Pickard puts you on the write procedure for circuit and software control of a micro-buggy.

Last month, basic principles of applied robotics and some practical examples were discussed, and we tootled off on a two-tone horn. First, now, a few more peripherals.

LED DRIVER

Data line PB4 activates the led driver circuit in Fig.20. The appropriate logic level enables the led to be turned on or off, ie. logic 0= off, logic 1 = on.

Logic 1 provides forward bias to the transistor, turning it on and allowing current to flow through the led pair via TR3.

Fig.21 shows the sound/light (horn /led) codes, and the sound and light test program is shown in Fig.22.

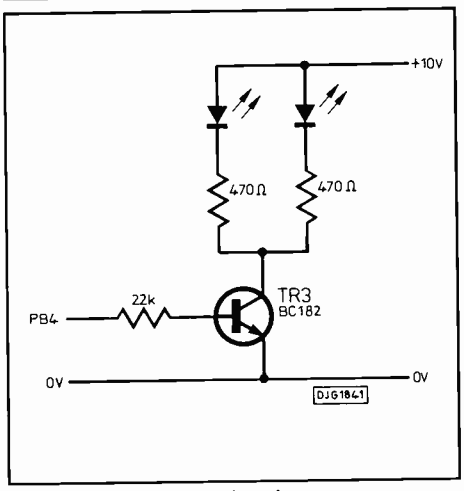


Fig 20. Led driver circuit.

COLLISION DETECTION

Data line PB7 is allocated to a strategically places microswitch on the front of the robot wired as in Fig.23, such that a collision may be detected by the use of appropriate software, eg, Basic lines:

```
80 IF (?&FE60 AND 128) = 0 THEN GOTO 100
90 IF (?&FE60 AND 128) = 128 THEN GOTO 80
```

This simple routine utilises the logical operator AND to test whether or not bit 7 (decimal value 128, 10000000) is set.

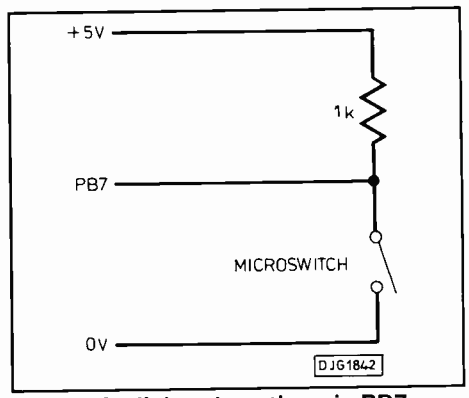


Fig 23. Collision detection via PB7.

FULL CONTROL CIRCUIT

The full control circuit in Fig.26 comprises the previous individual circuit sections which have already been described.

A complete layout and wiring diagram is shown in Fig.27. This is constructed on standard Veroboard which can be shaped or sized to suit the constructor's chassis. As stated before, various methods can be used for producing a motor/wheel unit. One possibility would be to modify or strip down a vehicle such as a 'Big-Trak' or radio-controlled vehicle with suitable steering.

The listing in Fig.24 provides a Basic routine for collision detection.

An alternative method of implementing collision detection could be to utilise the interrupt facility of the 6502 cpu. A microswitch connection can be made via CB1 which in turn connects to the cpu interrupt circuitry Fig 25). This is a more direct method, allowing direct communication with the cpu and interruption of an executing program. Apart from providing a more satisfactory software method, it releases PB7 for some other input sensor (or output) function. Also, CB2 could be used for another switch.

For example, CB1 could be wired as an interrupt on one or two front microswitches, with CB2 as one or two rear or side microswitches.

Further details of the use of interrupts will be covered later, including test programs in Basic and machine code (assembler).

TESTING

All sections of the circuit can be tested by connection to the user port before connecting and fitting to the vehicle assembly. Simple basic routines and programs can be tried, and a feature of the BBC micro which can be used is the programming of user keys. Individual functions can be assigned to up to 16 keys, including the edit keys. This function can be retained when writing larger test and 'on-line' programs and enables manual control of the robot (motors, tones, led and various combinations of these actions).

Whatever vehicle type is chosen, if expansion is intended consideration should be given to weight (including batteries, space required and mechanical stability).

A further point is that the fitting of on/off switches for supplies to pcb and motors is more convenient than chasing an 'aborted' robot, or than being deafened by continuous tones!

Fig 21 (below). Codes for horn and led circuits.
Fig 22 (right). Manual controls program for tones and leds.

HEX &	BINARY		ACTION PERFORMED
15	0001	0101	TONE 1 (500Hz)
35	0011	0101	TONE 2 (1000Hz)
45	0100	0101	LEDS ON
55	0101	0101	LEDS ON + TONE 1
75	0111	0101	LEDS ON + TONE 2

```
10 REM MICROBE 2.9
20 REM MANUAL CONTROLS (TONES
& LEDS)
30
40
50
60 ?&FE62=&70
70 ?&FE60=&00
80
90 *KEY 11 ?&FE60=&00IM
100 *KEY 12 ?&FE60=&10IM
110 *KEY 13 ?&FE60=&20IM
120 *KEY 14 ?&FE60=&40IM
130 *KEY 15 ?&FE60=&80IM
```

Fig 24. Collision detect (PB7) program.

```
10 REM MICROBE 2.11
20 REM COLLISION DETECTION (PB7)
30
40
50
60 ?&FE60=&0F
70
80 PRINT "FORWARD"
90 IF (?&FE60 AND 128) = 0 THEN
                          GOTO 120
100 IF (?FE60 AND 128) = 128 THEN
                          GOTO 90
110
120 ?&FE60=&00
130
140 PRINT "REVERSE"
150 FOR M=1 TO 2000
160 NEXT
170
180 GOTO 80
```

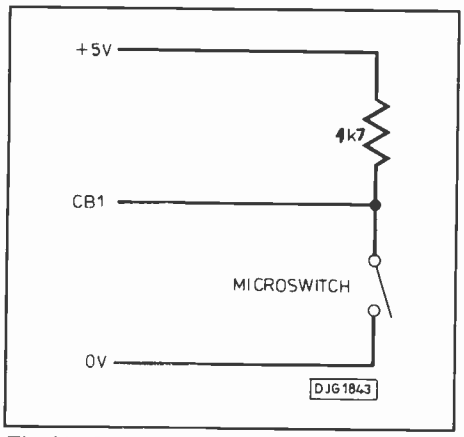


Fig 25. Collision detection via CB1 (for interrupt).

MANUAL CONTROL CODES

The table in Fig.28 provides useful information for programming of user keys (as utilised in Listings 1 or 2). The following information is also essential:

?&FE62 = &7F sets DO-D6 input, D7 output.
?&FE60 = &05 ensures robot is stationary!

*FX4,2 enables programming of edit keys as user keys(11-15), eg, *KEY 1 ?&FE60 = &15IIM.

HEX &	FUNCTION	USER KEY	KEY NO.
05	STOP	COPY	11
0C	LEFT	◀	12
03	RIGHT	▶	13
00	REVERSE	▼	14
OF	FORWARD	▲	15
15	TONE 1	f1	1
35	TONE 2	f3	3
45	LEDS ON	f4	4
55	LEDS ON + TONE 1	f5	5
75	LEDS ON + TONE 2	f7	7

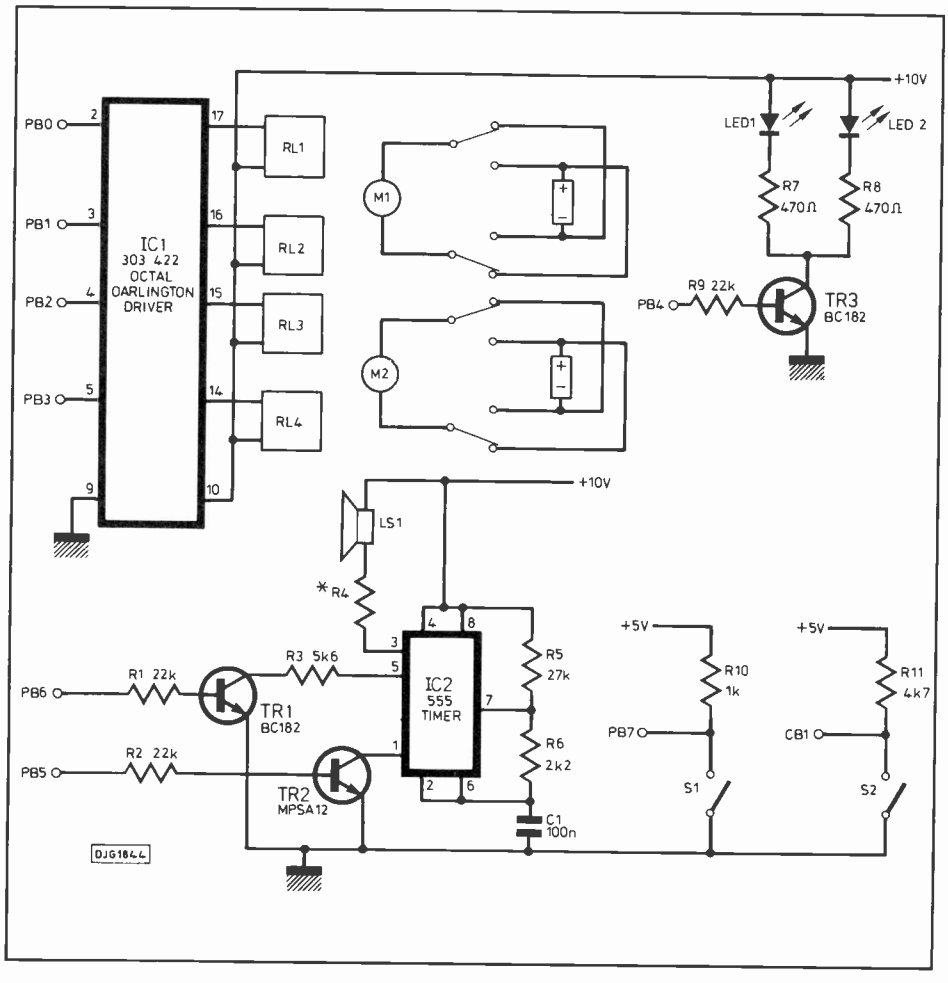
Fig 28. Manual control codes for user-defined keys.

PROGRAM TECHNIQUES

We can now move on and outline simple programming techniques which can be used to provide some useful software relevant to the operation of the robot. Programs are very simple and modular and can therefore be easily used as building blocks to suit personal taste. There may be many ways that they can be made more efficient and effective, but this is up to the individual programmer.

Assuming that all of the hardware is complete and has been tested using the two simple manual test programs, we can now proceed to write individual modules which will make up a complete test program. (Reference will need to be made to the various tables already discussed).

Fig 26. Full control circuit of Microbe 3.



BACK AND FORTH

The program in Listing 1 consists of a simple loop which will cause the robot to go forward, then stop, reverse and stop again. The GOTO statement in line 460 will cause this loop to be repeated until the program is stopped using ESCAPE.

A time delay between each function is provided using a FOR...NEXT loop. The value used to set the range within the loop produces a time delay in multiples of approximately two thousandths of a second. Thus 1000 provides a delay of about 0.5 of a second and 2000 a delay of 1 second.

Forward motion of the robot wheels is actually achieved by poking the hex value &0F into the data register of the 6522 VIA. PRINT statements are used to indicate the current motor action on the screen. The SOUND statement in each section signifies the start of the motor action.

Listing 1. Simple program for forward-stop-reverse-stop cycle.

```
10 REM MICROBE 3.1
20REM FSRS
30
40
50
60 ?&FE62=&7F
70 ?&FE60=&05
80
90 *FX4,2
100
110 *KEY 11 ?&FE60=&05IM
120 *KEY 12 ?&FE60=&01IM
130 *KEY 13 ?&FE60=&0DIM
140 *KEY 14 ?&FE60=&00IM
150 *KEY 15 ?&FE60=&0FIM
160
170
180 REM FSRS LOOP
190
200 ?&FE60=&0F
210 PRINT
220 PRINT "FORWARD"
230 SOUND 1,-12,20,1
240 FOR M=1 TO 2000
250 NEXT
260
270 ?&FE60=&05
280 PRINT
290 PRINT " STOP"
300 SOUND 1,-12,20,1
310 FOR M=1 TO 2000
320 NEXT
330
340  ?&FE60=&00
350  PRINT"REVERSE"
360 SOUND 1, -12,20,1
370 FOR M=1 TO 2000
380 NEXT
390
400 ?&FE60=&05
410 PRINT "STOP"
420 SOUND 1,-12,20,5
430 FOR M=1 TO 2000
440 NEXT
450
460 GOTO 200
```

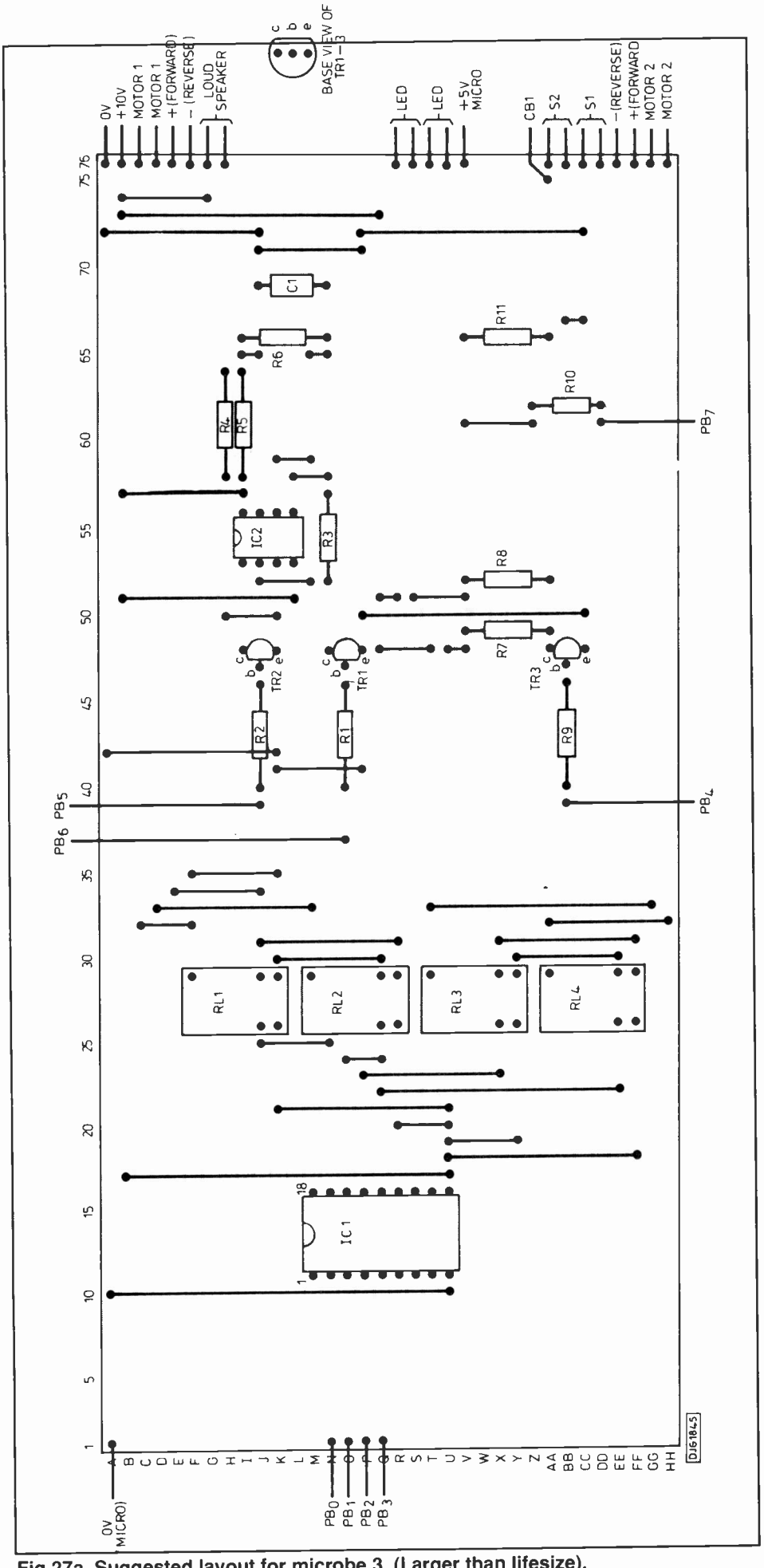


Fig 27a. Suggested layout for microbe 3. (Larger than lifesize).

SOUND 1,-12,20,1 produces a 'bleep' sound on channel 1 (from range 0-3), amplitude -12 (from range -15-0), pitch 20 (from range 0-255) and duration 1 (from range -1-254). The last section produces a longer sound (duration 10), to signify the end of the FSRS cycle which is then begun again (GOTO 200).

Also included in this program is the manual controls routine. Once the program is run, the programmable keys are set and can be used when the main program loop is not running. (Remember however, that the edit keys can not then be used unless these keys are reset.)

SOUND AND LIGHT

Listing 2 details a program which produces a sequence of audible tones by use of the appropriate hex codes for the upper 4 bits of the VIA data register (ie, &1 (0001) and &3 (0011)). The lower 4 bits should be set for stationary operation (ie, &05).

Thus &15 and &35 will produce tone 1 tone 3 respectively, with the robot stationary. Code &05 would produce complete inactivity. As in Listing 1, FOR...NEXT loops provide the necessary time delays. The GOTO statement provides continuous operation of the loop until the program is stopped.

In this program (Listing 3) codes &45 and &05 are used alternatively with the usual time delay to flash the led pair on and off.

COLLISION DETECTION

Listing 4 provides forward motion (?&FE60=&0F) and then by use of the logical

Listing 2. Tone loop test program.

```
10 REM MICROBE 3.2
20 REM SOUND
30
40
50
60 ?&FE62=&7F
70 ?&FE60=&05
80
90 *KEY 1 ?&FE60=&151M
100 *KEY 3 ?&FE60=351M
110
120
130 REM SOUND LOOP
140
150 ?&FE60=&15
160 FOR S=1 TO 1000
170 NEXT
180
190 ?&FE60=&05
200 FOR S=1 TO 1000
210 NEXT
220
230 ?&FE60=&35
240  FOR S=1 TO 1000
250 NEXT
260
270 ?&FE60=&05
280 FOR S=1 TO 1000
290 NEXT
300
310 GOTO 150
```

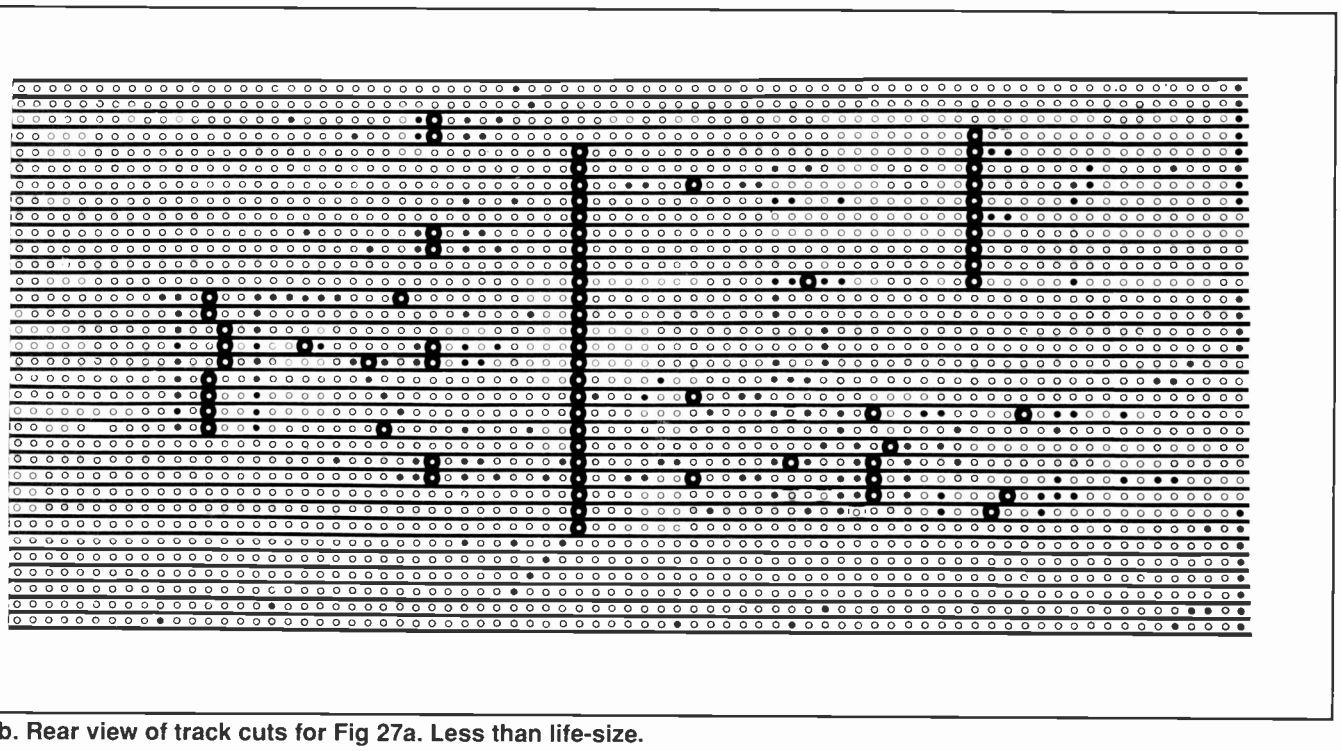


Fig 27b. Rear view of track cuts for Fig 27a. Less than life-size.

AND operator tests the state of bit 7 (PB7) for operation of the microswitch.

If PB7 is set, the GOTO statement in line 120 causes the REVERSE code to be poked into the VIA data register and thus the robot reverses on collision with an object.

The word "REVERSE" appears on the screen (or "OUCH" or something to your taste!). The motor reverses for a predetermined period (2000) and the cycle is repeated. This routine enables the robot to be released into its environment, with the ability to overcome obstacles.

The routine could be combined with the program in Listing 1, but will only work if a collision occurs at the right time in the cycle! Obviously, the limitation of this method could actually be improved either in Basic or machine code, but a more effective method would be to use some interrupt-driven software. This will be covered in a later article.

These four modules (plus the manual controls module) could be combined into one test program, but may need to be run separately. This could be achieved by the insertion of END statements and the use of the GOTO command to run the required section.

Listing 3. Flashing leds program.

```
10 REM MICROBE 3.3
20 REM LIGHT
30
40
50
60 ?&FE62=&7F
70 ?&FE60=&05
80
90 *KEY 4 ?&FE60=&45IM
100 *KEY 5 ?&FE60=&55IM
110 *KEY7 ?&FE60=&75IM
120
130
140 REM LIGHT LOOP
150
160 ?&FE60=&45
170  FOR L=1 TO 1000
180  NEXT
190
200  ?&FE60=&05
210  FOR L=1 TO 1000
230
240 GOTO 160
```

PROCEDURES

Before looking at improving the structure of test programs, it would be useful to look at another special feature of the BBC machine: BBC Basic Procedures.

A PROCEDURE is a more efficient and easier use of the Basic subroutine. Instead of using the keywords GOSUB and RETURN, the words PROC, DEF PROC and ENDPROC are used.

PROC is suffixed to a user defined label to enable a particular Procedure to be called by name, eg, PROCFORWARD. DEF PROC defines the Procedure, for example:

```
10 DEF PROCFORWARD
20 ?&FE60=&0F
30 PRINT "FORWARD"
40 FOR M = 1 TO 2000
50 NEXT
60 ENDPROC
```

Each time the statement PROCFORWARD is encountered in the program the above procedure or subroutine would be actioned, without having to specify a line number as with GOTO or GOSUB. ENDPROC is the equivalent of RETURN.

Thus the modules already devised for testing could be rewritten as PROCEDURES. These can be called up from within the test program by name only, regardless of line number. The Procedures can also be positioned away from the main body of a program, which aids clarity when reading or writing programs.

Lower case letters may be used for Procedure labels which helps then to stand out in listings. I have chosen to use lower case for the main Procedures, and upper case for the 'sub-' Procdures.

To be continued next month.

Listing 4. Collision detection during forward motion.

```
10  REM MICROBE 3.4
20  REM COLLISION DETECTION (PB7)
30
40
50
60  ?&FE62=&7F
70  ?&FE60=&05
80
90
100  REM COLLISION LOOP
110
120 ?&FE60=&0F
130  PRINT "FORWARD"
140 IF (?&FE60 AND 128) = 0 THEN
                              GOTO 160
150 IF (?&FE60 AND 128) = 128 THEN
                              GOTO 140
160  ?&FE60=&00
170  PRINT "REVERSE"
180  FOR M=1 TO 2000
190 NEXT
200
210 GOTO 120
```

PE

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BD56 1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
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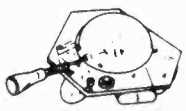

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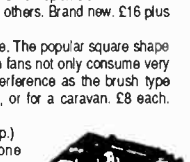

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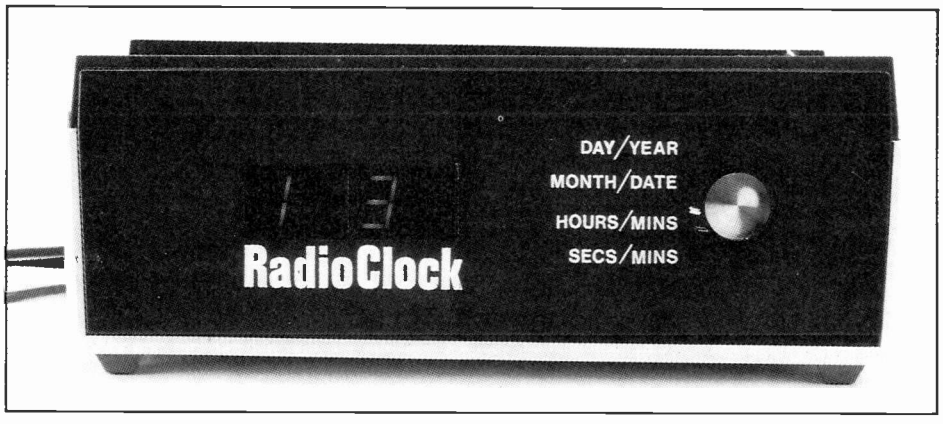
RADIO CLOCK

Part three: From the hardware aspects completed last month, John Becker concludes the project by looking at the software options.



The pin connections for the led display module are shown in Fig.20. Fig.21 gives the switch legends which may be photocopied to a size that suits you and pasted direct to the box front panel. The rectangle illustrates the module readout face but is not to scale; the hole should be cut so that the leds tightly push through it, friction then holding the module in place. Surprisingly, I was unable to locate a suitable bezel to match the module.

EPROM DATA

In my own model, I used a battery-backed static ram programmed and used as an eeprom, though I could equally well have used a standard eeprom. Alternatively, I could have used an ordinary eprom. The advantage of eeproms over eproms, as recently discussed in PE, is that they can be simply programmed from a 5V supply without the need for higher Vpp 'burn-in' voltages. Eeproms can also be readily reprogrammed without first erasing them in ultra-violet light.

In theory, all eeproms should retain their data even when the power supply is turned off. However, I experienced a little trouble with the battery-backed version which was susceptible to losing it's data if soldering was carried out in its vicinity while it was in the pcb; this required it to be reprogrammed once or twice!

Whatever eprom or eeprom you decide to use, ensure that it is a 2048 x 8-bit version having the same pin configurations as shown in the circuit diagram. With an eprom, pin 19 of IC7 on the pcb should be taken to +5V, not ground. Also see the note at the end.

DATA LOADING

You have a choice of methods for getting the data into the eeprom: to use an eeprom programmer (such as recently published in PE), by far the easiest method; or to take advantage of the spare socket on the lower left hand side of the decoder pcb, as expanded in Fig. 25.

I have not proved the viability of the latter method, but it's a suggested way in which those who do not own a programmer might be able to load data into the eeprom, though admittedly it will be more finicky to use than a programmer. You will need an 8-way spst 14-pin dil switch, an spco switch and a 10k resistor. Referring to the pcb layout, take each of the six upper left hand connections of the designated socket to the eeprom output lines. If you trace the pcb wiring you will find convenient wire links to which to solder the connections. Take the 7th upper connection to the connection at R33, and the 8th to the clock input to IC6.

The first lower left hand connection (joining to the commoned pins of the socket) goes to +5V; into the two holes below that insert the 10k resistor (so connecting switch number eight to +ve via the resistor); take the lower far right hole to a convenient 0V point.

The first six switches can be set to put either logic 0 or 1 on the associated eeprom output line. The 7th switch is used to take the R/W input of the eeprom to 0V, putting it into write mode. The final switch enables the clock input to the counter IC6 to be toggled up and down, so stepping the counter forward (the up transition triggers it, down has no effect). The receiver pcb is left unconnected to the decoder pcb in this programming method (apart from the power supply connections). It may, with some devices, also be necessary to disable the output enable line, using another switch for the purpose.

The separate spco switch is used to reset the counter. Take the switch's outer pins to +5V and 0V respectively, and the centre pin to the sync input line. Resetting occurs when the sync line is taken high. For counting, the line needs to be held low.

Experiment with the switch settings until you are familiar with putting data into the eeprom, and checking that it has been recorded. For the latter, the eeprom is returned to read mode (pin 21 high), and the output lines checked with a voltmeter. The counter status of IC6 can be monitored on the led display, with S1 set to the seconds mode.

When you're ready, then program the data shown in Fig.22 into the eeprom at the address/count indicated. When you've finished the programming remove the temporary wire connections.

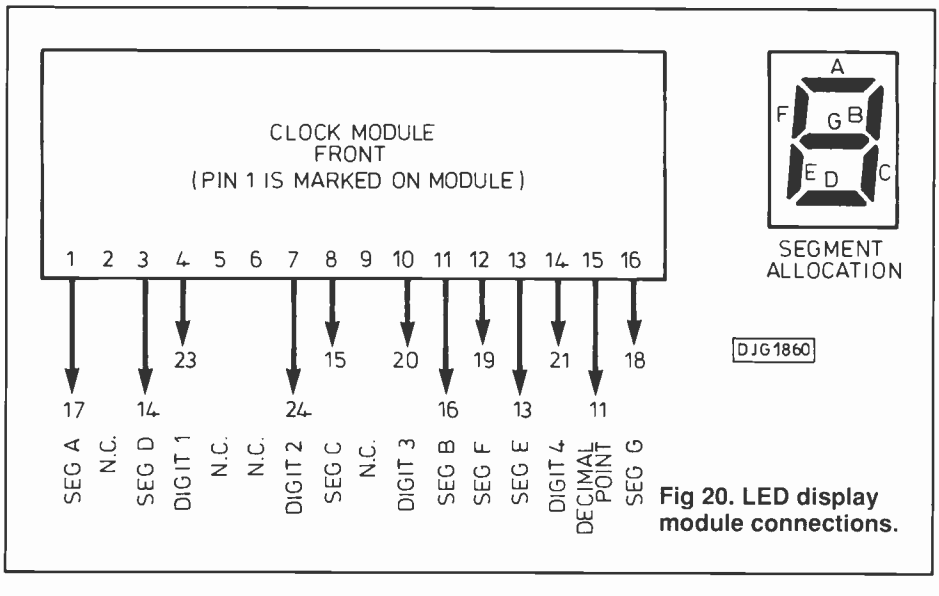


Fig 20. LED display module connections.

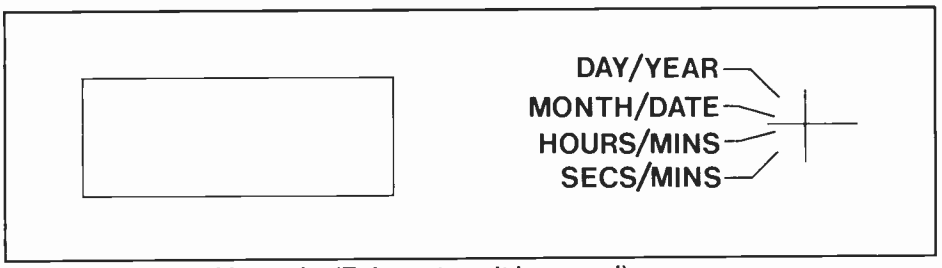


Fig 21. Front panel legends. (Enlarge to suit box used).

USING A PROGRAMMER

Using a programmer to program the eeprom is much simpler, though requires a greater number of data entries. The latter is due to the order in which the counter lines are connected to the eeprom address lines. They were arranged in this order to facilitate the tracking layout on the pcb. However, their order means that count numbers do not directly correspond with address numbers, though the end result is the same.

Fig.24 shows the data to be programmed using an eeprom or eprom programmer.

RUNNING THE CLOCK

When the clock is first switched on the displays will show meaningless numbers or blanks at all settings of S1, except for the seconds readout, which should be seen counting upwards from zero. The data will change on receipt of the first sync pulse, but is likely to be still meaningless or misleading. You should have observed, though, that the seconds counter had been reset. It is only after receipt of the 2nd sync pulse that the data readout should be valid.

Should a sync pulse not be received due to a reception error, the counter is likely to continue past the 60 seconds mark before automatically returning to zero. In this event the data readout will again be erroneous, but will be restored to accuracy after the next valid sync pulse. If the Rugby signal is totally lost, the counter will stop.

But note, though, that even if the signal is temporarily lost or the power fails, the clock will resume its display accuracy within two minutes of restoration of normal conditions; you do not need to manually reset it. I doubt if you can say the same for a clock that isn't radio controlled!

Incidentally, it has been interesting to observe in the four months between putting the clock into use and writing these words, how my wrist watch, which I had believed to be very accurate, has drifted in relationship between the seconds display and the Rugby sync signal. (Probably in keeping with changes in weather temperature!)

Fig 22. Relationship of binary code to count number. From left to right, the binary digits are seen on IC7 pins 17, 16, 15, 14, 13, 11 respectively. Ignore last two binary digits.

00	000000000	31	001100000
01	000000000	32	001100000
02	000000000	33	001100000
03	000000000	34	001100000
04	000000000	35	001100000
05	000000000	36	101100000
06	000000000	37	100000000
07	000000000	38	100000000
08	000000000	39	100100000
09	000000000	40	000100000
10	000000000	41	000100000
11	000000000	42	000100000
12	000000000	43	000100000
13	000000000	44	000100000
14	000000000	45	000110000
15	000000000	46	000001000
16	000000000	47	000001000
17	000000100	48	000001000
18	000000100	49	000001000
19	000000100	50	000001000
20	000000100	51	000001000
21	000000100	52	000001000
22	000000100	53	000000000
23	000000100	54	000000000
24	000000100	55	000000000
25	010000000	56	000000000
26	010000000	57	000000000
27	010000000	58	000000000
28	010000000	59	000000000
29	010000000	60	000000000
30	011100000		

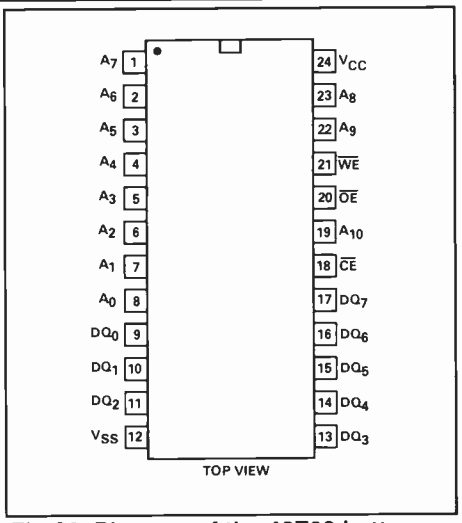


Fig 23. Pin outs of the 48Z02 battery-backed static ram as used in author's prototype for IC7.

Fig 24. Hex dump of the data for eprom programming into IC7. Note the addresses should start at hex 0000, not hex 2000 as shown.

```
HEX RUGBY EPROM

C*
      PC   IRQ   SR AC XR YR SP
.;   B780 7B7A 2C 34 3A 9D F8
.
.:  2000 00 00 04 60 10 08 00 00
.:  2008 00 04 40 80 08 00 00 00
.:  2010 00 00 04 20 10 00 00 00
.:  2018 00 00 00 00 00 00 00 00
.:  2020 00 00 04 20 10 08 00 00
.:  2028 00 00 00 00 00 00 00 00
.:  2030 00 00 40 A0 08 00 00 00
.:  2038 00 00 00 00 00 00 00 00
.:  2040 00 00 04 20 10 08 00 00
.:  2048 00 04 40 90 08 00 00 00
.:  2050 00 00 40 20 18 00 00 00
.:  2058 00 00 00 00 00 00 00 00
.:  2060 00 00 04 20 10 00 00 00
.:  2068 00 00 00 00 00 00 00 00
.:  2070 00 04 40 80 08 00 00 00
.:  2078 00 00 00 00 00 00 00 00
.:  2080 00 00 00 00 00 00 00 00
.:  2088 00 00 00 00 00 00 00 00
```

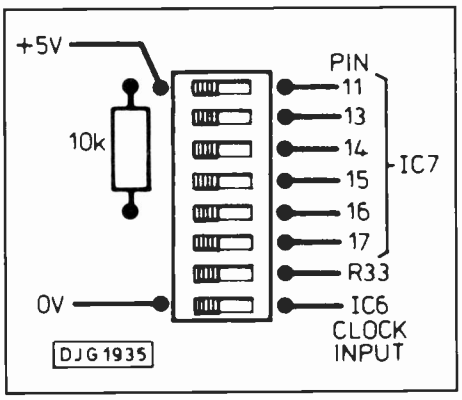


Fig 25. Suggested use of 8-bit binary switch for programming data into IC7.

ARISING POINTS

R14 is 330k not 33k as shown in the parts list.

R17 - R22 at 10k are the values used with IC7 as a 48Z02 device, but may need increasing to 100k with an eeprom or eprom device.

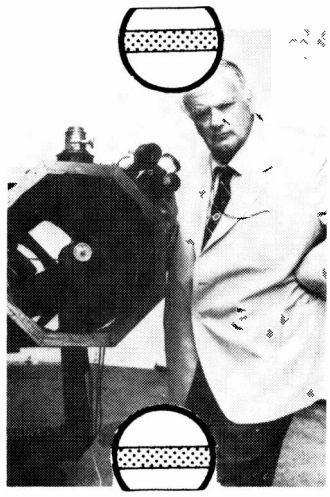
A dot matrix printer problem resulted in data following commas being omitted from the disassembled code in Fig 12, PE March 90. The hex dump codes are correct. The disassembly lines affected should read as follows:

```
2015  9D  B0  20   STA  $20B0,X
204D  BD  22  21   LDA  $2122,X
206B  BD  B4  20   LDA  $20B4,X
2072  9D  B4  20   STA  $20B4,X
207E  BD  B4  20   LDA  $20B4,X
2081  DD  16  21   CMP  $2116,X
2089  9D  C4  20   STA  $20C4,X
```

FUTURE OPTIONS

In my Feb 90 Editorial comments ("Ruling Data") I stated that I would soon be reporting in detail on a recently introduced series of intelligent liquid crystal displays. One aspect I shall be reporting on is how one of these displays can be interfaced to the Rugby clock. So, stay tuned in, and keep ahead and on time with PE! PE

SPACE WATCH



BY DR PATRICK MOORE CBE

Electronics replaces photography at professional telescopes but Austin's Comet could make the rest of us get our cameras out.

We are now well into the 'electronic revolution', when photography is being superseded - just as observations at the eye-end of the telescope were superseded a century ago. For many years the 200-inch Hale reflector at Palomar Observatory, in the United States, was in a class of its own, and magnificent photographs were taken with it. Now, however, electronic methods have taken over, and it has been officially announced that photographic surveys with the telescope have come to an end. It marks the conclusion of an era. There will still be some photography elsewhere - David Malin's results with the Anglo - Australian Telescope at Siding Spring will continue to be of immense value - but the Palomar decision is very significant.

New calculations have been made with regard to the orbit of Phobos, the inner of the two dwarf satellites of Mars. A.T. Sinclair, at the Royal Greenwich Observatory, has confirmed that it really is spiralling downward to destruction, and is approaching Mars at the rate of about 18 metres per century. This means that it will crash on to the surface in about 40,000,000 years from now, so that its destruction is not imminent. This limited life-span does, however, indicate that Phobos is a captured asteroid rather than a bona-fide satellite. Deimos, the outer satellite, is probably also asteroidal, but is further from Mars, and is not spiralling downward.

Further unsuccessful efforts have been made to detect a pulsar in the debris of SN 1987A, the supernova in the Large Cloud of Magellan. The pulsar has been recorded only once, and there must be doubts as to whether some mistake was made - or, perhaps, the 'beam' now misses the Earth, and we were lucky on that one occasion. We must wait and see.

AUSTIN'S COMET

The comet discovered last December by the New Zealand amateur Rodney Austin is now moving northward, brightening as it does so. At discovery it was 230,000,000 miles from the Sun, but at perihelion on April 9 it will be only 32,000,000 miles above the solar surface. In Britain we will not have a good view until after perihelion, particularly as the Moon will be obtrusive, but later in the month it should be really spectacular.

Comets are the most erratic members of the Solar System; one never knows how they will have behave - and some of us have sad memories of Kohoutek's Comet of 1973, which was expected to become brilliant, but which proved to be very puny indeed. According to modern theory, comets are very ancient, and come from the Oort Cloud (named in honour of the Dutch astronomer J.H. Oort, who first suggested its existence) at around one light-year from the Sun. If a comet is perturbed for any reason, it will start to 'fall inward', and unless it falls into the Sun, or is captured by a planet and forced into a short period orbit, it will simply return to the Cloud, not to be seen again for many centuries. Austin's Comet belongs to this class.

When the comet approaches the Sun, its icy nucleus - never more than a few miles in diameter - is heated, and the ices begin to 'boil off', so that the comet develops a head and also a tail or tails. Tails are of two kinds, dusty (curved) and gas (more or less straight); because of solar wind and solar radiation, the tails always point more or less away from the Sun, so that on its outward journey the comet travels tail-first.

THE APRIL SKY

This is the month of Austin's comet. Though it is always dangerous to make predictions, particularly where comets are concerned, there is a good chance that we are going to see the brightest comet for many years. First, however, let us see what the planets are doing.

Mercury is at its best this month. It is an evening object, reaching greatest elongation on the 13th, so that it will then be at half-phase. During the two middle weeks of the month, it should be easily visible with the naked eye after sunset; and when you find it, it will seem quite bright - though of course it is never seen against a dark background. Telescopes will show nothing except for the characteristic phase; all our knowledge of the surface features comes from one space-probe, Mariner 10, which by-passed the planet more than fifteen years ago.

Venus is brilliant before dawn, rising before the Sun in the east south - east. The phase grows from 50 per cent at the start of the month to more than 60 per cent at the end.

Mars is a morning object, now about as bright as a star of the first magnitude, but the apparent diameter is no more than 6 seconds of arc. The next opposition is not due until late November. Jupiter is past its best for this year, but remains bright in the western evening sky; Saturn, Uranus and Neptune are all in Sagittarius, and are visible before dawn.

There are no eclipses this month. The Moon is at First Quarter (half phase) on April 2, full on the 10th, Last Quarter on the 18th and new on the 25th. The main meteor shower is that of the Lyrids, which extend from April 19 to 25, with maximum on the 22nd; they should be well seen, as the Moon will not interfere - and there have been good displays in the past, notably in 1982. They are associated with Thatcher's Comet, which was seen in 1861 and has a very long period. (To avoid any possible confusion, let me stress that the comet was discovered by the American astronomer A.E. Thatcher, who had no connection with any modern politician!)

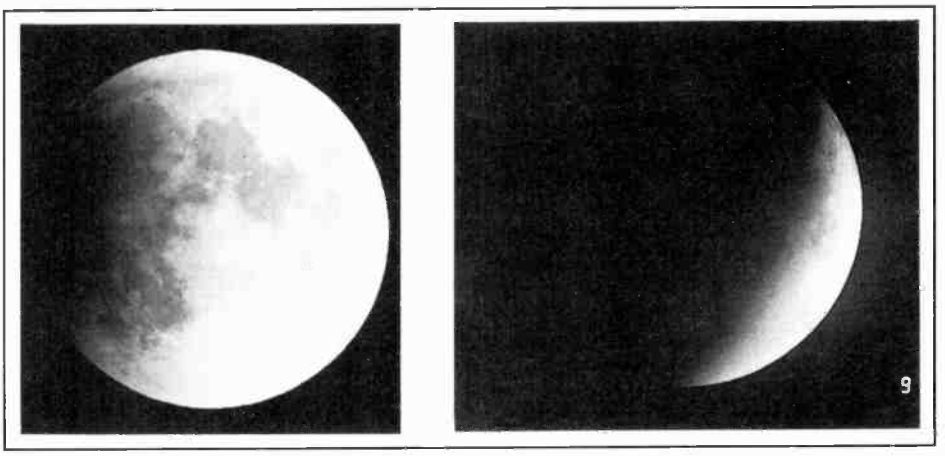
We have now almost lost Orion, though some members of the Hunter's retinue can still be seen in the west after sunset. Ursa Major, the Great Bear, is almost overhead, which means that the W of Cassiopeia is at its lowest in the north - though neither the bear nor Cassiopeia ever sets over Britain. The 'tail' of the Bear shows the way to the orange Arcturus, which is actually the brightest star in the northern hemisphere of the sky; its only superiors, Sirius, Canopus and Alpha Centauri, all lie south of the celestial equator. Follow the 'curve' from the bear through Arcturus, and you will come to Spica in Virgo. Capella is dropping in the north - west, Vega rising in the north-east.

Leo, the Lion, is high in the sky after dark, and is easy to find, though only Regulus is of of the first magnitude; the Pointers in the Great Bear can help in finding it - simply use them 'the wrong way round', ie away from the Pole Star. Much of the Southern aspect is occupied by the large, dull Hydra (the Watersnake), but look for the fairly prominent little quadrilateral of stars making up Corvus, the Crow. Corvus contains very little of interest, but at least it is distinctive.

Unfortunately it is never possible to be certain whether or not a comet will develop markedly; some do, while others (such as Kohoutek's) do not. All we can say at the moment is that Austin's Comet is highly promising, and in late April it may be a magnificent object in the dawn sky, providing photographic enthusiasts with a great opportunity. It will remain on view throughout May, and will be at its closest to the Earth (23,000,000 miles) on May 25.

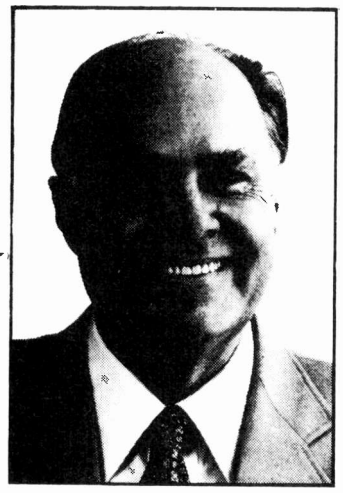
I do not for moment suggest that it will rival the great comets of the past such as those of 1811, 1843, 1861 or 1882, all of which cast shadows. But with any luck, it may be the brightest comet for many decades, so let us make the most of it!

PE



Two photos of the Lunar eclipse of Feb 9th, taken by M. Mobberley at 17.35 and 18.26.

STATE SIDE



BLANKET COVERAGE

Just what we need, one more environmental danger to worry about! This time it's low level ac magnetic fields. Do we have yet another, previously unsuspected, monster which may be doing us harm? The scientists, as usual, are arguing.

So what's all this about? How serious is the problem? And, more important, what can we do about it?

It all has to do with the possible interference with cell growth which may be caused by the presence of surprisingly weak alternating current magnetic fields. These fields radiate from power lines, power distribution transformers, and even electrical household gadgets. Electric blankets and heating pads seem to be among the offenders.

MILLIGAUSS EFFECT

Suspicions were aroused when a survey of child leukaemia cases in Colorado showed a remarkable correlation between deaths and the nearness of homes to power distribution transformers. Controlled scientific experiments with chick embryos and mice showed that magnetic fields as weak as one milligauss had a profound effect on cell growth,

We know that cells use electrical currents to function and communicate, and that these weak currents seem to operate at very low frequencies. Thus, it's not unreasonable to expect that an external magnetic force could induce destructive currents in cells which would interfere with their operation and screw up their duplication system.

HOW SERIOUS?

Well, how serious to us are the magnetic fields around our homes and offices? In most cases we may not have much to worry about. The magnetic fields from household appliances, while strong compared to one milligauss, are so intermittent that it's unlikely much permanent damage could be done. Most magnetically inductive sources, such as mixers, microwave ovens, carpet cleaners, washing machines, and so on, are not normally used for hours at a time.

What about tv? Although it radiates energy, at normal viewing distances there isn't a problem. Its office equivalents, though, computer video display screens, may be more problematic. Research seems to indicate that where women are exposed to several of these at once, as in an airline reservation centre, for example, that an inordinate number of miscarriages and deformed births result.

On the home front, the electric blanket could also be a problem. Some people in America have suggested that, in the long term, its radiated magnetic fields might be potentially lethal.

Just when we thought the story of Gorbachev and the Free Bears would send us to sleep safely in our beds again, is Wayne Green's bedtime story going to give us cold sleepless, nights?

FIELD TESTS

Being a new problem, I found it difficult to find anyone making test equipment sensitive enough to measure these low ac magnetic fields. Eventually, I did find a small firm, here in America, making milligauss meters, so I bought one and used it to check out my home and office. There was good news ... and bad.

The good news was that my home was far enough away from a power distribution transformer and the magnetic level was only a hundredth of a milligauss.

I found the fields around the power cubes which supply my portable electronic equipment with 6V dc to fall below 1 mG at 30 cms. The audio equipment fell off to 1 mG at 1 metre. Very little field was found to be radiated by the home electrical heating system. The video displays at my office were all under 0.5 mG at the normal working distances. In my hamshack the field strength around the amateur radio transceiver was quite low ... until I turned on the power amplifier. It had to be moved at least six feet away from my operating position before its field was down to the 0.1 mG range.

The bad news was my electric blanket, which rang the bell with 150 milligauss! As an interim measure, I now use it only to pre-warm my bed.

ENTREPRENEURIAL OPPORTUNITIES

If it is ac fields which are doing the reported cell damage, one solution for blankets might be to first rectify the current feeding to them. Someone might be able to do a nice business selling blanket rectifier units.

Entrepreneurs might also do well selling video display shielding retrofit kits. In view of the potential product liability suits, I suspect that manufacturers will quickly make sure that the magnetic radiation from their terminals is below any alleged danger level.

Of course, this suspicion of ac mag fields could just be another technological red-herring you can follow with amusement. Besides, it does seem that most people truly believe they are indestructible. Entrepreneurs might not make the bucks after all. On the other hand, there will be a few people who will be concerned, so you might think in terms of building milligauss meters or doing milligauss consulting ...

And, just in case, manufacturers of electric blankets should either increase their liability insurance to cover the potential of hundreds of thousands of law suits, or get to work and start making low magnetic field blankets. Or both.

DIRECT RELATIONSHIPS

Is that all there is to it? Are we out of the woods? Maybe, maybe not. Could it be that even dc magnetic fields are doing us in too? It may be that we need to make our blankets with magnetic cancelling wiring rather than just change to dc operation.

Recent research with cells aligned with the earth's magnetic field versus cells even a few degrees off alignment, has shown some alarming effects on cell growth. There may be more to the old idea of sleeping with your head to the north than we believed.

SCIENTIFIC ODDS

Scientists are still learning about how DNA duplicates; about how defects in certain

genes can cause great problems in life; how cells communicate, etc. They're making progress, but they've a long way to go.

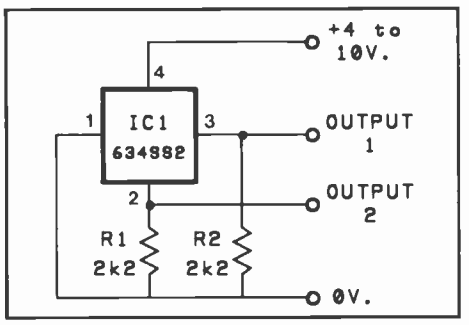
Of course, there are some scientists who have reviewed the evidence and testified that they are not convinced that the dangers are real. But I seem to recall an article in the *New Yorker* citing the substantial payments made by the American power industries to the scientists being quoted. Money has been known to blind scientists as well as politicians.

Until more is known, anyone concerned about possible magnetic hazards can take reasonable precautionary measures. It doesn't hurt much to avoid stacking the odds against us. As a PE reader, you'll know where the major sources of magnetic fields are. You can make sure that power transformers are moved further away from work and living areas. And perhaps you should go back to non-electric bed warming!

Wayne Green is the publisher of several magazines in America and is well known for his outspoken views on many matters of public concern. This concern led him to become a candidate in the Primaries of the American Vice-Presidential campaign of 1988.

He is knowledgeable in many subjects, ranging from education and electronics to communications and publishing. Living, as he does, in the USA, he has the benefit of learning about American research before the information becomes internationally known.

Now read the CEGB's statement, and the Editorial comments on page 9.



Hint for experimenters: Hall effect sensors, such as the 634SS2 (RS304-267), respond to changes in magnetic fields. The device has differential outputs and a sensitivity of 7.5 to 10.6 mV/mT. (1 Tesla = 10^4 Gauss).

THE CEGB'S POSITION

We asked the Central Electricity Generating Board (CEGB) for their comments and they sent the following statement:

Electric and magnetic fields are created by the flow of electricity through power lines, cables or appliances. They also occur naturally.

The electricity industry has been involved in research since 1978. None of the studies have found any ill effects on health, either amongst the general public or its own staff.

However, some research studies in America have suggested that weak magnetic fields near power lines may increase the risk of cancer. As very large numbers of people are exposed to electric and magnetic fields in their everyday lives, the suggestion of even a remote possibility of a risk to health needs thorough investigation.

The CEGB is therefore spending in the region of £1m per annum to further its electric and magnetic field research programme. That programme covers four main areas: measuring the magnetic fields which exist in certain environments, including inside people's homes; measuring people's actual exposure to fields; biological studies; and epidemiological studies.

A recently completed study by Leeds University showed no link between childhood cancer cases and either the proximity of overhead lines of the magnetic fields generated by them.

Having reviewed all the evidence, the CEGB does not believe that the electric and magnetic fields as normally encountered by people in everyday life have been shown to present any health risk to the industry's staff or to the public.

Similar conclusions have been reached by a number of national and international bodies, including the World Health Organisation, the International Labour Organisation, the International Radiation Protection Association, the Industrial Injuries Advisory Council and the National Radiological Protection Board.

Nevertheless, the National Grid Division will continue to keep a close watch on the situation and to contribute to the on-going international research programme.

(The CEGB National Grid Division operates the main 'supergrid' high voltage electricity transmission system in England and Wales.)

Bliss or Blight?

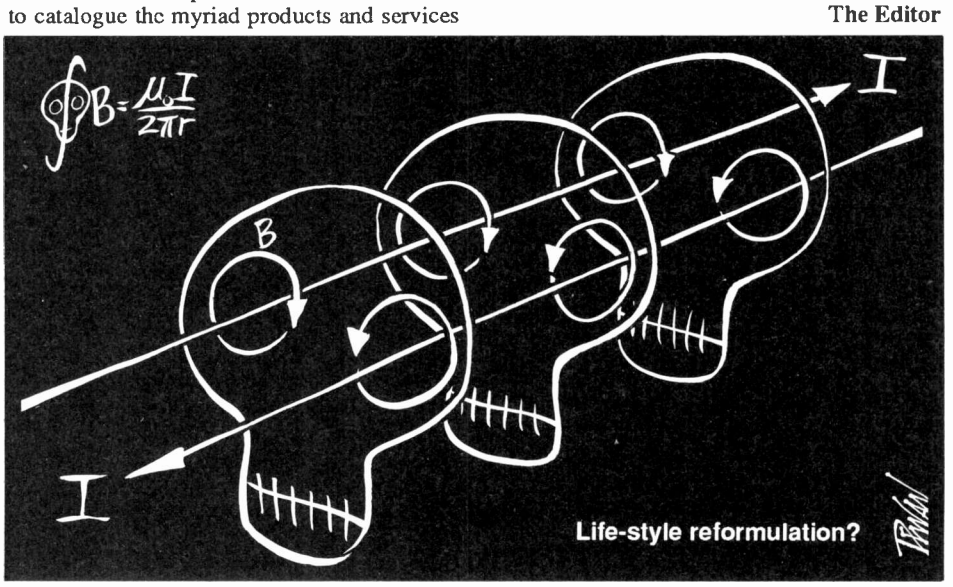
Continued from page 9.

health and safety concern. We have also seen reversals of attitude towards some matters; what's out of favour this week could be back in favour next. To respond to every single suggestion of a new area of concern could lead to catastrophic hypochondria! I, for one, prefer to enjoy life without excessive concern for its risks. It's acknowledged that life may be shortened by failure to worry about all risks, but that's more acceptable to me than never taking a risk on anything and then living in mourning for pleasures once loved or never tried.

In his article, our correspondent quotes electric blankets as being potentially hazardous. I have always felt that this is true, but not for his reasons. The hazard is more from electrocution and fire. A bed warmed by an electric blanket is one of life's delights, but I will only pre-warm the bed; never will I sleep with the blanket plugged in. I do not have that degree of trust in switches and insulation. Especially since I returned from a weekend away to find the fire brigade in attendance at my smoke-filled house. The blanket had been accidentally left on, it overheated and caused the bedclothes to smolder, fortunately without bursting into flame.

From wishful thinking I must also hope that the ac mag field hazard is disproved. Society as we know it cannot function without electrical power. You don't need me to catalogue the myriad products and services which are affected. Even if we may ultimately find another way of powering our technological apparatus, it must surely take a generation or two to implement it. I am prepared to accept the risk as a lesser potential evil than that inherent in dispensing with the electrical products that enhance my life.

The Editor



Diode behaviour was examined last month and we looked particularly at their use in rectifying ac to dc. We now see what other functions they can perform.

PHOTODIODE

A photodiode consists of a diode in a transparent package. This allows light to reach the pn junction. The effect of light on the junction is to excite electrons, giving them enough energy to escape from the atoms. This causes hole/electron pairs to be created in proportion to the amount of light falling on the junction. Since the holes and electrons are charge carriers, the current through the diode increases.

A photodiode is usually connected so that it is reverse-biased (Fig.24). The small leakage current causes a voltage to develop across R1. When light falls on the diode the leakage current increases. The voltage across R1 increases as a result of this. Usually the output of this circuit is fed to an amplifier. The signal from the amplifier may then be used to drive measuring circuits or to act as a logic input to then be used to drive measuring circuits of to act as a logic input to digital circuits.

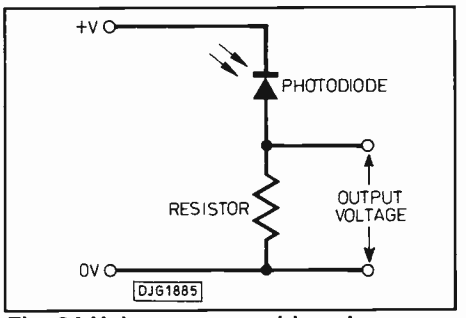


Fig. 24 Using a reverse-biased photodiode.

Photodiodes are used as sensors in instruments for measuring light levels. They are also used in control applications, such as for automatically switching on illumination at dusk, or controlling the operation of the sliding doors of lifts. Certain types of photodiode are specially sensitive to infra-red radiation. These have a plastic package that is opaque to visible light, but transparent to infra-red.

PIN photodiodes have a layer of intrinsic (ie, not doped) semiconductor between the p-type and n-type layers.

ZENER DIODE

***Investigation 6** - Properties of a zener diode*

Repeat Investigation 5, but using a BZY88C3V9 zener diode. How does its behaviour differ from that of an ordinary reverse-biased diode?

AVALANCHE BREAKDOWN

As we increase the reverse voltage across a diode, the minority carriers are in an increasingly strong electric field. They gain more and more energy to set free electrons from the atoms in the lattice. More electron/hole pairs are produced. This increases conduction. The increasing number of carriers generates even more electron/hole pairs, and so on. The effect is like an avalanche. Suddenly, conduction increases very rapidly and a large current begins to flow. The diode is destroyed if it is not designed to withstand this large current.

The voltage at which avalanche breakdown brings depends on the way the diode is made. It can be anything between 5V and 1000V but is fixed for any given type of diode. These avalanche diodes are manufactured to conduct in the reverse direction at a specified voltage, and to be able to withstand the resulting high current. Such diodes are often called zener diodes, though the true zener diode works in a rather different way.

One important application of the zener diode is in voltage regulation, as shown in the next investigation.

***Investigation 7** - a voltage regulator*

You need: battery box
R1 27 ohms
R2 2k2, and a selection of resistors between 180 and 680 ohm
D1 BZY88C3V9, 3.9V zener diode
testmeter or voltmeter to 10V

Connect the circuit of Fig.25, as in Fig.26. Note that the zener diode is reverse-biased. The idea of the circuit is to vary the load (the current passed by R2) and see what effect this has on the voltage supplied to the load.

Begin with R2=2k2, and measure the voltage. Remove D1 and measure the voltage again. Replace D1 and repeat, using various other resistors for R2, one at a time, to take various load currents. Read the voltage each time, with and without the zener diode. Record your results in a table:

What is the effect of having the zener diode in the circuit?

Load (ohms)	with zener	without zener
2200		
680		
470		
"		
"		

BASIC ELECTRONICS

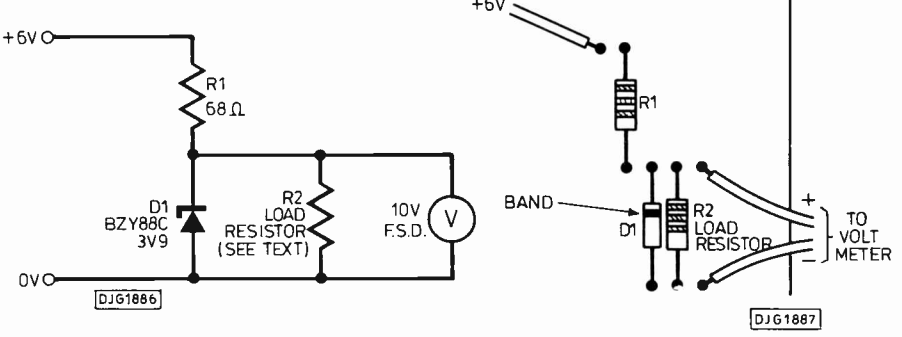
Part Five
By Owen Bishop

Examining the fundamentals of photo diodes, leds and zeners. Plus two modules and a system to construct.

ZENER CURRENT

In Investigation 7 the current through the load varies widely as the resistance of the load is changed. But the voltage across the load remains remarkably steady at or close to 3.9V. The voltage drop across R1 is 6-3.9=2.1V, and the current through it is 2.1/68 = 0.026A or 26mA. As long as the voltage at the junction of R1 and D1 remains constant, a constant current of 26mA flows through R1. Part of this flows through the load. When the load is 2200 ohms, the current through the load is 3.9/2200 = 1.8mA. The remaining current, 24.2mA, must therefore flow through the diode. When the load is 180 ohms, the current through it is 3.9/180 = 20mA. The remaining current, 6mA, flows through the diode.

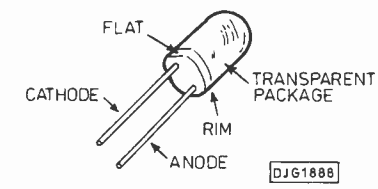
Fig 25. Circuit for investigation 7, and its breadboard layout (Fig 26).



To obtain good stabilisation the current through the diode should always be at least 5mA. Thus a load of about 180 ohms, taking 20mA and leaving 6mA going through the diode, is about the maximum that this circuit can supply. At the other extreme, when the resistance of the load is high, a relatively large current, 24mA, flows through the diode. We have to ensure that the diode can pass a current of this size without breaking down. Zener diodes are made in a range of power ratings. Given that the voltage across the diode is 3.9V and the current is 24mA, or 0.024A, the power is P=IV=0.0936W, approximately 100 milliwatts. The BZY88C series is the lowest-rating series, rated at 500mW, so there is no chance of the diode being destroyed in this circuit.

LIGHT-EMITTING DIODE

Diodes of this type are made from a different kind of semiconductor material, gallium arsenide. When a current passes through the diode, light is emitted. The most common type emits red light, but diodes emitting green, yellow or orange light are also available. They are used singly or in special arrays in a variety of display applications. Single diodes are usually packaged as in Fig.27. The package is of transparent plastic, usually coloured according to the light the led emits. In the type shown, the rim is cut away on one side to indicate which wire is the cathode terminal. A variety of rectangular and triangular shaped leds are also manufactured.



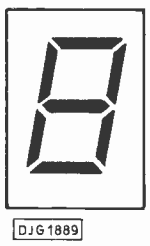


Fig 27. Typical light emitting diode.
Fig 28. Leds in 7-segment numeric array.

The seven-segment led display (Fig.28) is a familiar feature of the numerical displays of calculators, cash registers, clocks, microwave ovens and many other items of electronic equipment.

Another type of diode emits infra-red radiation. Diodes of this type are very often used in remote control. The infra-red leds in the hand-held control unit produce a coded train of pulses. This is received by an infra-red photodiode (see above) on the tv or video set, decoded by logic circuitry which then responds to the control commands. Infra-red leds and photodiodes are also used in intruder-detection systems. The advantage is that the beam of infra-red radiation is invisible to the human eye so that the intruder may walk unawares into the beam and cause the alarm to be sounded.

An led has the usual property of a diode in that it conducts in only one direction. However, leds are not able to withstand high reverse voltages. If the reverse voltage is greater than 5V there is a danger with most types that the led will be destroyed. The following investigation demonstrated the use of an led and also gives you practice in electronic calculations.

***Investigation 8** - Light-emitting diode*

You need: battery box (6V)
D1 TIL209 or similar light-emitting diode
R1 a range of resistors of value between 100 ohm and 470 ohms
testmeter or voltmeter with 2V scale

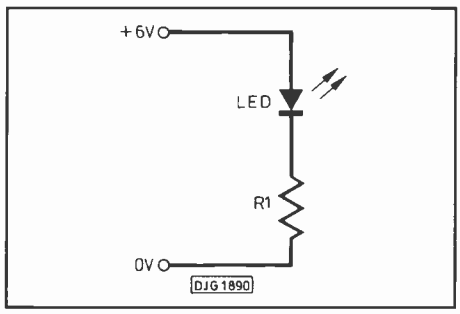


Fig 29. Circuit for Investigation 8.

Set up the circuit of Fig.29, with a 180 ohm resistor as R1. The led glows brightly. Measure the forward voltage drop of the led. Measure the voltage drop across R1. Assuming that R1 has its nominal value, 180 ohms, calculate the current flowing through the resistor (and also through the led).

Now try these practical exercises:

1) In a battery-powered device, you want to economise in current by allowing only 5mA for powering the led. Assuming the same voltage drop as before, what value resistor would you use for R1? Try this in the circuit, measure the voltage drop across the resistor, and calculate the actual current flowing.

2) You are designing a device that needs a warning led. You decide to make it bright by passing 25mA through it (this is the maximum current rating for several types of led). What value resistor would you use for R1? Try this in the circuit, measure the voltage drop across the resistor, and calculate the actual current flowing.

MODULES OF THE MONTH

6. Temperature sensor

The circuit of this is similar to Fig.3 of the article in PE March 90, except that it has a variable resistor in place of the fixed resistor. This allows you to set the output level (V) obtained for a given temperature. Fig.30 shows the thermistor (R1) soldered on the board, but you could instead use a pair of flexible wires to join the thermistor to two thermal pins at C5 and E4.

Parts required: R1 bead-type thermistor, resistance 247k at 25°C; VR1 10k sub-miniature horizontal preset resistor, preferably with a small knob, as shown; SKT1 3-way pcb socket; stripboard 63mm x 25mm (Vero 15354)

7. Relay

This module uses a very small relay intended for circuit-board mounting. Relays of different manufacture have the terminal pins differently arranged. Check carefully against the catalogue description before cutting the copper strips or soldering the wire links to the board. The circuit of the module is shown in Fig.32 for guidance. Since the relay coil is inductive, the module includes a protective diode. This allows the module to be safely used as the load of a switching transistor (Fig.31, Fig.32)

Parts required: D1 1N4148 silicon diode; RLA1 micro-minature relay 6V; SKT1 2-way socket; SKT2 3-way POC socket; stripboard 63mm x 25mm (Vero 15354)

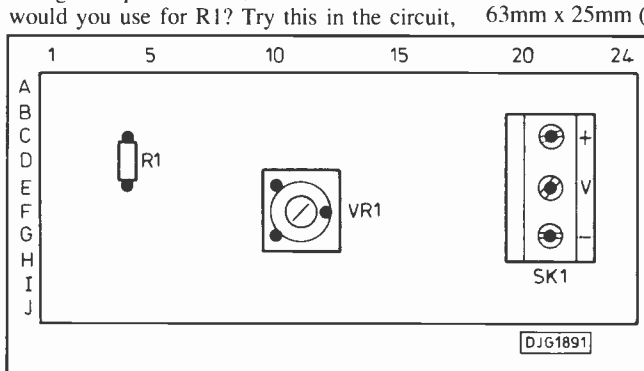


Fig 30. Module 6.

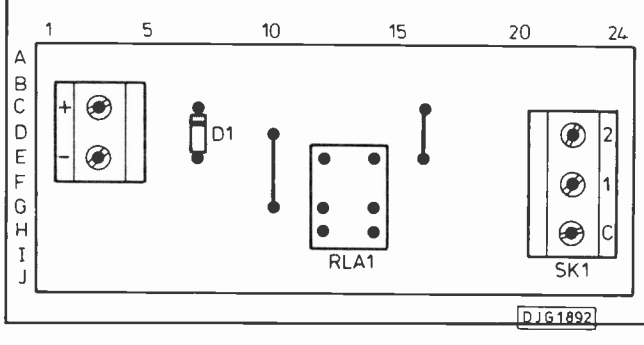


Fig 31. Module 7.

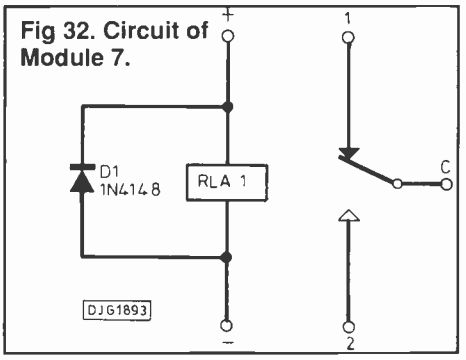


Fig 32. Circuit of Module 7.

SYSTEM OF THE MONTH

Fire alarm/overheating alarm

This system (Fig.33) turns on a lamp or other alarm device when the temperature reaches a given level. It can be used as a fire alarm or an indicator of overheating, in a greenhouse for example. The temperature is sensed by Module 6, the output of which rises as temperature increases. This rising output is used to switch on a relay (Module 7). The temperature at which this happens is set by adjusting VR1. The switch contacts of the relay are wired into a separate circuit which controls a lamp, an audible warning device (eg Module 5). The sensor and/or the warning device may be mounted on long leads, if necessary.

The response to temperature is a gradual one, so the relay may switch on and off repeatedly when the temperature is hovering around the selected level. Next month we describe a module that improves this system by providing a more definite clear-cut action.

DISCUSSION

Investigation 6: The results are similar to Fig.34. As voltage is reduced below zero the curve first has the shape of Fig.23b (last month). A very small leakage current flows. At a given voltage, -3.9V in the case of this zener diode we find a 'knee' in the curve. Conduction suddenly begins and a large reverse current flows.

Investigation 7: Without the zener diode, R1 and the load simply act as a potential divider. The voltage across the load varies widely depending on the resistance of the load is *stabilised* at approximately 3.9V, independently of the amount of current flowing through the load. It may fall a little if the load has low resistance and draws a relatively high current. PE

Fig 33. System diagram of fire alarm.

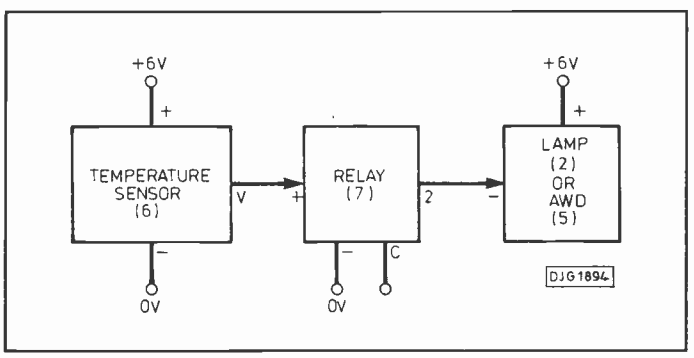
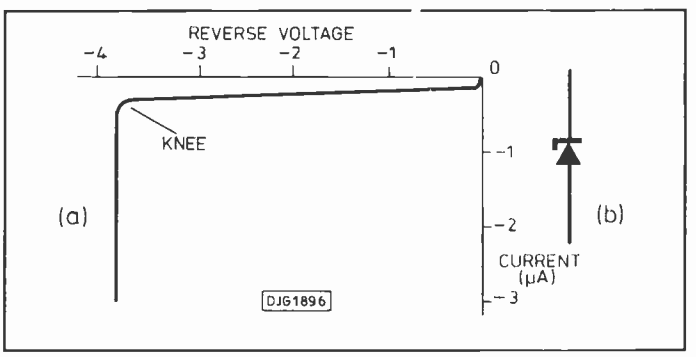


Fig 34. (a) Reverse-bias characteristics of a 3.9V zener diode. (b) Circuit symbol for a zener diode.



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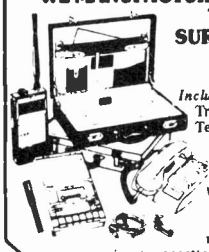

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ELECTRONS FROM PHOTONS

By Tom Ivall

Better use of solar energy could make recycling even more greenly desirable.

Did you know that its now cheaper to light a garden shed by solar enegy (and I don't mean through a skylight) than to run a mains cable 20 metres or so out from the house? Even in the UK. So says Professor Robert Hill, a physicist and expert in photovoltaics at Newcastle upon Tyne polytechnic.

The other day I was clearing out some old stanchions and pipes from my own garden shed to give to our local scrap-metal collector who comes round the streets in an ancient lorry. My shed doesn't yet have solar-power lighting - but there's a link here which will become apparent. I noticed that the old lorry was piled high with discarded fridges, washing machines and other assorted white goods. What a waste, I thought. Is it really necessary for such obviously modern designs of household appliances to be thrown away so quickly?

Of course, the answer is no. In the same shed we have a beautifully made fridge, admittedly expensive when bought, which is still working well after 35 years. It has needed no repairs or maintenance. The explanation, as everyone knows, lies in the degree of built in obsolescence.

RECYCLING

Obviously the white goods on the scrap-metal lorry were intended for recycling. No doubt some of the electric motors, containing valuable copper windings, would be taken out and reconditioned. Presumably the sheet metal parts would be squashed and melted down.

In itself recycling is a laudable activity. What is in question is the increasing frequency at which it is being done and hence the increasing consumption of energy needed for both this purpose and the original production of the goods. Furnaces for melting down scrap metal need a lot of heat.

If Green conciousness leads to Green action there could well be an upsurge of consumer resistance to built-in obsolescence. People would want domestic appliances to last longer and would be prepared to pay the higher prices necessary for the higher quality construction. Some, like myself, might even get aesthetic pleasure from looking at well-made objects, however mundane. The economics of manufacture and supply would have to adjust to this new pattern.

ENERGY EFFICIENCY

Meanwhile, if the industrialised world really must go on using more and more energy in the pursuit of perpetual economic growth, for goodness' sake let us convert and use the energy economically and without fouling up the environment. At present the cheapest way to produce electricity is by burning fossil fuels. Eventually the sources of these fuels will be exhausted and before that the prices will go up. Nuclear power is certainly an option, though at the moment private enterprise - in the UK at any rate - has given it the thumbs-down.

Among the alternative, benign ways of generating electricity, the direct conversion of solar radiation is beginning to look increasingly attractive. This is particularly so in the 'sun belt' regions of the world between the latitudes of 40 N and 40 S. To begin with, the Sun's energy irradiating the Earth is about 800,000 terawatt-hours per year - approximately ten-thousand times the present energy requirement of the whole world.

SOLAR POWER

Already solar cells based on the photovoltaic effect and the semiconductor p-n junction have proved practical for low power applications such as unattended relay stations, pocket calculators, battery chargers, boats, satellites and pumping water out of the Sahara Desert.

In space the solar constant is about 1400 joules per second (1.4 kW) per square metre. On Earth we can expect to receive under good conditions 1kW per square metre of solar panel area facing the Sun - and this figure is in fact used as an international standard. The problem is to convert as much as possible of this rather diffuse radiant energy into electricity. Conversion efficiency is all-important.

Efficiencies of solar cells are rising all the time as development continues. In the laboratory figures of about 23% have been obtained recently. According to Professor Hill, efficiencies of 40% can be expected in the next two or three years.

MASS PRODUCTION

But in mass-produced solar cells the present efficiencies are somewhat lower - up to about 16%. In commercial form they are typically made up into modules of thirty or more cells, connected in series to give a total voltage of about 15V. In turn these modules can be assembled into large arrays. The modules cost about £50 per square metre to manufacture.

Probably the most familar use of this technology is in the ubiquitous solar powered pocket calculator. The cells are thin film devices made of amorphous silicon. But this material isn't really suitable for higher power applications. It gives an initial efficiency of about 6%, which degrades and settles down finally to about 4%.

The best results now are coming from solar cells manufactured as thin films of cadmium telluride or copper indium diselenide. These products give efficiencies of 10% or more and are claimed to have good stability and potentially long life.

LOCAL POWER

One of the useful features of the photovoltaic method of generating electricity is its flexibility for local use. You don't need huge, centralised power stations with cables running out in all directions. Nonetheless some large-scale solar power stations are now being built on an experimental basis. Their usage of land is said to be about the same as for coal or nuclear stations. One of them, at Lugo in Southern California, USA, generates about 1 megawatt.

It's all very well in Southern California, but what about places like Northern Europe where the sun is obscured by cloud for much of the time? Obviously some form of storage is needed. Apart from rechargable batteries there are some very unusual ideas in energy storage being considered. I was once involved, very peripherally, in a scheme for storing energy in a giant flywheel. To reduce air friction and hence losses the flywheel was to revolve in a huge vacuum chamber.

It sounds simple enough to be practical, but you would think there would be neater ways of doing the job.

PE

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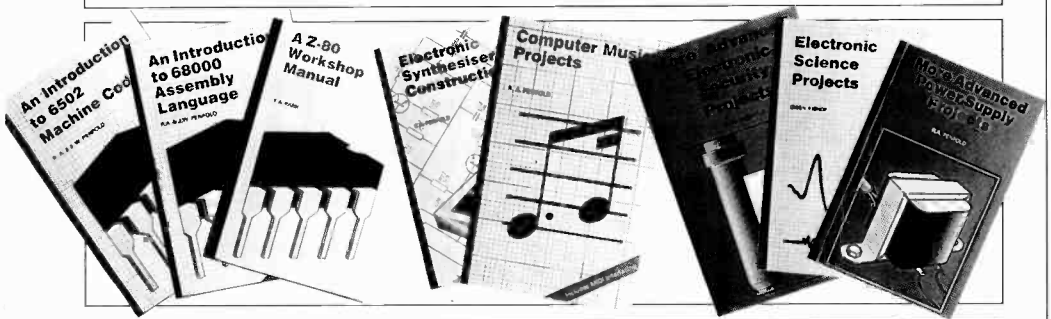

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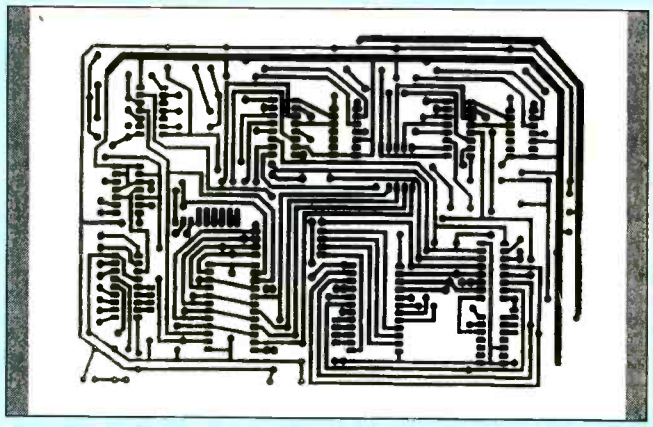

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RES. FREQ. 28Hz. FREQ. RESP. TO 3KHz. SENS. 92dB. **PRICE £21.00 + £3.00 P&P.**

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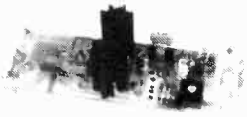

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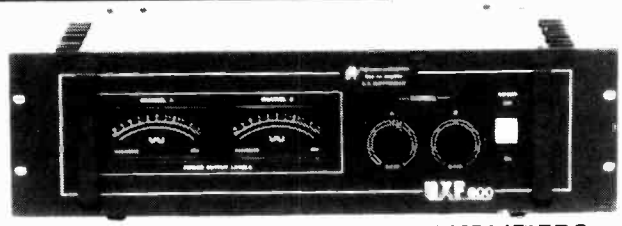

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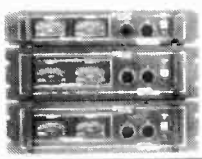

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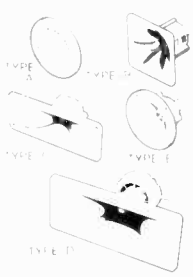

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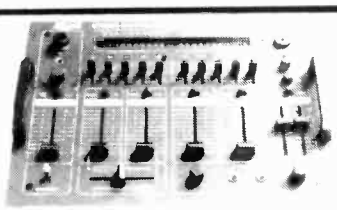

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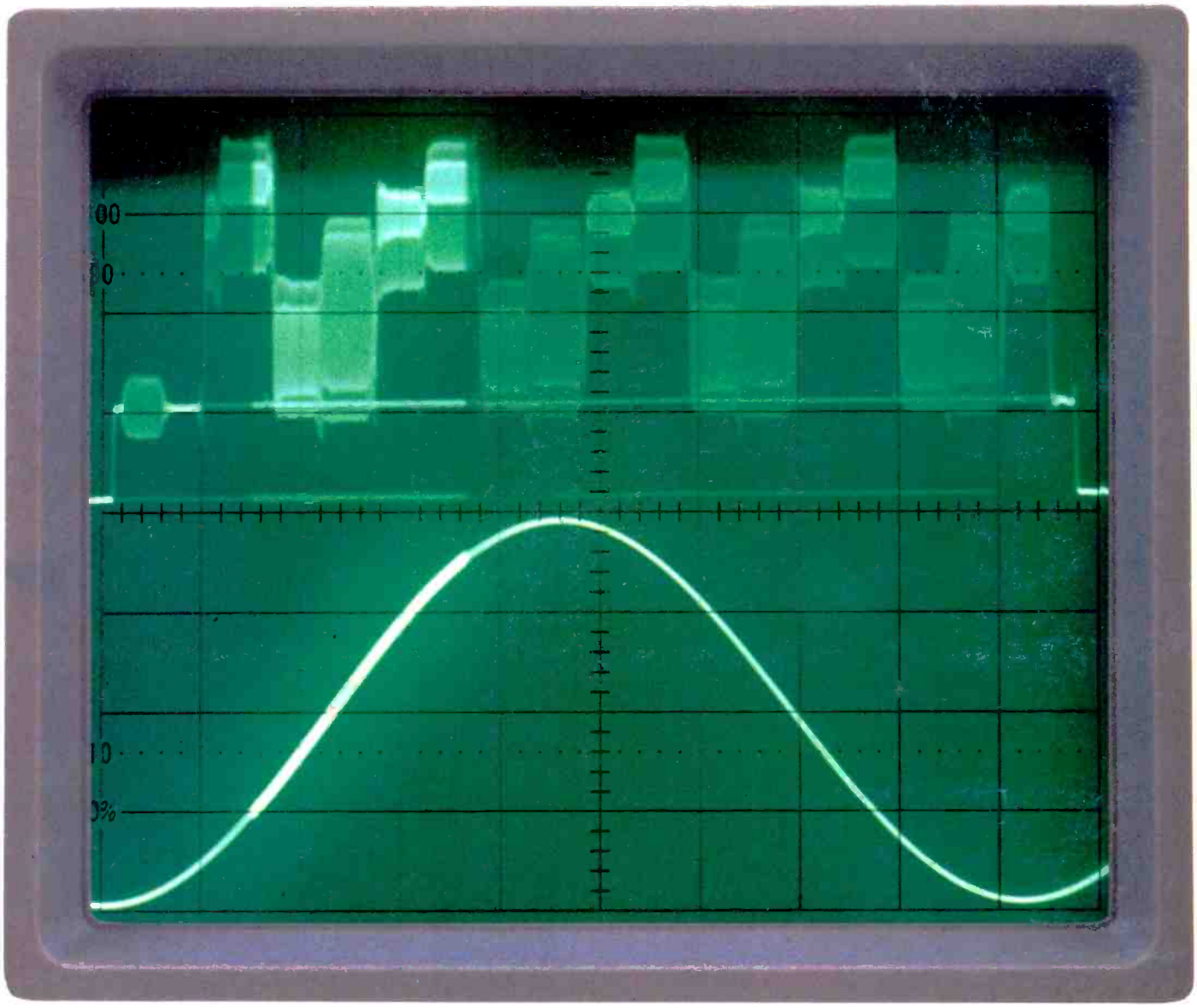

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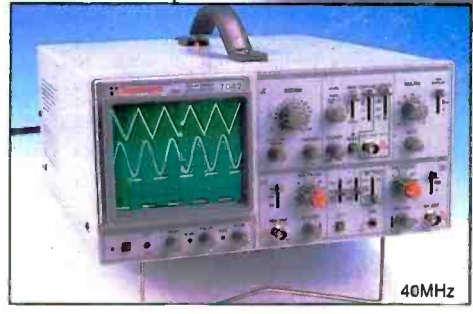

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