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Page 13 ▲ Page 4 ▼

Page 5 ▼

NEXT MONTH

We're lining up an issue that should delight anyone with an eye to controlling the world! Automation is the main theme. We'll explore the ways in which a robot car can be constructed and controlled; we've an authoritative feature in which we describe how your PC can be interfaced for input and output control; there's a layman's look at Artificial Intelligence; and we'll conclude the automatic radio clock project.

(So sorry we couldn't bring you the rear wiper and eprom programmer this month due to lack of space - they are being rescheduled for a later issue.)

DON'T MISS OUR GREAT APRIL 1990 ISSUE

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PRACTICAL ELECTRONICS

VOL 26 NO 3 MARCH 1990

CONTENTS

CONSTRUCTIONAL PROJECTS

SPECIAL FEATURES

REGULAR FEATURES

PRODUCT FEATURES

PE TAKES TECHNOLOGY FURTHER - BE PART OF IT!

NEWS

VIDEO DUBBINS

With the ever increasing popularity of video cameras, the need for a vcr dubbing kit is probably felt by many readers. Well, you're in luck! Maplin's vcr dubbing and changeover kit has been introduced, and it provides a high quality, low price method of editing video camera tapes.

The kit permits two video recorders to be permanently connected together via special video relays in the unit. A switch on the front panel transposes all the connections so that the playback machine becomes the recorder and the vcr that previously was recording becomes the playback machine.

The unit allows tapes to be edited backwards as well as forwards, completely eliminating the laborious task of transferring all the connections each time. Also incorporated is an amplifier to eliminated losses in the video signal. A further feature is that a third vcr can be connected, which can record the final output to make a finished master.

Connections are via scart sockets for all three machines (the plugs are not included in the kit and must be made up according to the particular connectors on your own vcrs), duplicated on 6-pin DIN sockets for right and left audio and BNC socket for the video. Apart from the scart plugs, the kit comes complete with everything needed including the case and pcbs.

The Video dubber kit is coded LM71N and costs £49.95, including vat. For further information, contact any of Maplin's nationwide shops, or their head office at PO Box 3, Rayleigh, Essex, SS6 8LR. Tel : 0702 554161.

NEW YEDA AWARD PLANS

A revised time schedule for the Young Electronic Designer Awards has been announced and Texas Instruments Ltd (TIL) has once again committed itself to the project.

For the past five years, YEDA has been supported by TIL and Cirkit Holdings PLC. Cirkit's withdrawal provides the opportunity for fresh sponsorship plans to be implemented by TIL and for the competition's timetable to be re-evaluated.

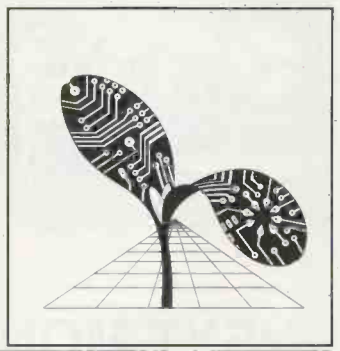
A number of educationalists have expressed concern that projects submitted for YEDA are judged during the spring and summer terms when examination pressures are at their greatest. The new proposals mean that the 1990 judging programme will commence in September, with projects being assessed in the autumn term, and the final presentation ceremony taking place at the beginning of 1991.

Projects undertaken in the academic year 1989/90 will be eligible for this year's programme. In effect there will be an 18 month entry window. Thereafter, the YEDA year will run from January 1 to December 31.

YEDA's track record speaks for itself - some 1000 educational establishments (secondary schools, colleges of further education, technical colleges, polytechnics and universities) are now involved in the scheme.

We are sorry to learn that Cirkit are no longer involved with YEDA, but are pleased to commend this worthwhile scheme to any prospective sponsor or entrant.

For further information contact The YEDA Trust, 24 London Road, Horsham, West Sussex, RH12 1AY. Tel : 0403 211048.



CATALOGUE DATABASE

Continuing our browse through advertisers' literature

Electrovalue's 1990 catalogue proclaims that the company is the leading UK supplier of quality components. They've certainly had splendid opportunities to prove they have a forefront position, having been established as long ago as 1965. Indeed, they're only a few months younger than PE, and no doubt they'll be celebrating their Silver Anniversary in proud style. Why not wish them happy birthday and **ask for details of their extensive component range**. We're sure that you'll find that you too will have happy returns when you order your goods from their detailed selection. **Electrovalue Ltd**, 28 St Judes Road, Englefield Green, Egham, Surrey, TW20 0HB. Tel: 0784 433603.

Litesold have a range of products that are **vital to any electronics constructor**, whether an early starter still hatching his way through birdnested breadboards, or a fully-fledged eagle-eyed addict intent on achieving the ultimate in assembled pcb perfection. Yes, **soldering irons are the key to turning you on to constructional success,** and Litesold have a catalogue that could open the door to your electronic ideals. Whether you want the simplest possible portable soldering iron, a variable temperature bench top unit or a complete industrial solder station, the chances are that Litesold's new catalogue will contain what you want. Many other allied products are included as well, such as copper bits, solder, wire strippers, flux, desoldering equipment, fume extractors, and even wood burning tools (for artistically engraving the legends on your teak or mahogany front panels, no doubt!). **Litesold** can be more formally addressed as **Light Soldering Developments Ltd**, Spencer Place, 97-99 Gloucester Road, Croydon, Surrey, CR0 2DN. Tel: 01-689 0574.

TIS (Technical Info Services) offer a service of vital importance to anyone involved in equipment maintenance: **they supply technical service manuals and data sheets.** Their recent shortform catalogue lists a selection of circuit and repair manuals for tvs, video, computers, radio, audio, electronics, vehicles, domestic and wiring, and a selection of general interest subjects. The full catalogues contain listings of **thousands of manuals** and service sheets. It appears that TIS are associated with STREE, the Society of TV, Radio and Electrical/Electronic Engineers. **TIS** are at 76 Church Street, Larkhall, Lanarks, ML9 1HE. Tel : 0698 884585.

Verospeed's massive new catalogue has an enticing flash across its front cover: "Stop dreaming, start collecting". The slogan is appropriate in two worthwhile ways since the catalogue is most certainly one you should collect, and because Verospeed are a **member of the Air Miles scheme**. There are several hundred pages in this catalogue, all containing the type of product which practically every electronics constructor would wish to buy, **from components and communications equipment, to test gear and technical books.** It shouldn't take long to notch up a few more leagues to your favourite tropic isle for there's such a wealth of goods to choose from, and there are air points to be scored with any purchase over ten pounds value. Head for the sunshine and ask Verospeed about their high flying product range. **Verospeed,** Boyatt Wood, Eastleigh, Hants, SO5 4ZY. Tel : 0703 644555.

Ward Electronics are a company devoted to addicted electronic diyers! If you want to **make your own pcbs,** you really should have Ward's list of pcb materials. It covers fibreglass boards, including plain copper laminate and pre-sensitised, etching tanks and accessories, drills, **uv light boxes, ferric chloride** and other chemicals, and a good selection of tools and additional materials. **Ward Electronics,** 27 North Street, Redruth, Cornwall, TR15 1HJ. Tel : 0209 211050.

NEWS

LINE LOGGING

Renowned for their Revox taperecorders, F.W.O. Bauch have announced that they and Photo Acoustics have entered into a joint venture encompassing the telephone surveillance and logging market.

Photo Acoustics has designed and manufactured a range of telephone interfaces, Pati II, IV and VIII, for use in conjunction with Revox logging recorders.

The British Telecom approved interface, when linked to a Revox C274, C278 or any B77 logging recorder, will record both halves of telephone conversations for up to three days at eight hours per day, on one 10.5 inch reel of tape. Two logging machines can be run from each interface and up to eight lines can be recorded simultaneously.

Pati has been manufactured to fit into a standard 19 inch rack unit and can be run from standard telephone extension cable with the necessary number of BT plugs for connection to BT sockets.

The interface for the Revox logging recorder is now readily available, and has already generated considerable interest.

For further information contact F.W.O. Bauch Ltd, 49 Theobald Street, Borehamwood, Herts, WD6 4RZ. Tel : 01-953 0091.

TRIPLE POWER

Here's a new power supply that should find favour in any devotee's electronics workshop: it's a new triple-output benchtop psu that costs only £89.50 plus vat.

Global Specialities are the UK manufacturers of the Model 1300 psu, which has a fixed output of 5Vdc (±0.25V) at 1A maximum. This output has a line regulation of 0.2%, a load regulation of 1% and a maximum ripple of 10mV peak to peak. The variable outputs are 0-20Vdc at 0.25A max, with a line regulation of 0.05% and a maximum ripple of 10mV p-p.

The outputs can be used independently, or can be interconnected to accommodate different voltage and current requirements. Current limiting prevents damage from short circuits.

There is a front panel voltage and current meter and this has an accuracy of ±5% of full scale. Also included is an led overload indicator.

The Model 1300 measures only 76 x 254 x 178mm and weighs 2.7kg. It is ideally suited to the requirements of hobbyists, educational establishments and technicians.

For further information contact Global Specialities, Rackery Lane, Llay, Wrexham, Clwyd, LL12 0BP. Tel : 0978 833920.

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.

Mar 7-8. Laboratory 90. G-Mex Centre, Manchester. 0799 26699.

Mar 9-10. London Amateur Radio Show. Picketts Lock Centre, Edmonton, North London. Advance ticket sales and trade enquiries to The Secretary. LARS, 126 Mount Pleasant Lane, Bricket Wood, Herts AL2 3XD. 0923 678770.

Mar 28-29. Laboratory, Science & Technology Show. Kelsey Kerridge Sports Hall, Cambridge. 0799 26699.

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.

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

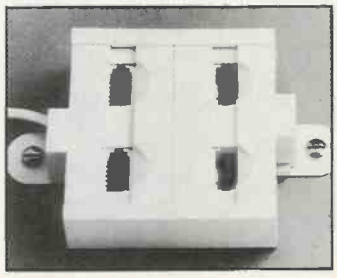
Sep 25-27. British Laboratory Week. Olympia, London. 0799 26699.

SWITCH APPEAL

Building upon the success of their replacement battery pack range for telecommunications equipment, Switch Electronics have now introduced a specially selected line of telecoms accessories. "As with our replacement battery packs which have gained a reputation for reliability and cost efficiency," explains Managing Director Steve Wickens, "we have taken a great deal of time and trouble evaluating the accessories market before selecting our new stock product lines."

Among those lines, the company are offering cordless telephone handset aerials, extension leads, reels and kits, 4-core cable, tone ringers with led, and double adaptors. Their newest addition is an ingenious 4-way adaptor, which is BABT approved, and is intended to solve the frequent connection problems which occur when users wish to connect more than two items to one line. "It will be a real boon to users and installers, saving all kinds of connection headaches", says Steve.

For further information contact Switch Electronics Ltd, 241 Desborough Road, High Wycombe, Bucks. HP11 2QW. Tel : 0494 463532.



NEWS

ARCTIC WIRE

Sitting in the temperate warmth of your workshop surrounded by multicoloured wire spaghetti, you probably haven't given a thought to one of the tribulations experienced by Arctic explorers: frigid cabling problems.

The recent British Icewalk expedition led by Richard Swan probably wished they had given further thought to cabling when theirs failed in the harsh environments. Luckily, Sir Ranulph Fiennes and his team were at hand and they knew all about cold connections and had come prepared. They had some spare Raychem cable which they gave to the Swan team and, according to the chief operator, communications improved dramatically from then on.

Raychem, Europe's foremost manufacturer of sophisticated wire and cable, had supplied a complimentary range of highly flexible power and coaxial cable to Sir Ranulph for the unsupported Polar Trek 89 expedition. The cables were chosen because of their outstanding low temperature flexibility. During the 1989 expedition, Raychem power cable was used at the base camp on Ward Hunt Island, the most northerly point in Canada, to connect the electrical circuit to a remote generator. Coax cable was used for general hook-up of equipment within the base camp and to connect a high power radio transmitter to a rhombic antenna on a 60 ft high tower.

Sir Ranulph's experience with these cables has led him to request their use again for the 1990 history-making Soviet-British North Pole expedition. The expedition will be the first Soviet-British venture and will make an unsupported attempt on the North Pole. It leaves from the tip of the Siberian Arctic in March.

If you've problems with cabling in unusual conditions, follow in Fiennes' footsteps and ask Raychem for advice. They can be contacted at Faraday Road, Dorcan, Swindon, Wilts, SN3 5HH. Tel : 0793 482138.

SPLASHPROOF RANGING

An easy to use autoranging push button dmm which meets water resistance requirements, is yet another new instrument from TMK. Measurements are indicated on a large 21mm liquid crystal display with full function annunication. The 3.75 digit 3999 count display also indicates overload and low battery.

Model G20 measures dc voltage from 100 microvolts to 400V with a basic accuracy of 0.5% and ac voltage from 100mV to 700V. Both alternating and direct current are from 1mA to 20A in five ranges. Resistance can be measured to 4M and has a best resolution of 1 ohm. Diode and audible continuity are fitted as a standard with the buzzer operating at a conductivity less than 1k. Frequency, an additional feature, is from 40Hz to 20kHz with a best resolution of 1Hz. A separate Data Hold button enables readings to be retained in all modes.

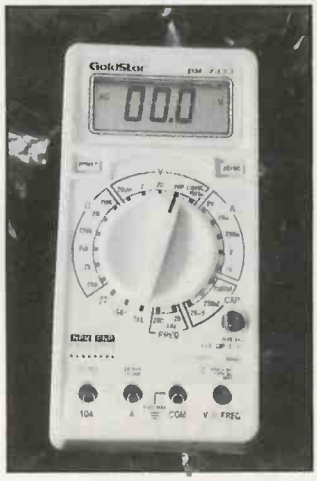
Housed in a rugged yellow case, Model G20 is designed to IEC and DIN standards for Class II safety, measures 85 x 182 x 34mm and weighs 360gms. Fully guaranteed for 12 months, this compact hand held unit is ideal for field, laboratory, workshop and hobby applications and comes supplied with a 9V battery, test leads, spare fuse and an operating manual. Its price is £78 plus VAT.

for further information contact: Mike Dixon of TMK at Building 3, GEC Estate, East Lane, Wembley, Middx HA9 7PJ. Tel: 01-908 3355.

MULTIFUNCTIONAL DMM

Another new meter from Alpha Electronics is the GoldStar 7333, a hand held dmm which features a single, easy to use, 25 position rotary switch for both function and range. With a large 3.5 digit 1999 count liquid crystal display this latest instrument offers high accuracy and input impedance, auto zeroing, low battery and overrange indication, measured units annunciation and full overload protection. Functions are ac and dc voltage and current, resistance, frequency, capacitance, npn and pnp transistor gain, diode test and audible continuity.

Rugged and reliable in a solid yellow case the DM7333 measures dc volts to 1000V with a basic 0.3% accuracy, ac volts to 750V and alternating and direct current to 10A. Resistance is to 20M with a separate 200 ohm range. Capacitance is measured to 20µF and frequency to 200kHz. Powered by a single 9V battery, measuring 185 x 90 x 45mm and weighing 425gm this latest unit from Alpha is fully guaranteed for 12 months and comes ready for use with test leads, spare fuse, battery and operator's manual. With its multiple functions the 7333 is the ideal tool for all field, laboratory and workshop applications, as well as for hobby and diy. The price is £59.95 plus VAT. For further information contact: Alpha Electronics Ltd, Unit 5, Linstock Trading Estate, Wigan Road, Atherton, Manchester M29 0QA. Tel: 0942 873434.



FREQUENCY ANALYSIS

Bridging the gap between the best of Bruel and Kjaer's sound level meters and the company's top-of-the-range laboratory real-time signal analyser is the new portable Type 2143 real time signal analyser.

According to B&K, the 2143 leads the market in providing analysis down to 1/24 octave, in real-time, in the field. Large internal memory plus disk storage allows for storage of set ups and reference data for field use. Measurements can be analysed on the spot, or downloaded back to base into a computer for more exhaustive analysis. The unit weighs less than 22lbs and is weather resistant. Battery life is in excess of four hours and can be extended by invoking a snooze mode between measurements (PE wonders if the operator is allowed similar privileges!).

This sophisticated field data gathering system retains the acquisition and analysis facilities of its big brother, the 2123 real-time signal analyser designed primarily for laboratory use.

The analyser features flexible, expandable input features including selectable preamp, charge and direct input, high pass filters and A-weighting.

The 2143 addresses a wide range of applications in acoustics and vibration measurement. It can be combined with ancillary B&K equipment for sound power and building acoustic measurements.

For further information contact Les Minikin, Bruel and Kjaer (UK) Ltd, 92 Uxbridge Road, Harrow, HA3 6BZ. Tel : 01-954 2366.

NEWS

PLUGGING THE GAP

"Come and help us celebrate the opening of our new Northern Warehouse", invited Doug Simmons of Maplin. "Be delighted to", responded David Bonner, PE's advertising executive.

Comes the great day, and David makes an early start to catch the train. But somehow, BR and London Transport had (uncharacteristically!) run into problems that day. To cut short the transitory tale, David couldn't get up to Yorkshire. But, to partly dispel the disappointment, Doug Simmons has kindly told us all about the Opening.

Maplin's purpose built distribution centre is at Wombwell, near Barnsley in Yorkshire and it was opened in the presence of the local Mayor, local dignitaries and VIPs, Maplin Directors, executives and staff. Performing the opening honours was Terry Patchett, MP for Barnsley East.

The Mayor, in his opening remarks, commented that Maplin's presence was of major importance to the district's employment prospects. Local unemployment, he said, was running at 13%, and already Maplin had recruited over 70 local staff, a figure that could rise dramatically by 1993.

Terry Patchett congratulated Maplin on their choice of location for the new warehouse, and regarded this as a clear sign that the North is getting back on its feet.

Roger Allen, Maplin's Managing Director, highlighted the role of the local Economic Enterprise Department who had helped convert what had been a deserted colliery slagheap(!) into a modern 65,000 sq ft automated warehouse. The total floor area of 95,000 sq ft includes a 39,000 sq ft mezzanine floor which is thought to be the largest free-standing floor in Europe.

The new distribution centre, which provides over double the working space of the previous warehouse in Essex, takes the company into the next stage of expansion, said Roger. This expansion will be no problem within the five acre site, and staffing levels over the next two years could easily be over 200.

In the past year, glowed Roger, Maplin have opened several new stores, taking the store total to 11. He expects this figure to reach 30 by 1993. At the same time, the company is keeping a watchful eye on Europe. "The new Maplin distribution centre will provide a major opportunity for the future growth and development of the company".

Best wishes, Maplin, we trust BR, LT and SNCF will cooperate when you invite us to the opening of your first European warehouse.

FLUKE'S 70 DMM

Fluke's 70 Series Handheld DMMs are described in a new leaflet recently received. The 70 series, which comprises three different models offering a wide range of features, are designed for general purpose measurement and testing in the lab, factory shop floor or in the field as well as in telecomms, automative and other more specialised applications. The leaflet describes the range and also the features and performances of all three specific models. Even the basic models provide a combined analogue/digital display, a 3200 count display and automatic ranging plus a three year warranty, while the more sophisticated versions provide Touch-Hold, continuity buzzer facilities plus higher measurement accuracies.

For further information contact: Philips Test & Measurement, Colonial Way, Watford, Herts WD2 4TT. Tel: 0923 240511.

CHIP COUNT

XL28C16 - AN EXCELLENT SPEEDY EEPROM

Fresh in from the USA is information on the introduction of the Industry's fastest full-featured cmos eeprom. Exel Microelectronics Inc are the manufacturers of the XL28C16 16K device, which is a full-featured electrically erasable programmable read only memory organised as 2K x 8 bits of non-volatile memory.

Operationally, it is fully compatible with the industry standard 2816 nmos devices, but it offers improved speed and power efficiency. For example, access times are reduced from 250 nanoseconds to 100ns, and standby current is reduced to less than 100 microamps. In addition, it provides for page mode programming whereby data is updated as a 16-byte page at a time. This speeds the updating of the prom and results in a full-chip rewrite in only 0.08 seconds.

"This device is widely used in a variety of applications worldwide", points out Ed Chow, Vice President and General Manager of Exel. "We already supply the nmos type of 2816 to a number of high volume users and we expect to widen our market participation with this faster, lower power device."

Expected applications include use in firmware for booting up computer or control systems, program storage for operating industrial or process controllers, traffic controllers, robotics and telemetry, measuring instruments and appliance controls. In addition, a wide range of consumer and communications products, including telephones, fax and video games require small amounts of information that can be occasionally updated on demand. Full-featured eeproms that can be instantaneously updated while in the systems yet retain the information when powered down are very useful in these types of products. (PE has an example of such applied updating in a forthcoming project, currently under preparation.)

The XL28C16 provides up to 10 years of secure data retention with or without power applied. Rewrites can be guaranteed for up to 10,000 times with typical performance exceeding 100,000 write cycles. The device features a page-wide input buffer and improved protection against inadvertent writes as compared to the standard nmos unit. Most applications will be able to use the product, including the write cycle, while using only a 5V power supply.

The eeprom is available in several packages, including the familiar 24-pin dil plastic package.

BYD11/31 MINI RECTIFIERS

Two new rectifier families in the new mini encapsulation have been announced by Philips Components. The type numbers are in the company's BYD11 and BYD31 series. Both families are avalanche protected and have excellent transient handling capabilities.

Key features of the new rectifiers include an hermetically sealed envelope with no possibility of moisture ingress, plus glass passivation to ensure optimum reliability. The glass body of the mini rectifiers eliminates flammability problems, and their small size, 3mm long, 1.7mm wide, saves pcb space and allows them to be mounted on 5mm pitch centres.

The BYD11 rectifiers are relatively slow, general purpose devices, available in 200V to 1000V versions with forward currents of 0.6A. The BYD31 devices are fast and are intended for surface mount applications. The devices have ratings from 200V to 1000V with forward currents of 0.5A. Philips' innovative SOD-91 encapsulation used for these rectifiers is the most recent addition to their selection of implosion packages.

MANUFACTURERS' ADDRESSES

Exel Microelectronics Inc, 2150 Commerce Drive, PO Box 49038, San Jose, CA 95161-9038, USA. Tel: Chris Pope on 408-432 0500.

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

CD VIDEO PART II

BY BARRY FOX
Winner of the
UK Technology Award

To put one hour of high quality video on cd, picture compression is reaching for new sophistication.

Suneyoshi Hidaka, deputy general manager of JVC's new Kurihama research and development centre at Kanagawa, near Tokyo recently gave me one of the first demonstrations of the technology which makes it possible to record an hour of digital video on a 5in cd. The demonstration given by Hidaka prefaced the October meeting held by the electronics industry in Tokyo to try and agree a common standard for picture coding.

Working Group 8 of the International Standard Organisation has a schedule for the future. By 1990 it will try to draft a proposal for motion picture coding at a data rate of between 1 and 1.5 megabit/second. In the period 1990/2 it will tackle the coding standards for data running at between 1.5 and 5 Mb/s and "later" look at the rates ranged between 5 and 60 Mb/s.

The 1.5 Mb/s proposal is tailored to cd and the new generation of digital telephone networks, called ISDN. The gross data rate from a cd is 1.5 Mb/s. A music cd, after error correction, has a net rate of 1.4 Mbit/s. A cd rom disc has more powerful error correction which leaves a net rate of 1.2 Mbit/s. An audio glitch may be occasionally acceptable but an error in the decimal point of a financial spread sheet most definitely is not. Hence the more powerful error correction used for cd-rom.

Motion video will be stored in cd-rom format, so the ceiling rate is 1.2 Mb/s. This is equivalent to around 150 kilobytes/second (known in the trade as the "speed of light for cd-rom") and is nowhere near fast enough to handle moving video pictures. Each individual tv picture needs at least 600 kilobytes and domestic tv systems reproduce 25 (or 30) pictures a second.

The 5 Mb/s rate targeted by the ISO will be used with a modified cd rom, that rotates at several times normal speed. Modified $^1/_2$in vcrs, derived from the VHS format, will be used for 60 Mb/s recording.

Using computer recorders (rather than finished cds) Hidaka and his team showed a string of simulations on one of the test sequences chosen by the ISO/IEC to challenge these new recording systems. The sequence shows a table tennis game, the intention being that the motion of bat, ball and players will show defects of the system as very obvious blur. Other standard test sequences show a garden with gently moving vegetation and a windmill.

At the amazingly low data rate of 1.1 Mbit/s the result was nothing short of astonishing; picture quality is as good as early VHS, with very little blur on motion. But this rate is still not slow enough because it leaves room for only one 64 Kb/s stream for sound. With audio compression this is adequate for good quality mono, but not stereo. So the challenge is now to reduce the video data rate to 0.9 Mb/s, thereby leaving room for 128 Kb/s of audio, enough for stereo sound.

The tv picture signal is compressed by converting the original analogue video waveform into digital code and then analysing each frame in a computer which looks for parts of the picture that remain unchanged, for instance the background to motion. Only information on the changes is recorded.

To keep the system running smoothly a full picture frame must be regularly transmitted in between the updating information. Different researchers have come up with different techniques. JVC for instance sends a "key" full frame every six frames, and then sends only updating information on picture changes for the next five frames. Other systems strike a different relationship between full and key frames. The snag is that it becomes necessary to time cuts in the picture content (eg, a change of view from long shot to close up) to coincide with the transmission of a key frame.

So far the computer processing has been so difficult that it takes two or three seconds of mainframe or mini processing power to analyse each frame and strip out the information on changing content. In practice the computer is left to "cook" a sequence of material overnight. The processed tape is then transferred to disc. Decoding must of course be in real time, with chips in the player reconstructing full motion video from the key frames and updating information received between them. The target, says JVC, is real time processing at both ends of the operation.

In parallel work, JVC has developed a system for storing high definition still pictures on a 5in cd. The process is called Hi-Vision Gallery, because it builds on the Hi-Vision high definition tv format developed by Japanese broadcasting station NHK and now adopted by Japan as a satellite broadcasting and studio recording standard.

Hi-Vision Gallery is already on public demonstration at the Gifu Museum of Fine Arts in Japan. Visitors can see hdtv stills on a screen; they do not know it, but they are being sourced from a cd.

When a 1125 line high definition still video picture is converted into digital code 954 Mbits of data are produced. (For those interested in detail, standard 4:2:2 coding is used, with 1035 active picture lines each broken into 1920 samples at a frequency of 74.25 MHz, and the resulting measurements coded into 8 bit words). The discs used at the Gifu art gallery record a full 954 Mb package of data for each picture stored, ie, without any compression. To provide sound with the pictures, two discs are run together in synchronism, one storing conventional cd stereo and the other hdtv pictures.

The video player has two solid state memories, each of 2.5 Mbyte (20 Mbit) capacity; as one fills with a picture streaming off disc, the other displays a picture already stored. It takes around 15 seconds for each picture to feed off disc, at a rate of 1.2 Mb/s. There can be wipes or special effects changeovers from one picture to the next. An illusion of motion is created by panning the picture as it is read from memory. The effect is very impressive.

Hi-Vision Gallery is spin off from a similar system which JVC built round the old VHD video disc.

JVC has been working on compression techniques, to squeeze more hdtv stills on a cd rom, and retrieve them faster. Because only one picture is being displayed at a time, the motion video technique of sending key frames and then updating information between them is clearly inappropriate.

The compression technique used for still picture video relies on analysing picture content and identifying areas where there is uniform information, eg, a wash of sky, white shirt, green leaf or patch of blue water. The compression circuit isolates the area and sends a limited number of key word instructions which tell the decoder what to do.

The most simple analogy is with a painting by numbers book where a child is given an outline, and told simply to fill it with a wash of colour. PE

Controversy is in the air again as I write this column, concerning Prince Charles' lamentations on the failure of the public to use the English language correctly, particularly regarding spelling, grammar and expression of ideas.

Working as I do in one of the branches of mass communication, I am greatly aware of the need for conveying information in a style and format that will be readily understood by the majority of readers. In the course of my work, I am inundated by mountains of documents whose sole purpose is to convey the importance of some new item or service. In the majority of instances, the meaning inherent in the wording is satisfactorily understandable. Certainly one is aware of occasional mistakes in grammar and in spelling, but to me, and no doubt to many other recipients of the information, the meaning is usually clear despite such irregularities. The primary matter that concerns me is whether or not the document has increased my awareness and understanding of the subject described.

In electronics, there is one area that is arguably far more important than any other regarding the need for instant understanding, and that is in field of component data sheets. Many data sheets are capable of conveying information in schematic or tabular form, and much design work only requires data of this nature. For example, I make regular use of chip pin out function diagrams, voltage and current tables, and waveform timing schematics. To anyone habitually using this type of data, understanding the information becomes second nature. However, I stopped short in my tracks a few weeks ago when I tried to understand the data sheet for a device of which I had had no previous experience.

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The device is one of a series of intelligent liquid crystal alphanumeric displays recently introduced by one of Britain's major manufacturing distributors. The displays, being now readily available to the hobbyist market, promise to enhance and simplify the readout display techniques used for a very wide variety of purposes. Consequently, I believed that I should further investigate them on your behalf. Well, whereas most data sheets I can read between eye-blinks, this one almost had me beaten. Eventually, I lashed up a bird's nest of wiring between the lcd, a couple of interfacing chips, and an ancient but trusty CBM 3032 computer.

Step by step, I progressively worked my way through practically every conceivable permutation of control signal, all computer-derived and monitored, before I succeeded in printing the first meaningful message on the lcd screen. Off and on, it probably took the best part of a week before I understood the device satisfactorily.

Now that I understand the device, I now also understand what the data sheet was trying to convey. I am far from happy, though, that a major British company should issue such obscure data. Had it been more adequately written I should have achieved display success in a matter of hours, not days.

For your further enlightenment, I shall be looking in detail at these very useful intelligent lcds in a future issue, possibly that of May 1990. I trust that my Anglo-linguistic technique will help you to understand and use them! Dare I hope for Royal approval as well?

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74LS11	0.24
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74LS13	0.34
74LS14	0.50
74LS15	0.24
74LS20	0.24
74LS21	0.24
74LS22	0.24
74LS24	0.50
74LS26	0.24
74LS27	0.24
74LS28	0.24
74LS30	0.24
74LS32	0.24
74LS33	0.24
74LS37	0.24
74LS38	0.24
74LS40	0.24
74LS42	0.50
74LS47	0.80
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74LS54	0.24
74LS55	0.24
74LS73A	0.30
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74LS114	0.45
74LS122	0.70
74LS123	0.80
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74LS125	0.50
74LS126	0.50
74LS132	0.65
74LS133	0.50
74LS136	0.45
74LS138	0.55
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74LS145	0.95
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74LS152	2.00
74LS153	0.65
74LS154	1.60
74LS155	0.65
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74LS221	0.90
74LS240	0.90
74LS241	0.90
74LS242	0.90
74LS243	0.90
74LS244	0.70
74LS245	0.90
74LS247	1.10
74LS248	1.10
74LS249	1.10
74LS251	0.75
74LS253	0.75
74LS256	0.90
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4016	0.36
4017	0.55
4018	0.60
4019	0.60
4020	0.80
4021	0.60
4022	0.70
4023	0.30
4024	0.48
4025	0.24
4026	0.90
4027	0.40
4028	0.60
4029	0.75
4030	0.35
4031	1.25
4032	1.00
4033	1.25
4034	2.50
4035	0.70
4036	2.50
4037	1.10
4038	1.00
4039	2.50
4040	0.60
4041	0.55
4042	0.50
4043	0.60
4044	0.60
4045	1.00
4046	0.60
4047	0.60
4048	0.55
4049	0.36
4050	0.35
4051	0.65
4052	0.60
4053	0.60
4054	0.80
4055	0.80
4056	0.85
4059	4.00
4060	0.70
4063	0.85
4066	0.40
4068	0.25
4069	0.24
4070	0.24
4071	0.24
4072	0.24
4073	0.24
4075	0.24
4076	0.65
4077	0.25
4078	0.25
4081	0.24
4082	0.25
4085	0.60
4086	0.75
4089	1.20
4093	0.35
4094	0.90
4095	0.90
4096	0.90
4097	2.70
4098	0.75
4099	0.90
4501	0.36
4502	0.55
4503	0.36
4504	0.95
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4510	0.56
4511	0.55
4512	0.55
4513	1.50
4514	1.10
4515	1.10
4516	0.55
4517	2.20
4518	0.48
4519	0.32
4520	0.60
4521	1.15
4522	0.80
4526	0.70
4527	0.80
4528	0.65
4529	1.00
4531	0.75
4532	0.65
4534	
4536	2.50
4538	0.75
4539	0.75
4541	0.90
4543	0.70
4551	1.00
4553	2.40
4555	0.36
4556	0.50
4557	2.40
4560	1.40
4566	1.40
4568	2.40
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40085	1.20
40097	0.36
40098	0.40
40100	1.50
40101	1.25
40102	1.50
40103	2.00
40104	1.20
40105	1.50
40106	0.48
40107	0.55
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15 V	7815	0.50	7915	0.50
18 V	7818	0.50	7918	0.50
24 V	7824	0.50	7924	0.50

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6 V	78L06	0.30	5 V	79L05	0.45
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RADIO CLOCK

John Becker shows you how to pluck precision time and calender data from the air waves, and acquire a new test gear tester into the bargain!

Anyone driving along the Great North Road can hardly fail to have been impressed by the great complex of aerial masts outside Rugby. These serve a variety of communications purposes, one of which is the transmission of coded time signals detailing information on year, month, date, day of the week, hours, minutes and, indirectly, seconds.

During the course of this article I shall describe how these signals can be decoded and displayed, either by use of a computer, or by a dedicated digital decoder and multiplexed 7-segment led display circuit. In a future article currently under preparation, a third decoding method will be described in which an intelligent 16-character lcd is used to display the entire date and time data. It is not necessary to own a computer in order to use this radio clock.

In addition to discovering how to build your own radio clock, you will also learn how easily an eprom or eeprom can be used as a logic controller without the use of a microprocessor. You will also discover how the logic applied to write a computer program can then be re-interpreted using dedicated chips to simulate the software routines. In this particular application, I used a computer to work out the necessary logic, and then designed the circuitry to match it.

As a peripheral benefit, the inherent accuracy of both the transmission carrier and the time data allows the clock to be used as an item of workshop test equipment, permitting precision checking of frequency-related items such as oscilloscopes, signal generators and frequency counters.

ATOMIC TIME

The high precision of the transmitted data is determined by an atomically controlled resonator based at the National Physical Laboratory in Teddington, Middlesex. In simple terms, the resonator can be more familiarly described as a crystal controlled oscillator, in which the crystal used is made of caesium. Tony Smith, in his *Hi-Tech Timing* article of PE May 89, described the principles involved at some length. In essence, caesium atoms are beamed through a magnetic field in association with a microwave cavity, a vco and a frequency multiplier in a closed loop feedback system, as schematically represented in Fig.1. Implementation of the schematics is highly complex, as the photo in Fig 2, kindly supplied by NPL, indicates!

The resonant frequency of the caesium-controlled system is 9,192,631,770 Hz, within an accuracy of one part in 10^{13}. Frequency synthesisers and dividers attached to the system allow other frequencies to be derived from the master frequency. Of particular interest to us here are those of 60kHz and 1Hz. The former is the frequency at which the Rugby signal is transmitted, and the latter is the rate at which the coded data bits are sent.

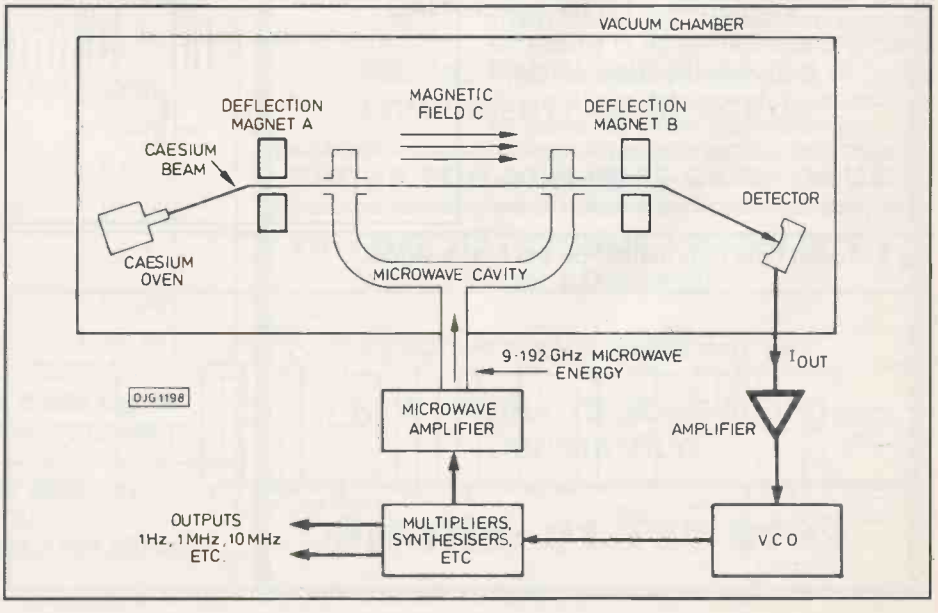
HISTORY TIME

It was in 1950 that the time and frequency service first began, transmitting data for one hour each day. It was not until 1966 that the service was extended to full 24-hour coverage.

At that time the service was introduced, Essen ring quartz oscillators were used as the frequency determining medium. Subsequently, Rubidium resonators replaced the quartz and continued in service until 1976, when the caesium beam standard was implemented.

In 1972 a coded format, known as the DUT code, was applied to the signal, taking the form of a series of double pulses from seconds 1 to 15. A binary coded sequence

Fig 1. Schematic representation of the caesium beam resonator



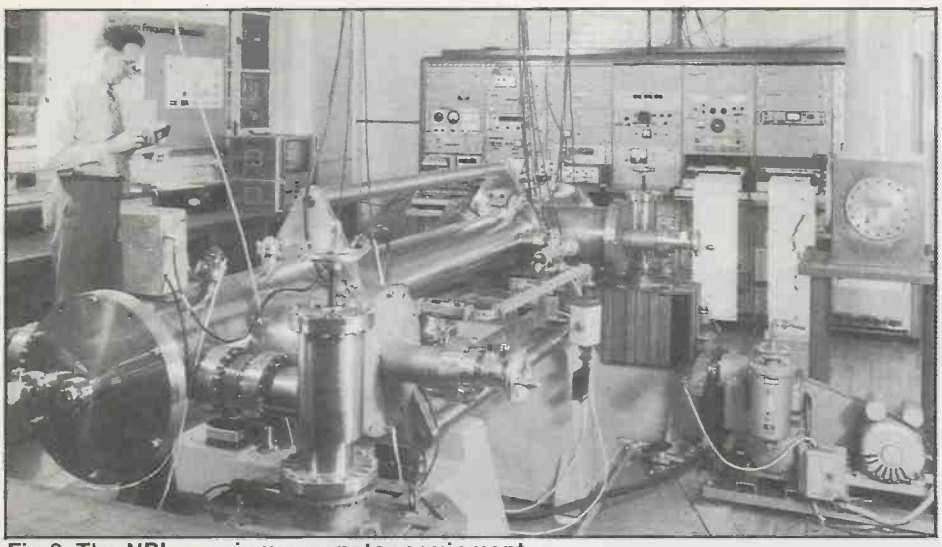


Fig 2. The NPL caesium resonator equipment.

providing time of day data in the form of 10ms bits (the fast code) was inserted into the minute marker space in 1974. The usefulness of this extra data was soon recognised and was extended to provide limited calender information. Fig.3 shows the fast code format, in this instance representing a time of 12:24 on September 28th.

An additional code was introduced in 1977. Known as the slow code, this is a bcd (binary coded decimal) sequence transmitted at the rate of one bit per second between seconds 17 and 51. The data provides year, month, day of month, day of week, and time of day information, in the order shown in Fig.4. Seconds 52 to 59 always contain the same logic data of binary 01111110, decimal 126, and provide a synchronisation marker code. The day of the week data is related to Sunday as day 0, and UK Civil Time is that transmitted, in other words, the signal automatically changes to GMT or BST as appropriate.

SECS	DATA	BINARY	DECIMAL
0	FAST CODE		
1 - 16	DUT CODE		
17 - 20	YEAR TENS	1000	8
21 - 24	YEAR UNITS	1001	9
25	MONTH TENS	0	0
26 - 29	MONTH UNITS	0111	7
30 - 31	DAY OF MONTH TENS	10	2
32 - 35	DAY OF MONTH UNITS	0110	6
36 - 38	DAY OF WEEK	011	3
39 - 40	HOUR TENS	01	1
41 - 44	HOUR UNITS	0101	5
45 - 47	MINUTES TENS	100	4
48 - 51	MINUTES UNITS	1001	9
52 - 59	MINUTE IDENTIFIER	01111110	126

Fig.4. Transmission data sequence and example representing 15:49 on Wednesday (day 3) 26th July (month 7) 1989.

CHOPPED BITS

The technique for transmitting the code might reasonably be described as brute-force amplitude modulation! The entire 60kHz signal is switched on and off to produce the pulses, the off-duration determining whether the data should be regarded as a 1 or a 0. Fig.5 diagrammatically shows the format for the slow code data transmission. Logic 0 is indicated by a transmission break of 100ms, and logic 1 by a break of 200ms. The fast code and DUT data formats are outside the scope of this article, but if you refer back to Fig.3 you'll get some idea of the fast code timing sequence, which takes place within 330ms.

Fig 5. The Rugby pulse waveforms and their timings.

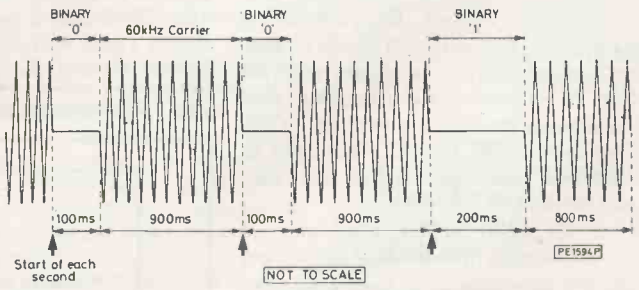
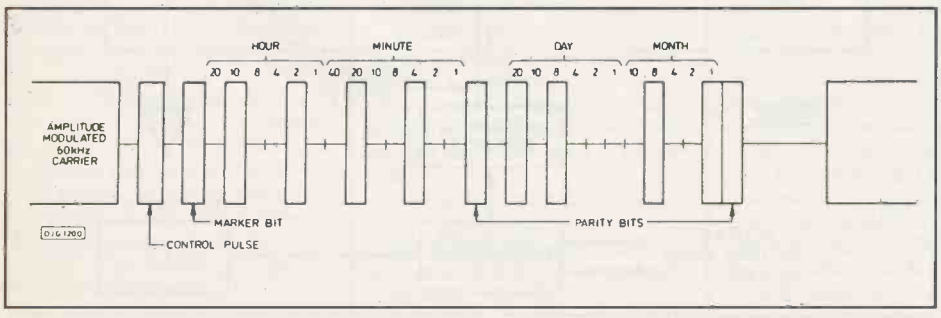


Fig 3. Coded time information on the 60kHz signal.



To make use of the data transmission there are four basic requirements. We need a receiver capable of tuning to 60kHz, a pulse length extractor, a decoder and a display unit.

Most domestic radios cannot receive the 60kHz Rugby signal. The conventional broadcasting stations transmit at frequencies above 150kHz, and this is the lowest frequency to which most receivers are capable of being tuned. (The first European stations listed for the low end of the long wave band are Brasnov in Romania, Donebach in West Germany and Tromsoe in Norway, all of which transmit on 153kHz. It is likely, though, that Allouis in France is the first one you will pick up most readily on a long wave receiver, transmitting on 162kHz.)

However, the 60kHz signal from Rugby is transmitted at 50kW, and is capable of being detected even by quite modest receivers within a few hundred miles radius. With more sophisticated receivers the useful range is quoted at around 1000 miles, and the information supplied by NPL indicates that reception has been made as far away as Newfoundland.

The receiver circuit I describe here is an extremely simple one, but in the area in which I live, mid Kent, it produces a very healthy output signal. Since the components for building it are very cheap, I suggest that you start off with this circuit, then, if you find that the area in which you live does not allow for a good signal, you could substitute the more complex 60kHz receiver described in PE April 85. Alternatively, you could buy a small ready-made vlf receiver module, such as that referred to in the April 85 article, namely Cirkit's 40-06002 receiver, which I understand is still available. Another choice is to modify an existing radio so that it tunes down to 60kHz, a matter on which neither I nor PE can advise, though.

RECEIVER

Fig.6 shows the simple receiver and the pulse extractor.

The aerial is brought into the first tuning coil, L1. The coil presents a high impedance

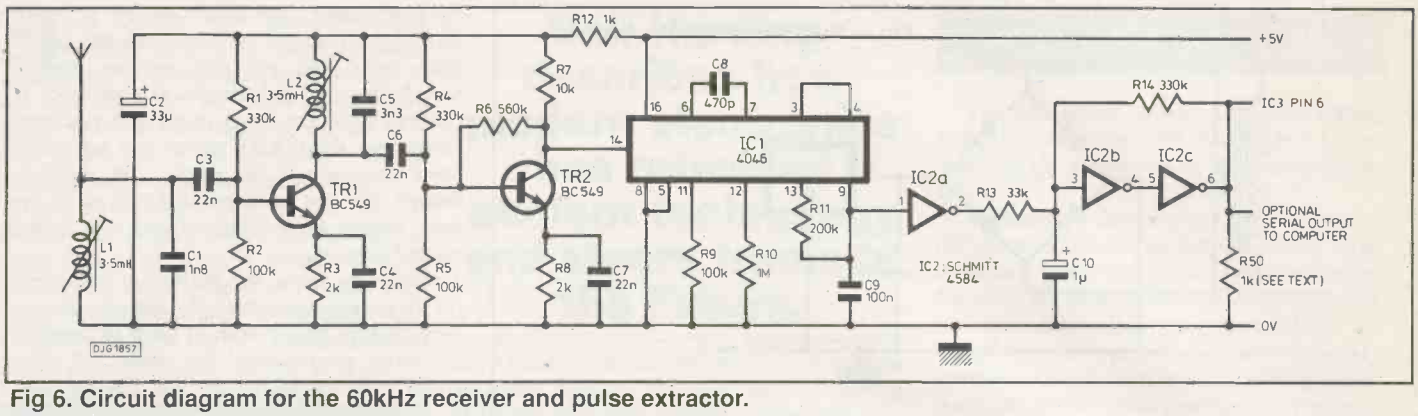
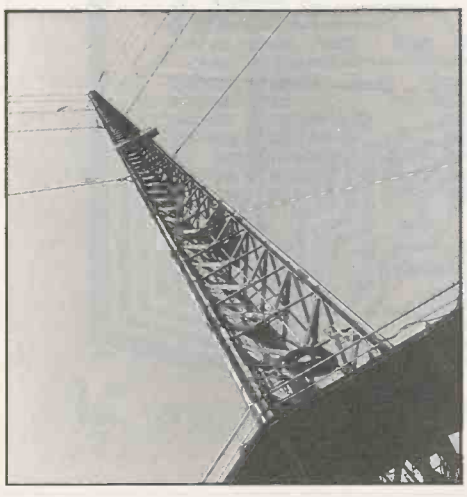


Fig 6. Circuit diagram for the 60kHz receiver and pulse extractor.

only to those signals of close to the frequency to which it is tuned. Signals of frequencies outside the tuned range are simply shorted straight to ground and have no effect upon the next stage, the second tuner. Signals within the range are amplified by the stage around TR1 which has another coil, L2, as its collector load. This is tuned to further select the required transmission frequency. Stage three, around TR2, amplifies the signal even more, to a level suitable for driving the phase locked loop (pll) around IC1.

This simple receiver has proved to be quite satisfactory in areas of good signal strength. It has, though, a couple of drawbacks in that neither automatic gain control nor tight frequency discrimination are employed. In simple terms, this means that the circuit may, in some circumstances, respond to the harmonics of unrequired signals, and it could be subject to signal strength fading under adverse atmospheric conditions. Where I live, a hundred or so miles from Rugby, signal fading has not been experienced. I have, however, experienced signal disruption from the harmonics transmitted from a nearby Amstrad 1640 computer. That machine appears to radiate a very strong signal from its screen circuitry at about 15kHz. Since 60kHz is a harmonic of 15kHz, the Amstrad signal tends to obliterate the Rugby signal. The use of a better receiver as discussed above would overcome this problem, which anyway is only an occasional one. Providing the simple receiver is adequately tuned, once the Amstrad is turned off the receiver again picks up the Rugby signal and the clock automatically sets itself to the correct time. (This is one great benefit of a Rugby controlled clock, it never needs manual resetting since the correct data is transmitted every minute.)

The time transmitting mast at Rugby. Courtesy of BTI.



PULSE EXTRACTOR

The output from TR2 is taken to the phase comparator input at IC1 pin 14. Internal circuitry within IC1 detects the phase relationship between the signal at pin 14 and the signal at the second phase comparator input at pin 3. In this application, the second signal comes from the integral voltage controlled oscillator (vco) having its output at pin 4. The vco frequency is set by the values of R9, R10, C8 and the voltage on the vco input pin 9. The output voltage level at pin 13 reflects the phase difference between the signals on pins 14 and 13. Since pin 13 is connected to the vco input, the vco output frequency varies in sympathy with any phase change, attempting to maintain zero phase difference.

The amplified Rugby signal is, of course, a chopped frequency signal. When the Rugby 60kHz is present, the pll will maintain a constant voltage at the phase comparator output. When the 60kHz ceases, the comparator output will change since the phase relationship has changed. Only on restoration of the 60kHz will the comparator output revert to its optimum level. In the circuit shown, I have set the component values so that in the presence of the 60kHz, the comparator output level is as high as possible. This is achieved by setting the basic vco frequency well below 60kHz so that full phase uniformity can never exist, though the pll will do its best to make it do so by trying to force the vco to its highest frequency. In the absence of the Rugby signal, the vco output will fall to its preset low frequency, and the phase comparator output will similarly fall to its minimum level. The two extreme comparator output levels closely approximate a full 0V to +5V swing at pin 9. R11 and C9 are used to mop up any extraneous level changes that could be caused by spurious noise present in the received signal.

For the pll to operate correctly, the input signal strength from TR2 needs to be only around 500mV peak to peak. The pll will quite happily accept signals above that amplitude, right up to full line level swing, consequently, an input level control was considered unnecessary. Should you wish to increase or decrease the amplification at TR2, increase or decrease R6 accordingly. The length of the aerial will also determine the signal strength. In my locality and using a single-wire aerial only four feet long, the received signal strength produces an output at TR2 in excess of 2V p-p.

If you decide to use a different receiver to that shown here, simply delete all components prior to C6, then bring the other receiver's signal direct into C6.

The smoothed comparator output voltage is taken to the inverting buffer IC2a, which ensures a full line-level swing. Each time there is break in the transmission frequency, the output of IC2a swings high, triggering the Schmitt trigger circuit around IC2b and IC2c. This circuit is used to additionally eliminate extraneous transmission noise pulses, triggering only to the long and short breaks relating to the Rugby code pulses.

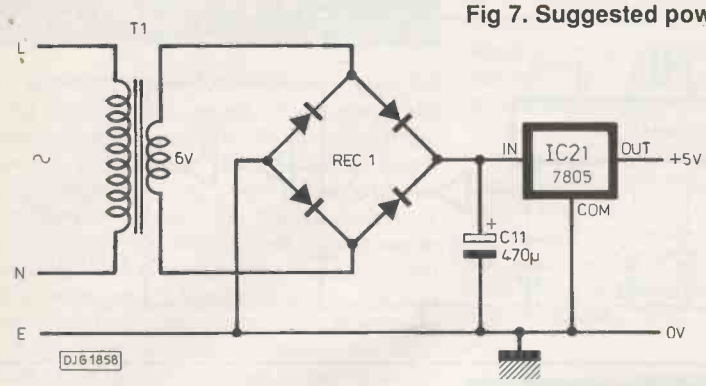
POWER SUPPLY

The entire circuitry of the receiver and decoder requires a well-stabilised supply of 5V dc, a voltage level which must not be exceeded.

To power the unit you may use an existing 5V stabilised supply capable of delivering at least 150mA. Alternatively, you can make use of part or all of the circuit in Fig.7.

With the latter, one choice is to use just C11 and IC21, bringing in a dc supply of around 9V. C11 provides initial smoothing, and IC21 regulates the voltage down to the required 5V. Although in theory a 9V battery could supply the input voltage to IC21, in reality it would not last very long supplying the necessary current. You could, though, use a mains powered 9V battery eliminator module, such as is used for powering cassette recorders and similar. The drawback of this method is that the receiver needs to be grounded for it to respond to the radio signal. It is unlikely that the battery eliminator will have a separate ground lead connection and so you would need to take another lead from the pcb 0V connection point to a ground point close to the receiver. A nearby central heating

Fig 7. Suggested power supply.



radiator would be a suitable ground point, providing you ensure that the lead is in contact with bare metal.

The third choice is to use a mains transformer, feeding its 6V secondary winding into the bridge rectifier. The dc voltage then appearing at the input to IC21 will be in the region of 8V to 9V. If you use a mains transformer, normal safety requirements should be observed, such as using an on-off switch, fuse and mains neon.

The psu should be checked out before inserting IC1 and IC2, ensuring that the output of IC21 delivers 5V dc.

RECEIVER CONSTRUCTION

Fig.8 and Fig.9 show the component and track layouts for the receiver and pulse extractor pcb. The pcb also holds the components for the initial binary code and sync pulse extractor, the circuits for which will be described later. The power supply regulator is also included on this board.

Tuning of the coils will be pretty straight forward if you have an oscilloscope available. It's a little more fiddly to tune them without a scope since it will be a matter of exercising your lo-tech workshop attributes: trial and error, and a bit of patience.

First, connect about four feet of wire to the designated point on the pcb (arrow 28). Lay or string the wire horizontally with its full length facing roughly towards Rugby (consult a map and a compass if you're not sure where Rugby is!).

In the final boxed unit 2mm sockets can be used for the aerial input and optional ground connection leads, and a 3.5mm jack socket can be used for the power input.

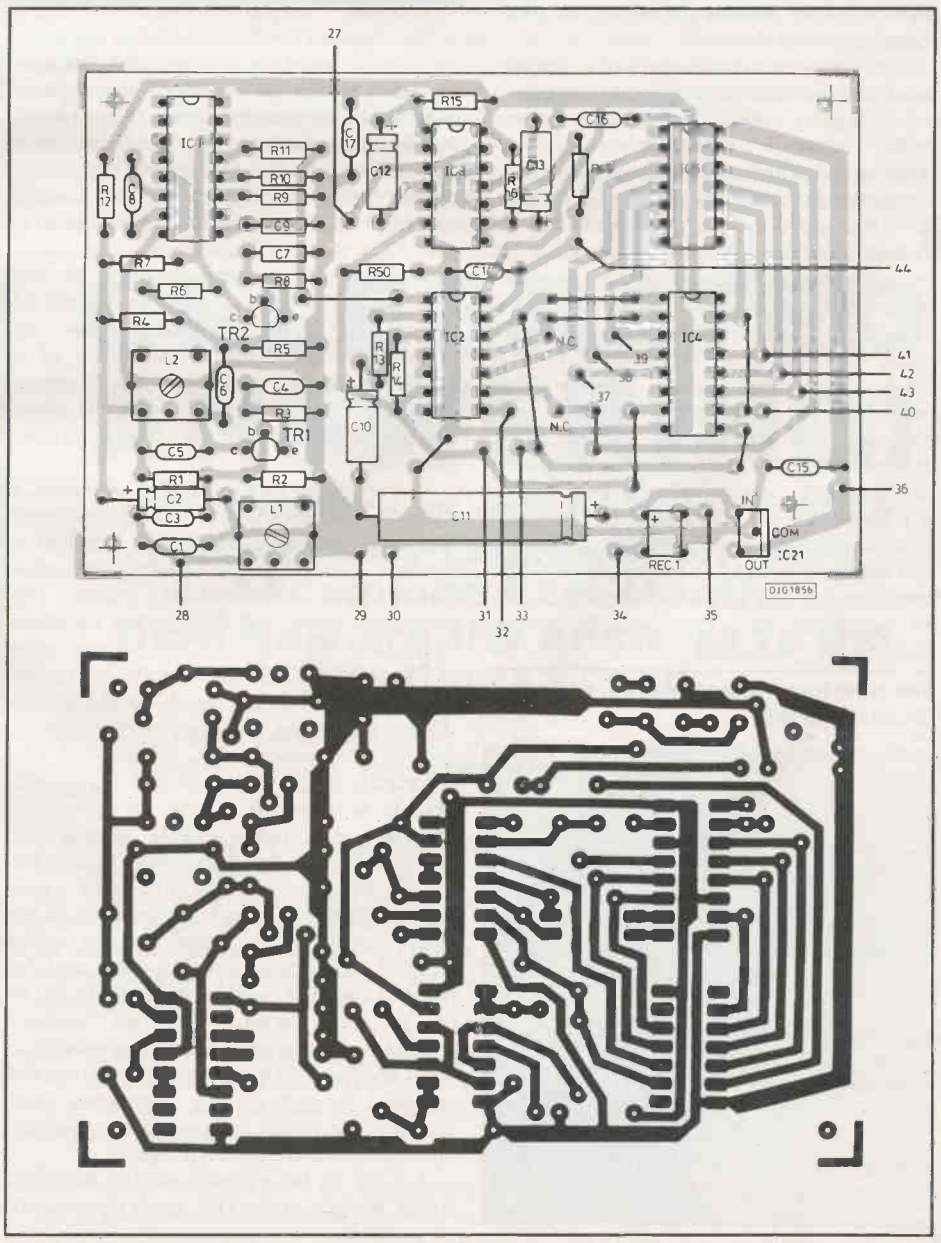
TUNING BY SCOPE

If using a scope, set its input amplifier to a high gain ac mode (say 10mV), set the timebase to the 10 microsecond range, and monitor the collector of TR2. Then, using a non-metallic screwdriver or similar flat-bladed tool, unscrew the tuning slug in the centre of each coil until it's about half way out. While observing the scope screen, now screw in the slug of L2 until you see the trace pulsing slightly up and down. Should you see no response, screw in the slug of L1 a bit and try again. Once a response is obtained, maximise L2's slug position for the greatest signal amplitude. Now screw in the slug of L1 until you again obtain the maximum signal strength. You should now be able to switch the scope input amplifier to the 1V ac range and adjust the sync setting until the signal trace locks and you can see the distinct waveform peaks and troughs. If your scope is calibrated you can cross check that you have tuned into the 60kHz signal and not some other transmitter! It should be obvious, though, that you are tuned to Rugby since the trace should be pulsing on and off at one second intervals.

Once you know the settings of both coils for maximum signal strength, it is advisable to very slightly detune both of them in opposite directions to minimise the chance of stray signal radiation within the unit feeding back to the aerial input, so causing the circuit to go into perpetual howl. The surge of inductive loads, such as fluorescent lights being turn on, are a possible cause of feedback triggering if the coils are tuned too closely to one another.

If you fail to obtain adequate signal strength, of at least 500mV p-p at TR2, (and preferable of around 1V p-p), progressively lengthen the aerial wire and retune.

Figs 8 and 9. Component and track layouts for the receiver and pulse extractor pcb.



RECEIVER AND PULSE COMPONENTS

RESISTORS

R1, R4	330k (2 off)
R2, R5, R9	100k (3 off)
R3, R8	2k (2 off)
R6	560k
R7, R49	10k (2 off)
R10, R15	1M (2 off)
R11, R16	200k (2 off)
R12, R50	1k (2 off)
R13, R14	33k (2 off)

all 0.25W 5% carbon film or better

CAPACITORS

C1	1n8 polystyrene
C2	33µ 16V elect
C3, C4, C6, C7	22n polyester (4 off)
C5	3n3 polystyrene
C8	470p polystyrene
C9, C14-C17	100n polyester (5 off)
C10, C12, C13	1µ 16V polyester (3 off)

SEMICONDUCTORS

TR1, TR2	BC549 (2 off)
IC1	4046
IC2	4584
IC3	4001
IC4	4015
IC5	4068

INDUCTORS

L1, L2	3.5mH adjustable (2 off)

MISCELLANEOUS

14-pin ic sockets (3 off), 16-pin ic sockets (2 off), printed circuit board.

PLL MONITORING

Now switch the scope to the 1V dc range and monitor the junction of R11 and C9. The scope trace should be seen swinging up and down between about 1V and 4V. A larger swing is even better. Check now that you see a full logic swing at the output of IC2a, pin 2, and that a similar swing occurs at the output of IC2c, pin 6.

If IC2a fails to respond it is possible that the signal output at TR2 is too low in p-p amplitude. Contrarily, too strong an output could also cause problems if there is a lot of noise in the received signal. Such a situation could arise if you are in a bad reception area, or if you are using too long an aerial, resulting in the harmonics of other stations interfering. In both instances the distinction between the Rubgy signal on-off states might not be clear to the phase locked loop. This could result in it failing to recognise the pulse breaks as a zero frequency input, so preventing the maximum swing at its comparator output, pin 13.

OPTIONAL POWER SUPPLY COMPONENTS

C11	470µ 25V electrolytic
REC1	1 amp bridge rectifier
IC21	7805 regulator
T1	Mains transformer, 6V 3VA secondary

SCOPELESS TUNING

If you don't have a scope, tuning can possibly be assisted by monitoring the junction of R11 and C9 with a dc voltmeter. There is convenient link wire connecting to IC2a pin 1 to which the meter's positive probe can be attached. The meter's negative lead, of course, is connected to the 0V psu line. As with the scope method, the coils L1 and L2 should be adjusted until the best voltage swing is seen on the meter. It's more tricky than using a scope, but it can be done providing you're patient.

PULSE USING

Having now extracted the basic pulses, we are now in a position to interpret them into meaningful data.

You have a choice of ways in which to make use of the data. Firstly, you could simply connect a suitable computer to the output at IC2c, and let it do the decoding and display. Alternatively, you can build the dedicated decoder to be described next month. A third option you can implement straight off is to use the signal and its pulses to check some of your workshop gear.

If you have an oscilloscope you can check the accuracy of its timebase by monitoring the 60kHz signal at the collector of TR2 or the 1 second pulses at the output of IC2c. The 60kHz signal will be absolutely precise, though the pulse widths may show a slight inconsistency in duration due to the restraints imposed by the inclusion of R11 and C9. However, the mean average pulse lengths will be sufficiently accurate to assess the scope's overall timing veracity.

It should be remembered, of course, that single pulses per second only occur between seconds 17 and 59. Second number zero contains the fast code and so has several pulses. Also, double pulses per second occur during the DUT code between seconds 1 to 16.

RECEIVER AND LOGIC PCB CONNECTIONS

(PCB 2 referred to is the decoder and display board to be described next month.)

Pin 27 - decimal point to pin 12 of pcb 2
Pin 28 - aerial input
Pin 29 - 0V dc input
Pin 30 - 0V to pin 9 pcb 2
Pin 31 - data output to pin 2 pcb 2
Pin 32 - sync output to pin 1 pcb 2
Pin 33 - clock output to line DA7 of optional computer using Basic program
Pins 34 and 35 - ac power inputs
Pin 36 - +5V output to pin 10 pcb 2
Pins 37 to 43 - data outputs respectively to lines DA0-DA6 of optional computer using Basic program
Pin 44 - clock output to pin 3 of pcb 2

COMPUTERISED DECODING

If you have a computer which has a parallel input port, and you are familiar with using the computer in a machine code mode, you might be interested to modify the decoding program given in Figs.10 to 12.

The program in Fig.10 is the Basic program that accesses the machine code routine for which the hex dump is given in Fig.11.

The machine code is written for a 6502 microprocessor controlling a parallel user port, the data direction register for which is addressed at decimal location 59457 (hex E841), and the input register addressed at decimal 59459 (hex E843). Only the D0 input line of the register is accessed. The program was written to make use of a 512 memory location block for data storage and control commencing at decimal 8192 (hex 2000). The machine code and data storage addresses may be placed at other locations to suit your own

Fg 10. The Basic routine which accesses the machine code routines of Figs 11 and 12.

```
350 DIMT(11),D$(7),M$(20),N$(10),S$(70)
360 PRINT"J"TAB(3)"RUGBY CLOCK MACHINE CODE PROGRAM"
370 IN=59457:DRT=59459:POKEDRT,0:DN$="[illegible]":X=8470
380 E$(0)="      SIGNAL ERROR":E$(1)="                    "
390 A$="99193962969":B$="1111222234444556666777889999":C$="0001111"
400 FORA=1TO11:POKE(X+A),VAL(MID$(A$,A,1)):NEXTA:X=X+A-1
410 FORA=1TO18:POKE(X+A),0:NEXT:X=X+A-1
420 FORA=1TO28:POKE(X+A),VAL(MID$(B$,A,1)):NEXTA:X=X+A-1
430 FORA=1TO7:POKE(X+A),VAL(MID$(C$,A,1))+10:NEXTA:X=X+A-1
440 FORA=1TO12:POKE(X+A),0:NEXT
450 N$="0123456789":FORA=1TO10:N$(A-1)=MID$(N$,A,1):NEXTA
460 C=0:FORA=0TO6:FORB=0TO9:S$(C)=N$(A)+N$(B):C=C+1:NEXTB:NEXTA
470 M$="???JANFEBMARAPRMAYJUNJULAUGSEPOCTNOVDEC?????????????????????"
480 D$="SUNMONTUEWEDTHUFRISAT"
490 B=0:FORA=1TO60STEP3:M$(B)=MID$(M$,A,3):B=B+1:NEXT
500 B=0:FORA=1TO21STEP3:D$(B)=MID$(D$,A,3):B=B+1:NEXT:POKE8370,1:X=8388
510 SYS8192:D=PEEK(8371):PRINT"S"R:PRINTDN$TAB(20)S$(D):FORB=1TO11
520 T(B)=PEEK(X+B):NEXT:M=T(3)*10+T(4)
530 IFPEEK(8370)=1THENS=1:IFD<>60THENS=0:R=R+1
540 PRINTLEFT$(DN$,8)"     "D$(T(7))"     "N$(T(5))N$(T(6))"  ";
550 PRINTM$(M)"     19"N$(T(1))N$(T(2)):PRINT:PRINTE$(S):PRINT:PRINT:PRINT
560 PRINT"     TIME    "N$(T(8))N$(T(9))"    "N$(T(10))N$(T(11)):GOTO510
```

```
2000 A2 00      LDX #$00
2002 A0 40      LDY #$40
2004 E8         INX
2005 D0 FD      BNE $2004
2007 88         DEY
2008 D0 FA      BNE $2004
200A AD B2 20   LDA $20B2
200D C9 01      CMP #$01
200F 90 0A      BCC $201B
2011 A2 10      LDX #$10
2013 A9 00      LDA #$00
2015 9D B0 20   STA $20B0
2018 CA         DEX
2019 D0 FA      BNE $2015
201B A2 00      LDX #$00
201D A0 00      LDY #$00
201F AD 41 E8   LDA $E841
2022 29 01      AND #$01
2024 D0 0F      BNE $2035
2026 E8         INX
2027 D0 F6      BNE $201F
2029 C8         INY
202A D0 F3      BNE $201F
202C 8C B3 20   STY $20B3
202F A0 01      LDY #$01
2031 8C B2 20   STY $20B2
2034 60         RTS
2035 A2 00      LDX #$00
2037 A0 75      LDY #$75
2039 CA         DEX
203A D0 FD      BNE $2039
203C 88         DEY
203D D0 FA      BNE $2039
203F AD 41 E8   LDA $E841
2042 29 01      AND #$01
2044 8D B0 20   STA $20B0
2047 EE B3 20   INC $20B3
204A AE B3 20   LDX $20B3
204D BD 22 21   LDA $2122
2050 AA         TAX
2051 EA         NOP
2052 EA         NOP
2053 EA         NOP
2054 AD B1 20   LDA $20B1
2057 0A         ASL
2058 0D B0 20   ORA $20B0
205B 8D B1 20   STA $20B1
205E C9 7E      CMP #$7E
2060 D0 04      BNE $2066
2062 A9 01      LDA #$01
2064 D0 02      BNE $2068
2066 A9 00      LDA #$00
2068 8D B2 20   STA $20B2
206B BD B4 20   LDA $20B4
206E 0A         ASL
206F 0D B0 20   ORA $20B0
2072 9D B4 20   STA $20B4
2075 AD B2 20   LDA $20B2
2078 F0 15      BEQ $208F
207A A0 00      LDY #$00
207C A2 0B      LDX #$0B
207E BD B4 20   LDA $20B4
2081 DD 16 21   CMP $2116
2084 F0 03      BEQ $2089
2086 90 01      BCC $2089
2086 90 01      BCC $2089
2088 98         TYA
2089 9D C4 20   STA $20C4
208C CA         DEX
208D D0 EF      BNE $207E
208F AD B3 20   LDA $20B3
2092 C9 40      CMP #$40
2094 90 03      BCC $2099
2096 CE B3 20   DEC $20B3
2099 60         RTS
209A 00         BRK
```

Fig 12. Disassembled code for the hex dump in Fig. 11.

```
HEX DUMP RUGBY M-C PROG

C*
     PC  IRQ  SR AC XR YR SP
.;  B780 7B7A 2C 34 3A 9D E6
.
.:  2000 A2 00 A0 40 E8 D0 FD 88
.:  2008 D0 FA AD B2 20 C9 01 90
.:  2010 0A A2 10 A9 00 9D B0 20
.:  2018 CA D0 FA A2 00 A0 00 AD
.:  2020 41 E8 29 01 D0 0F E8 D0
.:  2028 F6 C8 D0 F3 8C B3 20 A0
.:  2030 01 8C B2 20 60 A2 00 A0
.:  2038 75 CA D0 FD 88 D0 FA AD
.:  2040 41 E8 29 01 8D B0 20 EE
.:  2048 B3 20 AE B3 20 BD 22 21
.:  2050 AA EA EA EA AD B1 20 0A
.:  2058 0D B0 20 8D B1 20 C9 7E
.:  2060 D0 04 A9 01 D0 02 A9 00
.:  2068 8D B2 20 BD B4 20 0A 0D
.:  2070 B0 20 9D B4 20 AD B2 20
.:  2078 F0 15 A0 00 A2 0B BD B4
.:  2080 20 DD 16 21 F0 03 90 01
.:  2088 98 9D C4 20 CA D0 EF AD
.:  2090 B3 20 C9 40 90 03 CE B3
.:  2098 20 60 00 00 00 00 00 00
.:  20A0 00 00 00 00 00 00 00 00
```

Fig 11. Hex dump of the machine code program routines.

requirements providing the relevant address codes within the program are changed. The data direction and input register addresses must also be changed to match those of your computer. The timing factors built in to the program are determined by the number of clock cycles required to perform a given instruction and in relation the computer's clock frequency, in my own machine this is 1MHz. Obviously, then, this program is not suited to those who are not fully familiar with their computer.

In essence, the machine code routine determines the relative lengths of the pulses received from the output of IC2 along line DA0. From this information the routine allocates the pulses as either logic 1 or logic 0, building up binary codes having lengths and temporary storage locations relating to the number of pulses received. The routine also detects for the sync marker at the end of each minute's transmission cycle, at which point the data in the temporary locations is transferred to a second set of addresses.

The machine code routine is accessed once a second and upon return to the Basic routine, the data stored at the second addresses is displayed formally on the screen. The time and data information is thus only seen to change at each sync marker. There is, however, a seconds counter displayed on the screen repeatedly counting up to 60 for each second following the sync point.

In the event of occasional reception problems, such as total loss of signal, or loss of sync marker, a "Signal Error" indicator is displayed in addition to the data stored in memory. A loss of power on the receiver is also allowed for by the inclusion of R50 which ensures that line D0 will be held low in such an event.

Later, when I discuss the use of a dedicated circuit to decode and display the time data, you will find that the logic applied to that circuit will have a lot in common with the logic used in the machine code routine and I shall discuss that logic more fully.

For those interested in further exploring the machine code, the disassembled code is given in Fig.12. The main subsections are at the following addresses commencing at hex 2000:

2000 - 2009	600ms wait loop.
200A - 2010	check for previous detection of sync marker.
2011 - 201E	reset temporary store registers.
201F - 2025	check for logic 1 on input register.
2026 - 2034	"time out" error routine.
2035 - 203E	150ms wait loop.
203F - 2046	check input register logic.
2047 - 204C	increment seconds counter.
204D - 2053	select temporary storage register.
2054 - 205D	serial to binary conversion for sync register.
205E - 206A	check for sync marker.
206B - 2074	serial to binary conversion for selected temporary register.
2075 - 208E	transfer temp registers to main registers while setting any erroneous excess counts to zero.
208F - 2098	halt seconds counter if greater than 63.

Next month I'll discuss a decoding computer program that is written entirely in Basic, and describe the decoding and display circuits that perform without the need for a computer. Below is the list of components you will need.

PE

DECODER AND DISPLAY COMPONENTS

RESISTORS

R17-R22, R32	10k (7 off)
R23-R31	100k (9 off)
R33, R46	1k (2 off)
R34-R40, R45	150R (8 off)
R41-R44	220R (4 off)
R47, R48	20k (2 off)

CAPACITORS

C18, C20-C23	100n polyester (5 off)
C19	470µ 25V elect

SEMICONDUCTORS

D1-D4	1N4148 (4 off)
TR3-TR7	BC549 (5 off)
IC6	4518
IC7	2048 x 8-bit eprom or eeprom (eg 2716 or X2816A - see text)
IC8	74HC139
IC9	4069
IC10	74HC541
IC11-IC16	74HC595 (6 off)
IC17	74HC241
IC18	4511
IC19	4024
IC20	74HC237

MISCELLANEOUS

Multiplexed 4 x 7-segment common cathode led display module, 3p4w rotary switch, 14-pin ic sockets (2 off), 16-pin ic sockets (10 off), 20-pin ic sockets (2 off), 24-pin ic socket, printed circuit board, plastic case 206 x 146 x 74 mm, 2mm sockets (2 off), 3.5mm jack socket, knob.

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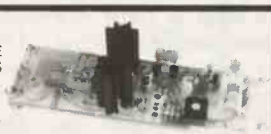

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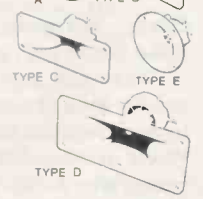

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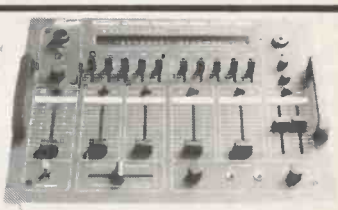

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To begin with, here is a summary of the main points and equations so far:

* Electricity is a flow of electric charge in an electric field.

* There are two kinds of electric charge, called *positive* and *negative*.

* Like charges attract each other; unlike charges repel each other.

* An electric current in a metal is a flow of negative charge *carriers* (electrons), from negative to positive.

* The flow of electrons is opposed by the material the current flows in - we call this resistance.

* The following equations show the relationship between voltage V, current I, and resistance R:

$R = V/I \qquad I = V/R \qquad V = IR$

* For two resistances in series, the combined resistance R is:

$R = R_1 + R_2$

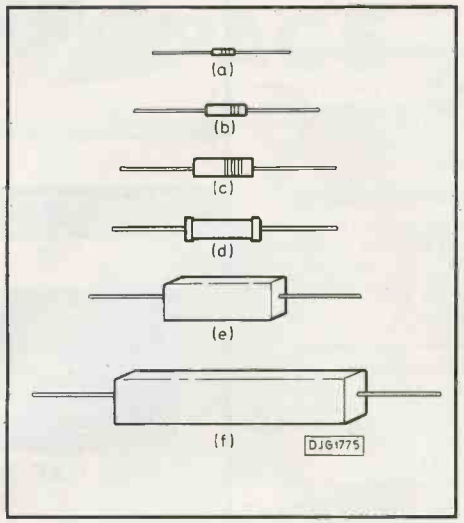


Fig 1. Resistors of different power ratings, drawn to two-thirds typical actual size:

(a) 1/8W (b) 1/3 or 1/4W
(c) 1/2W (d) 1W
(e) 3W (f) 10W

Resistors (d) to (f) are usually wirewound.

Ratings of audio systems are on average lower than those of lamps. An 8W system is loud enough for most purposes, while a 100W output is deafening - enough for a public address system in a large hall or theatre. But imagine trying to illuminate the stage with a single 100W lamp! This difference is due to the fact that the human ear is much more sensitive to the power of sound than the eye is to the power of light. It only takes a few microwatts to produce an audible sound - which is why sound from high-power amplifiers can so easily do permanent damage to the delicate mechanism of the ear. The mechanism is just not designed to operate at such a high wattage.

If a resistor is operating at a higher wattage than it is rated at, it gets too hot. Heating alters its resistance, for resistance is dependent on temperature. The excessive heat when it is over-run may alter its resistance permanently. At the worst, it may burn out the resistor altogether. So, when we are designing circuits, it is important to calculate what the rating of resistors should be. Of course, we can always be on the safe side and use resistors of high wattage, but such resistors are usually larger and more expensive then the low wattage types, so are to be avoided.

BASIC ELECTRONICS

Part 3 - resistors, capacitors and inductors

Owen Bishop discloses more fundamental facts to enlighten your quest for knowledge

* For two resistances in parallel:

$R = (R_1 \times R_2) / (R_1 + R_2)$

* In a potential divider, if V_{in} is across both resistors and V_{out} is the resistance across R_2

$V_{out} = V_{in} \times R_2 / (R_1 + R_2)$

The equations above are the ones you will need most often in electronics. In fact, these are about the only equations you need for the whole of this series. Its nice to get them over with at the beginning.

CURRENT AND HEATING

When we were describing resistors last month we mentioned resistance and tolerance but did not say anything about *power rating*. Fig. 1 shows fixed resistors of different power ratings. The importance of power rating depends on the fact that heat is produced when a current passes through a resistor. The resistor opposes the flow of current and the charge carriers lose energy. This energy is not destroyed. It appears in another form - heat. A similar thing happens with your bicycle brakes. The brake blocks rub against the rim of the wheel, opposing the motion of the wheel. The bicycle and rider wheel lose energy. The energy appears as heating of the brake blocks and rim.

When one kind of energy is turned into another kind of energy, the rate at which this happens is called the *power* of the conversion. Power is measured in *watts*. This unit is named after James Watt, the inventor of many of the early steam engines. You will have heard of this unit before in connection with electric lamps, and hifi systems. When we say that the power of a lamp is 100W, we mean that the rate of conversion of electrical energy into light energy and heat is 100W. Lamps are sold in various wattages: 25W, 60W, 100W, and 150W. The higher the wattage, the greater the rate of conversion of electrical energy and the brighter (and hotter) the lamp. With audio systems, the wattage tells us the power of conversion of electrical energy into the energy of sound waves.

POWER

Without going into the theory, we can state that for any electrical device, power P, in watts is given by the equation (Yes! - just one more equation):

$P = IV$

For example, take a torch bulb that passes 0.1A when the voltage across it is 6V. Its power is $P = 0.1 \times 6 = 0.6W$. Note that power is a *rate* of conversion, not an *amount* of conversion. We do not say watts per second as the time element is already included in the definition of power.

As another example, a circuit includes a resistor of 6.8 ohms which has a 3V across it. What wattage resistor is required? First calculate the current through the resistor: $I = V/R = 3/6.8 = 0.44A$. Now calculate the power: $P = IV = 0.44 \times 3 = 1.32W$. Obviously, a 0.25W resistor, such as a 3W wire-wound resistor.

Questions:

1. An electric heater works on 240V and has a current of 8A passing through it. What is its power?
2. A 2 kilohm resistor has 100V across it. What rating should the resistor be?

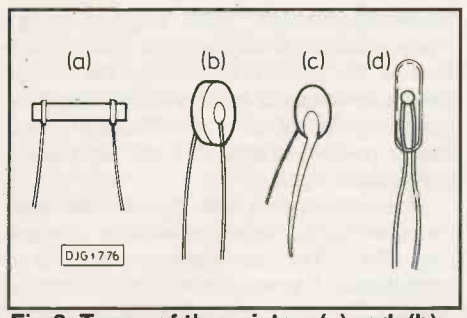


Fig 2. Types of thermistor: (a) rod, (b) disc, (c) bead, (d) glass-encapsulated bead.

Although we do not intend to go into the theory of the equation, we will at least show that 'P=IV' makes sense. Consider the current aspect of it. If V is constant, the equation tells us that P is proportional to current I. This makes sense because the larger the current, the more charge carriers, the more work has to be done to oppose their motion. Therefore more heat is produced.

Conversely, if I is constant, the equation tells us that P is proportional to V. V is the voltage drop, or *fall in electrical potential* across the resistor. We might ask 'Potential to do what?'. Electrical potential, like the *potential energy* you give yourself and your bicycle when you pedal up a hill, is the potential to *do work*.

As you free-wheel down the hill, your potential energy is converted into the energy of motion (kinetic energy). Potential energy is lost. This is another example of converting one kind of energy into another. In a resistor, electrical potential is converted into heat, so some of the electrical potential is lost. This shows up as the potential difference (or voltage drop V) across the resistor. Thus it makes sense for the power to be proportional to V, the amount of electrical potential energy converted.

THERMISTORS

We have already said that the resistance of a resistor changes with temperature. As the material of the resistor becomes warmer, the atom of which it is made begins to vibrate more and more strongly. It is like trying to push one's way through an agitated crowd. The resistance to the flow of charge carriers increases. This effect is small in most resistors and we often ignore it. Thermistors are made from materials in which the effect of temperature on resistance is greater. The material of a thermistor is shaped into a rod, a disc or a bead (Fig. 2), and may be enclosed in a glass capsule. Let us find out how thermistors behave.

Investigation 1 -
The effect of temperature on a thermistor

You need : battery box (6V)
R1 Bead-type thermistor with a resistance of 47k at 25 C
R2 10k carbon film or metal film resistor
testmeter or voltmeter with 2V scale
breadboard

Set up the circuit of Fig. 3, as in Fig. 4. Record the voltage across R2. Now grip the thermistor bead firmly between your finger and thumb to warm it. Watch the meter. What happens to the reading? What must be happening to the resistance of the thermistor? *Hint*: R1 and R2 make up a potential divider.

Let go of the thermistor. Allow it to return to room temperature. Does the meter return to its original reading?

Use the voltages recorded to calculate the resistance of the thermistor at the two temperatures, room temperature and 'finger-warm'.

More to do: Put the circuit in places at different temperatures, such as a refrigerator, other rooms, a greenhouse, places outdoors (not in direct sunlight). In each place measure the temperature with a thermometer and record the meter reading. Draw a graph to show how meter reading corresponds to temperature. Now you can use the circuit to measure temperature: take the meter reading, then use the graph to find out to what temperature this corresponds.

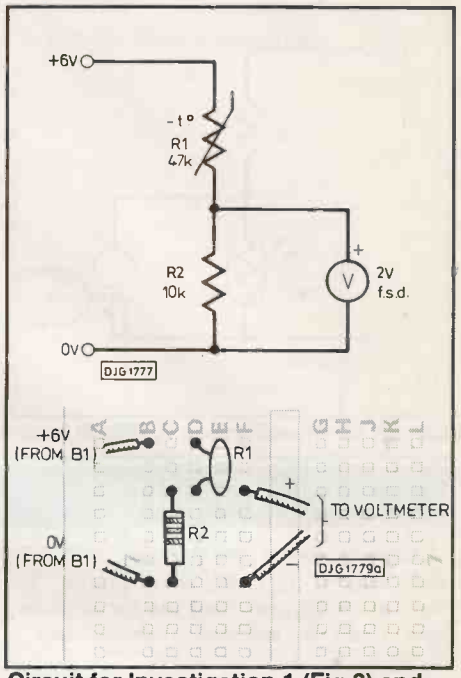
USING THERMISTORS

Thermistors are made of a semiconducting material. There is a lot more to be said about semiconductors next month but, for the moment, we will simply say that an increase in temperature brings about an increase in the number of charge carriers in the semiconductor. If the number of charge carriers increases, current flows through the material more easily. In other words, its resistance becomes less. Thermistors of this type, which have *reduced* resistance and increased temperature, are known as *negative temperature coefficient* or *ntc* thermistors. This is indicated by the '-t°' in the circuit symbol. Note that this change in resistance with temperature is the *opposite* to that which occurs in metals.

We use ntc thermistors for a variety of purposes. They are used in thermometer circuits, as you have already seen in *investigation 1*. However, they are not ideal for this as their response is not *linear*. Equal changes of temperature do not produce equal changes of resistance at all points on the temperature scale. For this reason, thermistors are useful for measurements only over a limited range. However, they have many applications in circuits designed to respond to a single fixed temperature, such as fire alarms that depend on detecting abnormally high temperature. A future *System of the Month* demonstrates how a thermistor is used in a thermostat for maintaining constant temperature. Thermistors are also used in circuits to compensate for temperature changes that would otherwise affect the operation of the circuit.

Thermistors have the advantage that they can be made very small. This means that they respond very quickly to change in temperature - much quicker than the bulb of a mercury thermometer for example. They have been used by biological researchers to measure temperatures *inside* the leaves of plants. Their chief advantage is that we have to pass a current through the thermistor in order to measure its resistance. This current causes slight self-heating, making the thermistor a little warmer than its surroundings. The reading is slightly higher than the true temperature.

There are also ptc thermistors, which show increase in resistance as temperature increases, but this type has few important applications.



Circuit for Investigation 1 (Fig 3) and its breadboard layout (Fig 4).

LIGHT-DEPENDENT RESISTORS

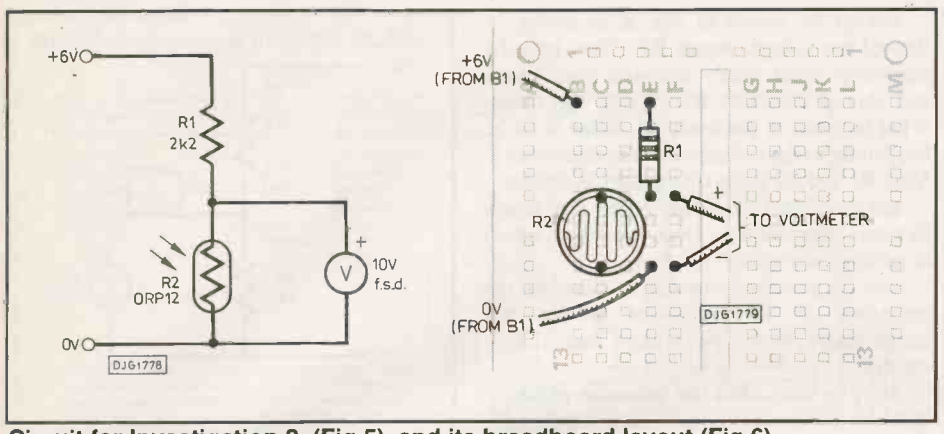
Light-dependent resistors (ldrs) are also known as *photoconductive cells (pccs)*. They are made from a semiconductor material, usually *cadmium sulphide*, in which case they are known as cadmium sulphide cells (CdS cells).

Investigation 2 - *LDRs*

You need: battery box (6V)
R1 2k2 carbon resistor
R2 ORP12 (or similar) ldr
testmeter or voltmeter with 10V scale
breadboard

Set up the circuit of Fig. 5, as in Fig. 6. Observe and record the reading on the meter. Now try (a) decreasing the amount of light falling on R2 by shading it; (b) increasing the amount of light falling on R2 by moving it nearer a window, letting full sunlight fall on it, or bringing an electrical lamp close to it. How do you explain what happens? *Hint:* yet another potential divider!

More to do: What will happen if you exchange R1 and R2? Answer the question first, then try it out practically, on the breadboard.



Circuit for Investigation 2, (Fig 5), and its breadboard layout (Fig 6).

USING LDRS

Light-dependent resistors are used in a wide range of light-sensing equipment. You may be familiar with their use for measuring light levels in automatic cameras and in photographic exposure meters. The voltage obtained from the sensor circuit is used to control the position of the leaves of the aperture diaphragm, or the action of the shutter.

They are used in control applications - switching on street lamps at dusk, for example. When the voltage from the sensor circuit rises above a certain level, the lamps are switched on.

In detection circuits they are used to detect when a beam of light has been broken. The next *System of the Month* explains how this works. This has such diverse applications as detecting intruders, cars entering of leaving a car park, objects on a conveyor belt, or horses passing the winning post.

CAPACITORS

A capacitor has two metal plates which face each other, are very close together, but do not touch. Between them is an insulating layer called the *dielectric* (Fig. 7). The dielectric may be air but it is usually a thin sheet of plastic, or a thin layer of a clinical substance.

When one plate of a capacitor is connected to a voltage source, electrons flow from the negative terminal of the source into one plate of the capacitor (Fig. 8a). The plate becomes negatively charged. The negative charge repels electrons from the other plate. They flow to the positive terminal of the source, leaving the atoms of metal with less than their proper number of electrons. The atoms thus have a positive charge. We say the plate is positively charged.

If the capacitor is then disconnected from the source, the capacitor remains charged (Fig. 8b). This illustrates one use for a capacitor, as a store or reservoir of electrical charge. The charge on a capacitor can remain there for a long time - it may be hours or even days before it all leaks away. Charge leaks away eventually as molecules of gas in the air become charged by contact with the terminal wires and are then repelled. There may also be a slow leakage of charge through the dielectric. The amount of charge stored in a capacitor can be very high, especially if the capacitor is charged to a high voltage. In these circumstances a charged capacitor can give unpleasant, and possibly lethal, electric shock if the terminals are touched.

Capacitors vary in the amount of charge that they can hold when charged to a given voltage. Think of a capacitor as being something like a water tank. The depth of water in the tank represents the amount of charge stored. In Fig. 9a we have a tank of small capacity; the water level is high but the amount of water in it is small. In Fig. 9b we have a tank of large capacity. The water level in it is not as high as in the first tank but the amount of water in it is much greater.

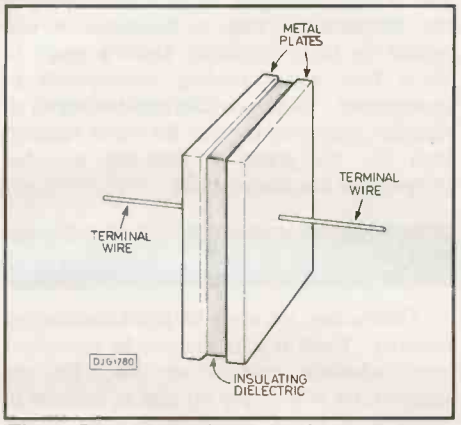


Fig 7. Structure of a capacitor.

Fig 9. Which tank contains more water?

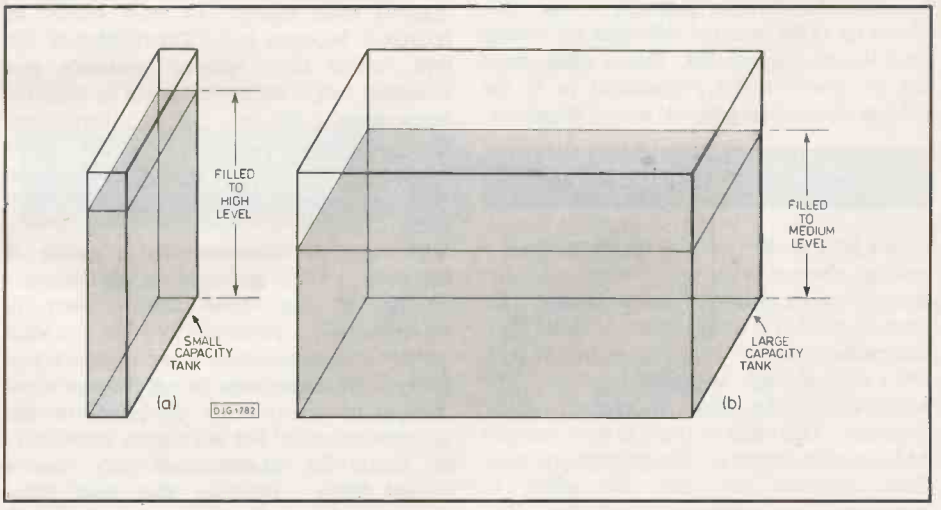
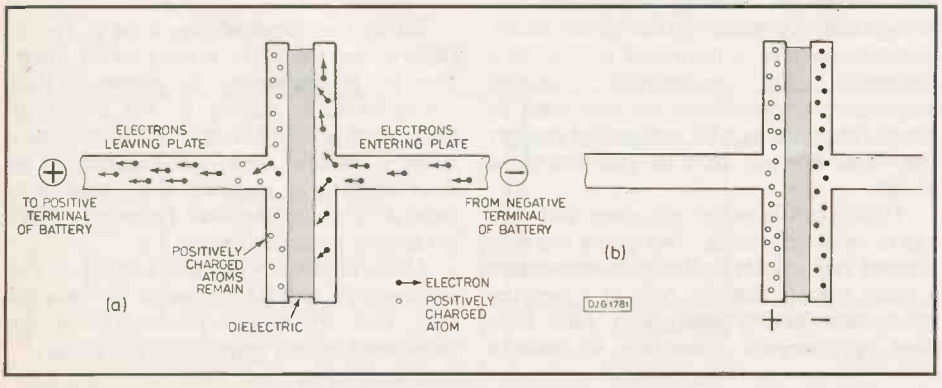


Fig 8 (a) Charging a capacitor, (b) charged capacitor.



The capacitance of a capacitor is related to the amount of charge it holds when charged to a given voltage. If two different capacitors are both charged to 6V, for example, the one with the larger capacitance holds more charge. Capacitance is expressed in farads (symbol F), named after Michael Faraday, a pioneer in the study of electricity. The unit is rather a large one for most practical purposes so we usually rate capacitance in smaller units:

* microfarad, symbol uF, equal to a millionth of a farad
* nanofarad, symbol nF, equal to a thousandth of a microfarad
* picofarad, symbol pF, equal to a thousandth of nanofarad

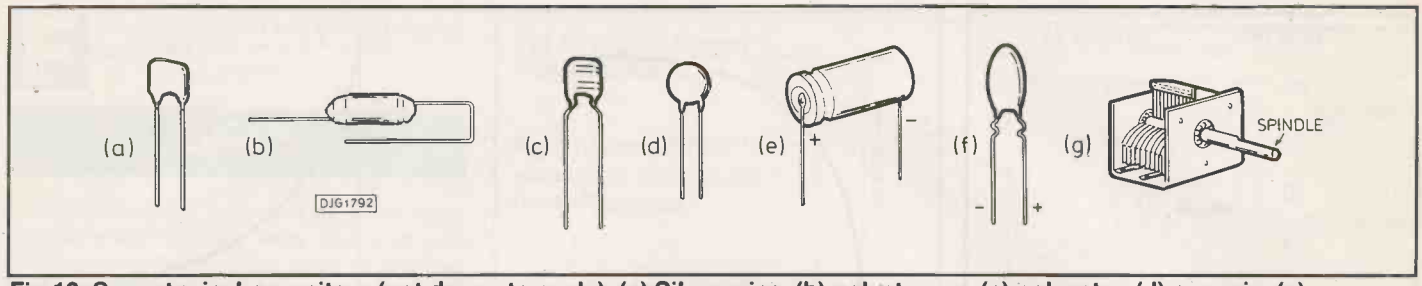


Fig 10. Some typical capacitors (not drawn to scale). (a) Silver mica, (b) polystyrene, (c) polyester, (d) ceramic, (e) electrolytic, (f) tantalum, (g) variable.

Fig. 10 shows some of the capacitors used in electronic circuits. The silvered mica capacitor (a) is formed of sheets of mica, a transparent non-conducting mineral, coated with a thin layer of silver to form plates. These have only small capacitance, but are very stable.

Polystyrene capacitors (b) have plates of metal foil interleaved with thin sheets of polystyrene. The plates are rolled to make the capacitor more compact. Their properties are similar to those of silver-mica capacitors.

Polyester and polycarbonate capacitors (c) have polyester or polycarbonate dielectric. They are inexpensive and used as general-purpose capacitors in the medium ranges of capacitance (10nF to 10uF).

Ceramic capacitors (d) have metal plates and a ceramic dielectric. They have high capacitance for their size and can withstand high voltages, but their capacitance is limited to about 100n.

In the capacitors described above, it does not matter which plate is made positive and which negative. We say they are *non-polarised* capacitors. For large capacitance we use *polarised* capacitors. The commonest type is the aluminium foil. In the first stage of manufacture they have paper soaked in an electrolyte between them. The plates are rolled and sealed into a cylindrical container. To complete the manufacture, a current is passed throught the capacitor. This causes a very thin layer of aluminium oxide to form on the surface of each plate. This is a non-conductor and acts as the dielectric of the capacitor. Because of the large area of the plates and the very thin layer of dielectric between them, these capacitors have large capacitance for their size. Capacitances of several thousand microfarads are made. They can withstand high voltages. Their disadvantages are (i) their tolerance is low (-20% to +50%); (ii) their capacitance may change with age and the amount of use; (iii) they are likely to explode if connected the wrong way round in circuit. (iv) they have a very high leakage current so lose charge fairly soon.

Tantulum bead capacitors (f) are made from particles of tantalum coated with oxide (the dielectric) and fused into a bead. They are polar capacitors. Their main advantage is that they have a very high capacitance for their size, so are particularly useful in miniaturised equipment. Their disadvantages are (i) low tolerance (-20% to +50%), (ii) low working voltage (up to 35V - less for higher capacitances), (iii) they are rapidly destroyed if the positive terminal is made more than 0.3V negative to the negative terminal.

Variable capacitors are used in tuned circuits. In one type (g), there are two sets of metal plates with air between them. One set is mounted on a spindle so that it can be turned to vary the area of plates that are opposite the fixed set. This varies the capacitance. Smaller versions of this, with plastic between the plates are made as low-capacitance trimmer capacitors. Another type of variable capacitor has a thin layer of plastic between the two interleaved sets plates.

A screw allows the 'pile' of plates and dielectric layers to be put under pressure. This compresses the dielectric, making it thinner so increasing the capacitance.

Investigation 3 *Charging a capacitor*

You need:
- battery box, 6V
- R1 22K resistor
- C1 4700µ electrolytic capacitor
- testmeter or voltmeter with 10V scale
- breadboard
- a fine felt-tip pen that will write on glass (but see below)
- a watch or a clock with second hands
- someone to help you

Connect the circuit of Fig. 11, as in Fig. 12. Take care to connect the capacitor the right way round, with its negative terminal wire (usually indicated by an arrow marked '-') connected to 0V.

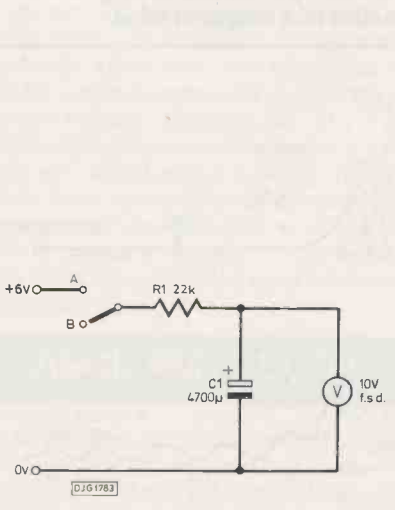
Ask your helper to time the investigation by calling out 'Now!' every five seconds, starting when you say 'Go!'. Things happen quickly in this investigation. The plan is for you to measure the voltage across the capacitor every five seconds when your helper says 'Now!'. The easiest way of doing this is to use a meter with a pointer, and a pen that can mark the glass or plastic cover of the dial. Every time your helper says 'Now!' mark the glass with a dot, level with the pointer. You will finish with a number of dots, showing the postion of the pointer every five seconds.

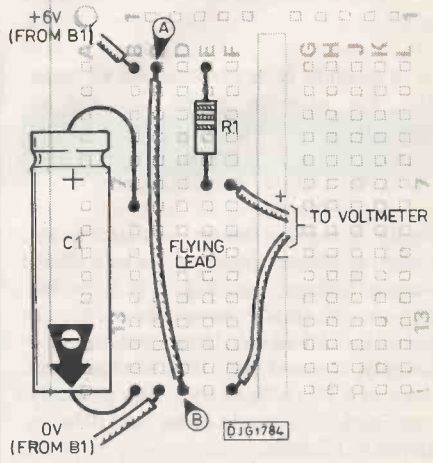
When the timing is over, you have time to work out what voltage corresponds to each dot. Alternatively, stick a paper label to the glass, so that the pointer shows beyond it, and mark the position of the pointer with pencil dots on the label. If you only have a digital meter, you will simply have to be very quick at writing down the readings - do a practice run first.

The flying lead is plugged into socket B and the voltmeter reads 0V to begin with.

When all is ready, push the flying lead into socket A and say 'Go!' at the same time. Your helper begins timing. Each time you hear 'Now!' mark the position of the pointer. As current flow through R1 and charges the capacitor, the voltage rises from 0V to 6V. Stop the timing when it has reached 6V, but leave the flying lead in socket B. Work out the reading for each dot and write the results in a table:

Circuit for Investigation 3, (Fig 11), and its breadboard layout (Fig 12).





Time (s)	Voltage (V)
0	0
5	
10	
15	
20 etc.	

Draw a graph of these results. Is the graph a straight line? If not, can you explain why? How long did the capacitor take to charge completely?

Now get ready to begin timing again. Put the flying lead in socket B and say 'Go!'. Mark the position of the pointer while the current flows through R1 to the 0V line and the capacitor becomes discharged. Stop timing when it has reached 0V. Work out the reading for each dot and write the results in a table like the one above. Draw a graph of your results. Is the graph a straight line? If not, can you explain why? How long did the capacitor take to discharge completely?

Repeat the whole of the above using a capacitor of different value, say 1000µF or 10000µF. How do the timings compare with those for the 4700µF capacitor?

Repeat using the 4700µF capacitor, but using a 27k resistor for R1.

CHARGING A CAPACITOR

The investigation shows that the time taken to charge the capacitor depends on:

* the capacitor - the larger its capacitance, the longer the time.

* the resistor - the greater its resistance, the longer the time.

For any given combination of capacitor and resistor we define a quantity known as the *time constant*, t:

$t = RC$

t is in seconds, R is in ohms, and C is in farads. For example in the first run of *investigation* 3, R = 22000, C = 0.0047, so:

$t = 22000 \times 0.0047 = 103s$ (approx)

Theory shows that the time constant is the time taken to charge the capacitor to 63% of the supply voltage (see Fig. 13). In the investigation it should have taken 103s to reach 3.78V (63% of 6V. If you were to use a 10V supply, it would take 103s to charge the capacitor to 6.3V (63% of 6V). You probably did not obtain a result close to 103s in *investigation 1* because:

* the tolerance of electrolytic capacitors is very low, -20% to +50%.

* an inexpensive meter takes a high proportion of the charging current that should have been going to charge the capacitor.

There is more about the time constant in future issues.

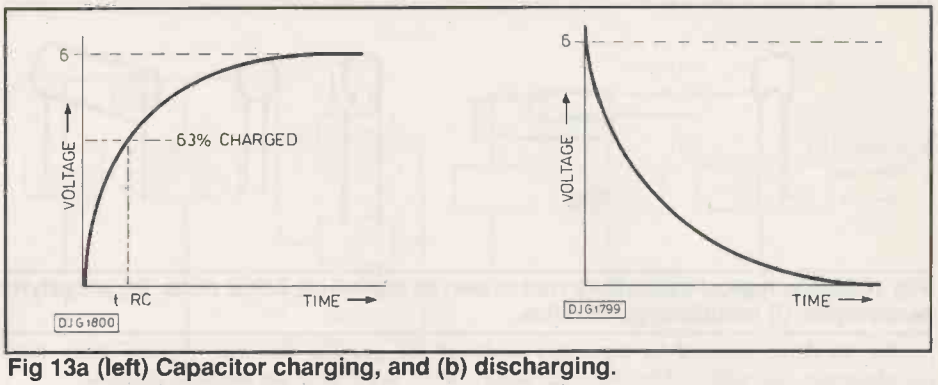


Fig 13a (left) Capacitor charging, and (b) discharging.

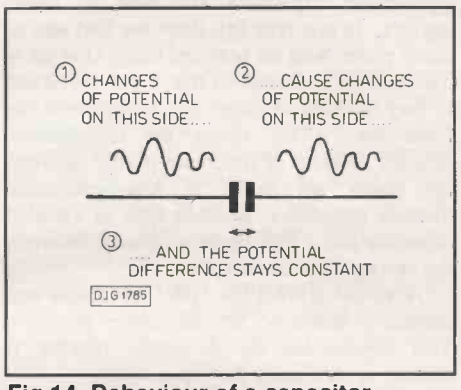


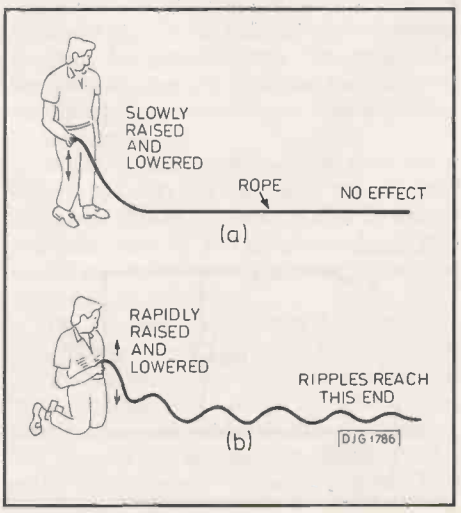
Fig 14. Behaviour of a capacitor.

CAPACITOR COUPLING

One of the properties of a charged capacitor is that it maintains the potential difference that exists between its plates. If the potential of one plate is made to rise, the potential of the other plate rises too and by the same amount. So, if an alternating voltage is applied to one plate of a capacitor, the voltage on the other side alternates too (Fig. 14).

In this way a capacitor is used to *couple* two parts of a circuit, so that signals can be passed from one part of a circuit to another.

Fig 15. Comparing a coupling capacitor to a length of rope.



One might wonder why the signal could not more easily be passed from one part to the other part along a piece of wire! The reason for using a capacitor is that the voltage on the two sides of the capacitor need not be the same. One part of the circuit may work best at one voltage and the other part work best at a different voltage. The insulating dielectric of the capacitor 'keeps the different voltages apart'. But it does not prevent a rapidly alternating voltage on one side from appearing on the other side.

The coupling effect depends on frequency. Think of the coupling effect as being like a piece of flexible rope lying on the ground. If we *slowly* raise and lower one end of the rope repeatedly, nothing happens at the other end (Fig. 15a). But if we rapidly shake one end of the rope, oscillations travel along the rope to the far end (Fig. 15b). The higher the frequency, the stronger is the oscillation signal reaching the other end of the rope.

Similarly, the higher the frequency of voltage change on one side of a capacitor, the stronger the signal reaching the other side. Conversely, the lower the frequency, the weaker the signal. This includes the extreme case, zero frequency, in which a constant voltage on one side has no effect at all on the voltage on the other side.

Summing up, we say:

Capacitors block low-frequency signals but pass high-frequency signals.

INDUCTORS

An inductor consists of a *coil* of wire, usually wound on an iron core. When a current flows through the coil a magnetic field is produced in and around the core (Fig. 16). The effect of the magnetic field is to oppose any change in the current flowing through the coil. The action of an inductor is like that of a rather soft rubbery hose (Fig. 17). Someone turns on the tap and a steady current of water flows out of the other end. If the tap is *slowly* opened and closed a little, repeatedly, the water current through the hose slowly increases and decreases repeatedly. But if the tap is opened and closed very fast (at high frequency), the rapid alterations in current are absorbed by the elasticity of the hose. The current continues to flow steadily out at the far end. The steady current flowing out is the *average* of the varying current that comes from the tap.

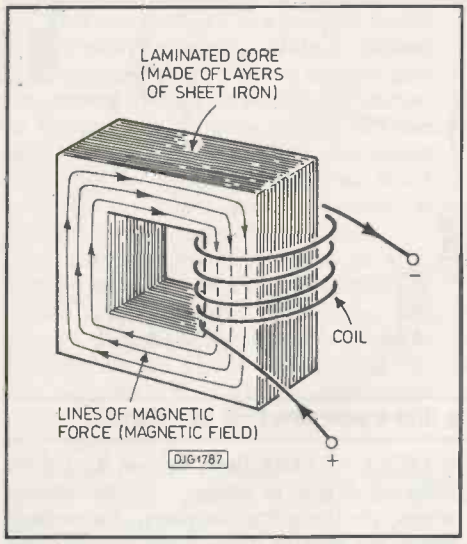


Fig 16. An inductor. Only a few turns of the coil are shown.

In the same way, a steady or slowly changing current flows through an inductor without alteration. But rapid changes in the current are damped down or choked. An inductor is often known as a *choke* for that reason. The extent to which an inductor is able to choke high-frequency variations in the current is called its *inductance*. A low-inductance corresponds with a short hose, in which current variations are not completely damped (Fig. 17c). A high inductance corresponds with a long hose, which chokes variations of all but the lowest frequencies. An inductor of high inductance usually has a coil with many turns of fine wire wound on a massive core.

As in the example of the hose, the choking effect is greater as frequency increases, so we can sum up by saying:

Inductors block high frequency signals but pass low-frequency signals.

Contrast this with the statement about capacitors, appearing above.

Inductors are not used in electronics as much as they were formerly. One of their big disadvantages is the size and mass of the core. This makes them unsuitable for use in miniaturised and portable equipment. A later part explains how small integrated circuit amplifiers are used to perform the same function as large inductors. However, in radio-frequency circuits, which have very high frequency oscillations, the inductors do not need to be large, and are preferred in such applications.

INDUCTIVE COMPONENTS

These include relays, electric bells, moving-coil meters, solenoids, and loudspeakers. They all depend for their action on the magnetic field produced when a current passes through the coil:

* in a *relay* the field attracts a moving *armature* which moves the contacts of a switch (Fig. 18) some relays have several switches that are opened or closed when the coil is energised. *System of the Month* demonstrates how relays are used.
* in an *electric bell* the armature moves the striker which hit the bell.
* in a *solenoid* the core is partly out of the coil to begin with. When a current passes through the coil, the core is pulled into the coil (Fig. 19). The core is attached to part of a mechanism and makes it move.
* in a *loudspeaker* the coil is surrounded by a magnetic field usually produced by a strong permanent magnet. When current passes through the coil, the coil moves. This is attached to the cone of the loudspeaker, which vibrates. If the frequency of vibration is in the audio range, sound is heard.

The inductance of an inductive component can often be a nuisance in a circuit. This investigation shows why.

Investigation 4 *an effect of inductance*

You need: battery box (6V)
LP1 a neon lamp, one of the small type used as pilot lamps will do.
L1 an inductance, such as a choke coil e.g. from a car or old radio set, a transformer coil, a coil from an electric bell, a solenoid, or relay coil
breadboard.

Set up the circuit of Fig. 20. Switch on. Does the neon lamp light? Watch carefully as you switch off. What happens?

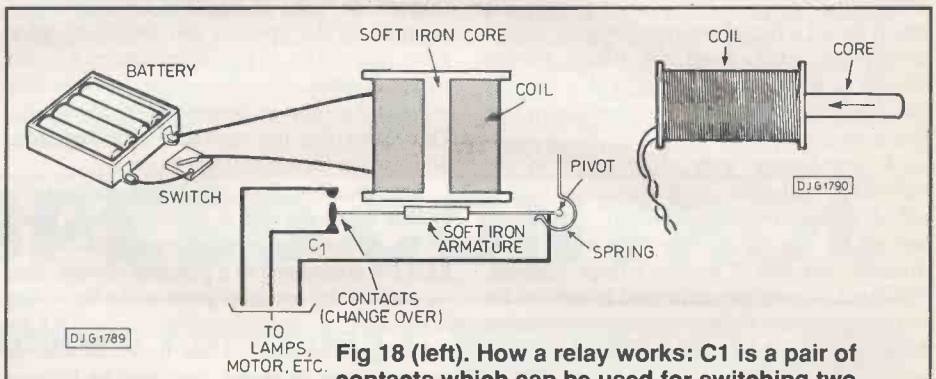


Fig 18 (left). How a relay works: C1 is a pair of contacts which can be used for switching two separate circuits. Fig 19 (above). A solenoid.

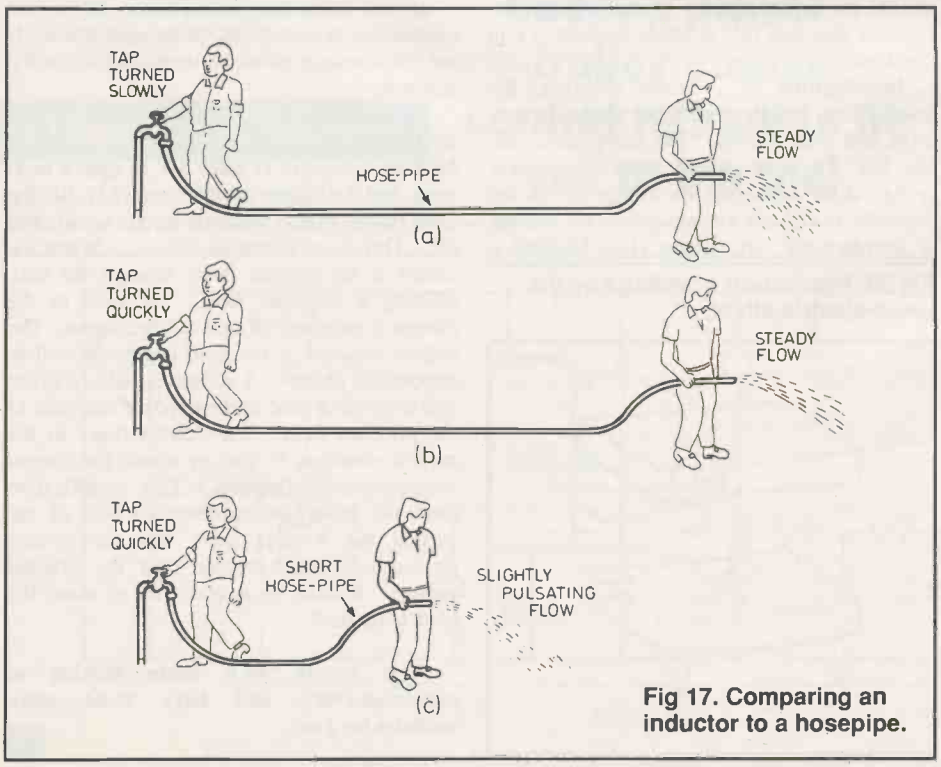
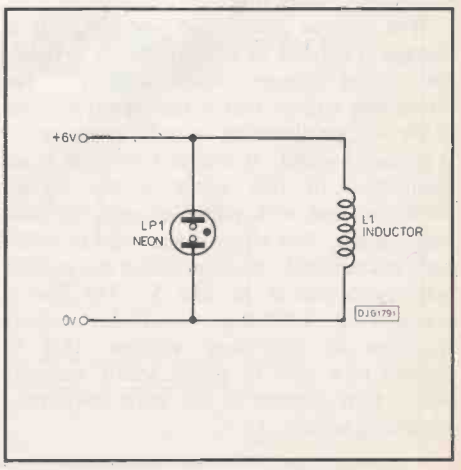


Fig 17. Comparing an inductor to a hosepipe.

Fig 20. Circuit for Investigation 4.



TRANSFORMERS

One further application of induction is the transformer. This has two, possibly more, coils wound on one core (Fig. 21). When a steady current (ie direct current) flows through one coil it generates a magnetic field in the core. But, since the current is constant, the magnetic field is constant and has no effect on the other coil, this produces an alternating magnetic field. The fact that the field is always changing in strength results in a current being *induced* in the other coil.

The coils of a transformer are referred to as the *primary coil* (the one to which a current is supplied) and the *secondary coil* (the one in which a current is induced). If the coils have the same number of turns the voltage in the two coils is the same. If the secondary coil has fewer turns than the primary coil, the voltage in the secondary coil is less than that in the primary coil. The effect is like a see-saw that is not pivoted at its centre (Fig. 22a). As side P (primary) moves up and down a large distance, side S (secondary) moves up and down a small distance. A transformer like this is called a *step-down transformer*. Such a transformer steps down the mains voltage (240V) to a lower voltage (eg 12V), suitable for operating electronic devices from the mains supply (240V).

A transformer with more turns in the secondary coil than in the primary coil is called a *step-up transformer*. It is like the see-saw of Fig. 22b. Side P moves a short distance, but side S moves a large distance. This kind of transformer is used to step up the voltage from the generator of a power station before the power is fed to the distribution network.

PIEZO-ELECTRIC EFFECT

This depends upon the properties of certain types of material including crystals of quartz. When such a crystal is subject to mechanical forces, its shape is slightly altered. This causes a voltage to be generated beween one face of the crystal and the opposite face. This is known as the *piezo-electric effect*. If contacts are attached to opposite surfaces of the crystal, this voltage can be used in electronic circuits (Fig. 23).

The reverse effect also operates. If a voltage is applied to a piezo-electric crytstal, the crystal changes shape slightly. An alternating voltage makes the crystal vibrate. If the voltage alternates at audio frequencies, it produces sound. A common example of an application of this effect is the crystal earphone used with portable radio sets and tape-players. The effect is also used in solid-state buzzers and sirens, including the audible warning device of Module 5. The device contains a solid-stage oscillator which produces an alternating voltage. This is applied to a slice of piezo-electric material which then vibrates at the same frequency, producing sound.

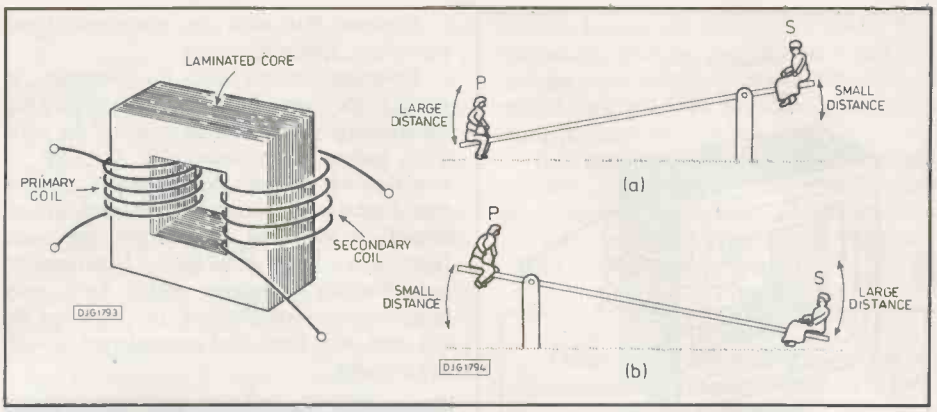


Fig 21 (left). A transformer, and comparing it to a see-saw (Fig 22 - right).

ANSWERS AND DISCUSSION

Power: (1) P = 8 x 240 = 1920W. (2) I = V/R =100/2000 = 0.05A; P = IV = 0.05 x 100 = 5W. Use a 5-watt or higher wattage resistor.

Investigation 1: The voltage rises as the temperature rises. If R1/R2 is considered as a potential divider, then we can use the equation given previously. In this investigation, Vin and R2 are constant. Therefore, if we find that Vout is rising this must be because R1 is decreasing. This shows that the resistance of a thermistor decreased as the temperature increases.

Investigation 2: In bright sunlight the voltage falls very low, to about 0.005V. When the ldr is shaded the voltage rises to 5.75V. If R1/R2 is considered as a potential divider, then we can use the equation given at the beginning of this Part. In this investigation Vin and R1 are constant. Therefore, if we find that Vout is rising as light decreases, this must be because R2 is decreasing. This shows that the resistance of an ldr decreases as the light decreases. If R1 and R2 are exchanged, the Vout changes in the opposite direction (6V in bright sunlight, 1V in the shade).

Investigation 3: When charging, the voltage rises rapidly at first but gradually rises more and more slowly. The curve looks like Fig. 16a. The reason for the shape of the curve is that, at the beginning, the voltage across the capacitor is OV; the voltage across the resistor is therefore 6V. A current (1 = 6/22000 = 0.00024A = 0.24mA flows through R1 and the capacitor begins to charge. As the voltage across the capacitor increases, the voltage across the resistor falls. Less current flows through the resistor and the capacitor charges more slowly. Charging is not as fast as it should be because some of the current passing through R1 goes to the meter (unless you are using a meter with a fet input, such as a digital voltmeter). Charging takes about 3-4 minutes.

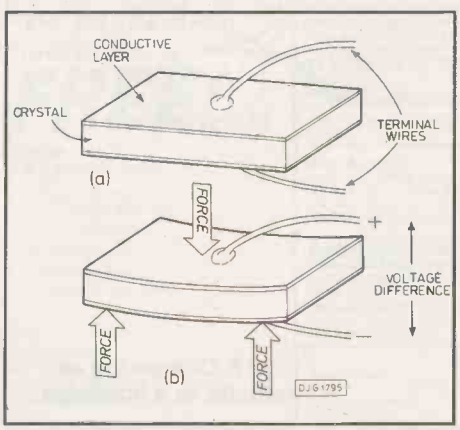
When discharging, the voltage falls rapidly at first, but gradually falls more and more slowly. The curve looks like Fig. 16B. The reason for the shape of the curve is that, at the beginning, the voltage across the capacitor is 6V; the voltage across the resistor is therefore 6V. A current (again 0.24mA) flows through R1 and the capacitor begins to discharge. As the voltage across the capacitor decreases, the voltage across the resistor decreases. Less current flows through the resistor and the capacitor discharges more slowly. Discharging takes 2-3 minutes. Discharging is faster than it should be, and faster than charging, because some of the current passes through the meter (unless you are using a meter with a fet input, such as a digital voltmeter).

If we substitute a capacitor of higher capacitance in this circuit, charging is slower. If we use a resistor of higher resistance, charging is slower.

Investigation 4: The neon lamp does not light when the circuit is switched on. This is because it requires at least 70V to light a neon lamp, and the battery provides only 6V. But the lamp flashes briefly when the circuit is switched off. This is explained as follows. When the circuit is on, current flows through the coil, creating a magnetic field. As soon as the current is switched off, this field collapses. The sudden removal of the field causes the coil to oppose this change. A current is *induced* in the coil to create a field in the opposite direction to the previous field. The current flows in the reverse direction to that in which the current was previously flowing. This investigation does not show the reverse direction of the current but it does show that the voltage produced is much higher than the original voltage. It must be at least 70V to make the neon lamp flash.

Next month we'll begin looking at semiconductors, and have some more modules for you.

Fig 23. Production of voltage by the piezo-electric effect.



Display News

P.E. EXTRA!

Published Bi-Monthly | Issue No. 3PE/89 | Selected Distribution

WELCOME READERS!

PRACTICAL ELECTRONICS

This 12 pages is a small sample of *Display News* which we mail to our customers every 6 - 8 weeks. If you would like to order from it use the form below, telephone and use your credit card or drop us a line. Either way you will automatically be put on our mailing list and will receive future editions free. In the unlikely event that you find nothing to interest you this time, then you can write and request to be placed on our mailing list anyway!

We hope that you will join us and enjoy the greatest surplus bargains and the best service and backup available.

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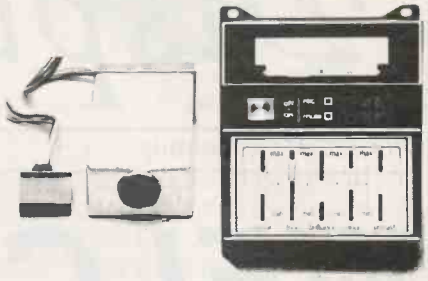
Ultrasonic Control Assembly



These TV sub-assemblies were made for Doric/Rediffusion. Even though they are brand new they are sold at a parts recovery price, as we have no data on them. There are four main sections to the assemby. Most importantly, is a stand alone ultrasonic receiver. It can be taken out by removing only two screws and comes complete with a plug on the end of its flying leads. It is shown removed in the photograph. It should work fine with the transducer listed elsewher in this issue of *Display News*. The second section is a switch, mechanically controlled by the square button shown in the photograph. It may also be switched off by a solenoid which is activated by a pulse from the ultrasonic receiver. In other words the switch may be manually set and reset, or alternatively remotely reset by the solenoid. The third section is a bank of five slide potentiometers mounted on a PC board, complete with dress up knobs. Finally there is a standard degaussing panel and fuse.

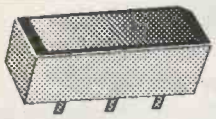
All for only..... £6.95! (B)

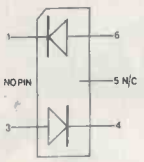
Digital Clock Modules

This is really a kit - not only do we supply the clock module as shown but also the correct mains transformer to power it, two rectifiers and a data sheet. Add push button switches to suit your requirements and you have a functioning clock with optional alarm and snooze capabilities. It will even control a radio for you! Features a bright 4 digit 1/2" high LED display, easily readable in room light. Power failure indication and brightness control features are also included. The board only measures 3" x 1-1/2" and the transformer just 2" x 1-1/2", so a nice compact clock can be assembled. To make life even easier, as an option we will include five microswitches for only £1.50 when ordered with the module - add MSC to your order. The data sheet is full, not only for the board but also with the connections for the transformer, switches and diodes. Everything you need in one package!

Now Only: **Module & Transformer: £7.95 or 3 sets for £22** (A)

Jumbo LEDs





These are both high intensity attention getting jumbo size LED's. JL-1 shown on the left, contains yellow LED's in a flat top package similar in size to an integrated circuit. JL-2 on the right is red with a large dome top. The pins of both fit standard Veroboard and mount flush to the board. Although JL-1 contains two LEDs and JL-2 has six, they both seem to be of the same intensity and would dress-up any panel! JL-1 is 5/8"L x 1/4"H x 1/4"W. JL-2 is 7/8" diameter by 5/8" high.

Either type £1.50 each. 5/£6.95. 50/£62 (A)

XT / AT Switchable Keyboard

A replacement or backup keyboard for IBM PC, PC-XT or PC-AT, all in one! It has a switch on the rear to convert betwen models! LED indicators for Caps,Scroll & Num Locks. Standard 10 function keys plus 56 on the main bank and 19 on the keypad, 85 in all. Made by NCR for the English & US markets. **Absolutely standard.** Brand new & boxed with manual and key template for user slogans on the function keys. Attractive beige, grey and cream finish, with the usual retractable legs underneath. A generous length of curly cord, terminating in the standard 5 pin DIN plug. A beautiful clean piece of manufacturers surplus. What a deal!

BRAND NEW AND BOXED!

£49 each (B) **2 for £95** (C)

12" Green Screen Chassis Monitor

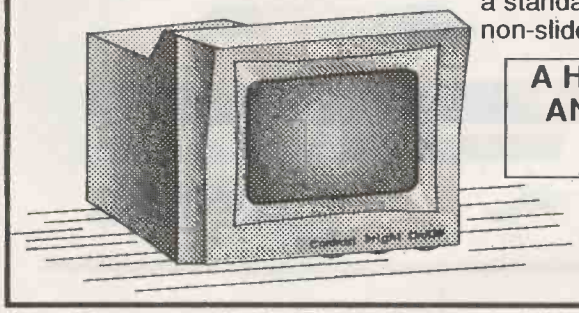
What a price! A brand new and boxed Wang 12" green screen monochrome monitor chassis. And an added plus - it has a composite video input so should be compatible with the earlier IBM PCs which had composite output. Also of course fine with other composite machines. The CRT is adjustable for tilt so that you can box it pretty much as you want. Requires 12vdc.

Now only £29 each or 2 for £50 (F)

Quality Surplus and Support - only at Display!

The Best Prize Deal!

There has never been a deal like this one! These are brand new and boxed 9 inch green screen monitors made by NEC. They were manufactured to a very high specification for a famous company that uses banks of them day and night - and the quality features of the monitor show it. They have deep etched screens for eyeresting non-glare use and the case is so designed that any overhead light is shadowed by the lip of the top of the front escutcheon. It also has easy to reach but unobtrusive contrast, brightness and On/Off front panel controls. The case is made of tough plastic with a carrying ledge incorporated into the case design for easy portability if required.. Total reliability for continuous use is built in. They have a standard composite 75Ω input and a switch to optionally route this to a high impedance circuit so that a number of monitors can be daisy chained on one line without pulling it down. An output socket is provided for daisy chaining, if required. Both input and output sockets are standard BNC. There is a generous allowance of controls brought out to the rear panel, namely H-hold, V-hold, V-height, V-lin. Sub-brightness and HF-Peak. The monitor is powered by 220/240v AC by way of a standard male chassis socket. Four oversize rubber feet provide a completely non-slide grip. The overall dimensions are 11" x 11" x 11".



A HIGH QUALITY MONITOR AT AN UNHEARD OF PRICE - AND BRAND NEW AND BOXED - STRAIGHT FROM THE MANUFACTURERS NEC.

Only £39.95 (D)

The Amazing "Telebox"

Turns most computer monitors into A QUALITY COLOUR TELEVISION

Computer type video monitors, are by necessity, constructed to a much higher standard than domestic television receivers. Better electronics and far higher definition CRT tubes are chosen to give long term reliability and superior picture quality. Very often, costly computer type monitors are under-utilised by being dedicated to a particular computer system - and then only being used for computer purposes. With an incredibly small outlay of **only £29.95** the Display Electronics **TELEBOX** will enable that very same, dedicated computer monitor to be used for a host of other audio visual applications, giving more effective use of equipment, and making smaller budgets stretch that much further.

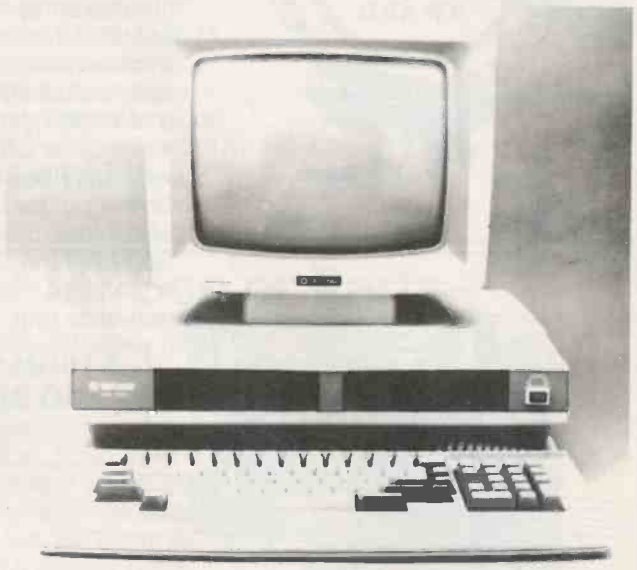
The **TELEBOX** consists of an attractive fully cased unit, containing all electronics ready to plug into a host of video monitors made by manufacturers such as MICROVITEC, ATARI, SANYO, SONY, COMMODORE, PHILIPS, TATUNG, AMSTRAD and many more. Push button controls on the front panel allow reception of 7 fully tuneable off air UHF colour television or video channels. Composite and RGB video outputs are located on the rear panel for direct connection to most makes of monitor. For complete compatability - even for monitors without sound - an integral 3 watt audio amplifier and low level Hi Fi audio output are provided as standard.

Order as:	TELEBOX ST	For monitors with composite video input	£29.95
	TELEBOX STL	As ST but with integral speaker	£34.95
	TELEBOX RGB	For use with analogue RGB and composite monitors	£65.95 (B)

Colour when used with Colour CRT. RGB version NOT suitable for IBM /PC or clone type colour monitors.
Data sheets on request. PAL overseas version please call. SECAM not available

The Fabulous Tatung

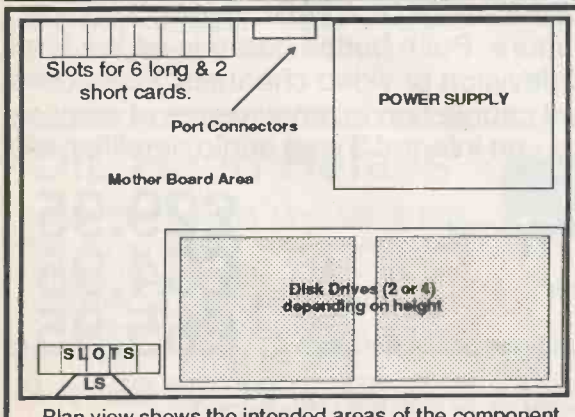
- ***Twin 80 track double sided 5½" floppies - 1 mgbyte per drive***
- ***Port for add on 8" drives***
- ***Both serial and parallel ports***
- ***Dual processor***
- ***Supplied with CP/M free***
- ***Bundled software free***



The Tatung TPC-2000 is the big brother of the famous Einstein computer. It is a modern stylish three piece system comprising an ultra thin 92 key keyboard, a 12" green non-glare etched screen monitor and an attractive console, all as shown in the photograph. Not only does the TPC-2000 come with two built in Teac 55F high density drives, giving 2 megabytes storage in total but a port is also supplied for the addition of up to four standard 8" drives either in double density or IBM format.
The central microprocessor is the faster version of the Z80, the Z80A, with 64K of directly addressable RAM. A system expansion port is provided for, amongst other things, the addition of a simple TTL input/output board so that the computer can convert to an industrial controller and many other external applications.
The serial port is standard RS-232 and the parallel, standard Centronics. The keyboard features 32 user definable keys, a numeric keypad plus text editing keys. It also features its own integral microprocessor for keyboard entry processing, thus freeing up the CPU for other, and faster, work.
The TPC-2000 was manufactured by Tatung for use in small businesses, educational establishments and home applications. It comes complete with CP/M, Wordstar and Basic and of course a full manual for the machine . Although this computer originally sold for £1400 a cancelled export order enables us to bring it to you at the amazing price of.....

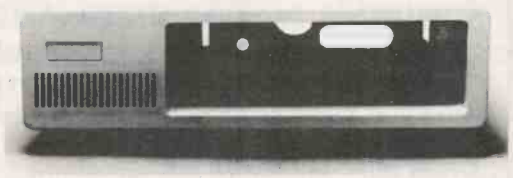
Only £299! (E)

BRAND NEW & BOXED!



Plan view shows the intended areas of the component parts of a computer. Drilling and brackets fitted.

Computer Cases for IBM Compatibles & Others



Brand new IBM grey coloured computer cases. Standard PC size but suitable for almost any computer. The chassis is complete with mounting brackets and drilled. Platform and brackets for 4 half height or 2 full height 5-1/2" floppy or hard drives. A loudspeaker plus its lead and plug also included. Overall outside dims: 19"W x 15-1/4D x 5-1/2"H. Rubber feet and mains switch cut-out. Ready to be filled!

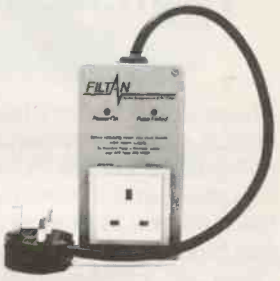
Only £34.95 (E)

Dram SuperSpecial!

4116	16K DRAM	250 nanosecond or better	75p each or 100 for £59.00
4164	64K DRAM	300 nanosecond or better	9 for £6 or 18 for £11.50
		200 nanosecond or better	9 for £8 or 18 for £15.50
		150 nanosecond or better	9 for £10 or 18 for £19.00
41256	256K DRAM	150 nanosecond or better	9 for £27 or 18 for £52
		120 nanosecond or better	9 for £32 or £18 for £57

All Drams are shipping code (A). **Call for larger discounts on higher quantities.**

Mains Suppressors and Filters



Clean your power of interference that causes so much inexplicable trouble - always just when you don't need it! The "Filtan" from Crotan is a British made high current mains spike suppressor and RF filter in one, capable of handling up to 10 amps! It also eliminates spike and surges from both the common and transverse modes of the supply. The attractive case has an integral 13 amp socket for your equipment plug and the flying lead terminates in a quality plug (to BS 1363A standard) to go to the mains socket. There is an internal fuse plus one in the plug. Both are replaceable. Two LED indicators are provided, one for power "on" and the other lights if the internal fuse fails, which is a nice touch. Measures 6" x 3" x 2". A suppressor/filter for those of you who want to take no chances with their equipment and data! Brand new. In Inmac's catalogue at £65.00!

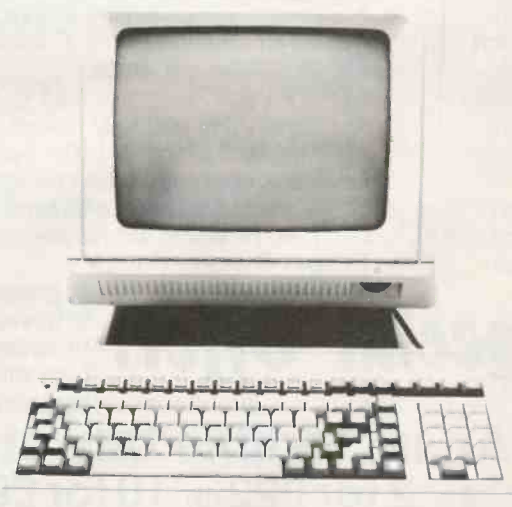
Model 6/N/230 Filtan from Crotan. Virtually identical to the above but the socket on the front, which accepts the equipment plug, and the mains lead are both fitted with the Continental type two pin round socket and plug. Rated at 230 vac at 6 amps so it is more than capable of coping with most computer set ups.

Either type: £15.95 each or 2 for £29.95 (B)

Belling-Lee type L2127 mains RFI filters rated at 250 volts 3 amps maximum. Comes complete with a built in mains cable (English coding), and a three pin miniature non-reversible socket and a mating plug, to go to the equipment. Ideal for those who are bugged by RF interference. Very compact. Dims 3-1/8" x 2.5" x 1.5".

£3.95 each or 3 for £10 (A)

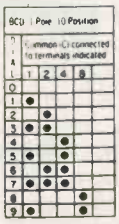
High Performance Microprocessor Controlled Computer Terminal



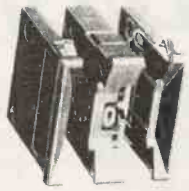
Model 6402/12 high performance video terminal, complete with slimline keyboard, intended to be connected to a host computer. This unit is loaded with sophisticated features including text editing capability. The RS-232 or 20ma current loop interface to the host computer can be set up from the keyboard via a Menu selection which has additional options for setting the serial printer port configuration, keyboard operation, edit mode parameters and screen configuration. Baud rate to the host can be set at any of the standard rates from 50 to 19,200. Communication is keyboard selectable for half or full duplex, 7 or 8 bits with 1 or 2 stop bits. Parity may be selected for odd, even, none, mark and space. Protocol is X-on/X-off, DTR with RTS control in block mode. Connection to the host is via a standard 25 way D connector, as is the printer. With all the options available, and as they are so conveniently selectable, the terminal should be OK with most host computers. The text editor includes the normal cursor control plus line insertion or deletion, line or page edit and character insert and delete and has four modes for line or block blinking or steady. Tab setting and other WP features are also included. A special Wordstar mode is selectable. The screen memory option permits 4 screens of one page each. RAM is non volatile so that the terminal set up and status is retained after power down. The monitor is 12" with swivel/tilt and the screen non-glare green phosphor with 80 columns by 25 lines, the 25th reserved for status information. The keyboard is 103 key, including 11 function keys and 7 keys dedicated to the text editor. Little or hardly used condition, complete with manual and 30 day guarantee. All in all this terminal contains pretty well all of the features which you could want - especially the price!

A Gift at only .....£129! (E)

Miniature Thumbwheel Edge Switches

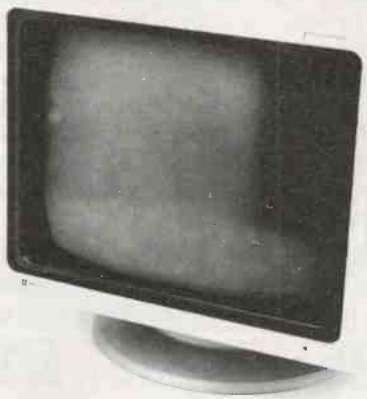


Binary Coded Decimal thumbwheel switches. This is a quality heavily gold plated single pole 4 position (1-2-4-8) 10 station switch that makes contact in accordance with the decimal/binary code table shown. The wheel is matt black with decimal 0 to 9 engraved in white. The switches are end stackable to make up as many digits as required, with cheeks at each end. Switch action is break before make and rated at 0.5 amp max. Measures only 1-5/8"L x 1"H x 1/4"T.



Switch: £2.95 ea. 4 for £11. 8 for £22. (A **End cheeks: 75 p per pair.**

High Resolution 14" *Green* or *Amber* Monitors



These are extremely high resolution monochrome 14" monitors with your choice of either green or amber screens. They are suitable, and plug compatible, with all PC's fitted with a Hercules or equivalent card. It comes equipped with a modern type swivel/tilt base and a laser etched matt non glare screen to give excellent readability and super high definition. With this high resolution you needn't worry about the quality of your graphics - they are unbelievable! The text is easy on the eyes too! An extra bonus is that the integral power supply provides positive 5 and 12 volts outputs for powering two disk drives or whatever. This supply is brought out to two standard Molex disk drive sockets at the back of the monitor. On top of all these features, a large volume purchase lets us sell at a price way below even low resolution monitors - let alone one that will power disk drives! They are brand new and boxed and made by a well known company in Italy. State whether Green or Amber. Large quantity ex-stock - excellent discounts available.

Green Screen: £69 **Amber Screen: £79** (E)

Cooling Fans

Please specify 110 0r 240v for AC fans.

3 inch	AC. 1.5" thick	£ 8.50 (B)
3 inch	AC 240v. Papst Slimline 25mm (1") thick. Low noise	£ 9.95 (B)
3.5 inch	AC. ETRI Slimline - only 1" thick.	£ 9.95 (B)
4 inch	AC 110/240v. 1.5" thick.	£10.95 (B)
4 inch	AC 1.5" thick	£ 9.95 (B)
4 inch	As above RFE and fully tested	£ 4.95 (B)
10 inch	AC. Round 3.5" thick. 110v. Special: suitable 230v transformer for mains operation when bought with this fan - £5.00 only.	£10.95 (B)
3 inch	DC 1" thick. Order no.812 for 6/12v or 814 for 24v.	£15.95 (A)
4 inch	DC 12v. 12 watts. 1.5 " thick.	£12.50 (B)
4 inch	DC 24v 8 watts. 1" thick.	£14.50 (B)

Special Offer! A beautiful little ultra slimline high performance 12 vdc 3.12 watt axial fan. It uses an electronically commutated brushless motor to give long life, very low noise and extra high efficiency operation. Measures only 92 mm square by an incredible 18 mm thin!

An incredible buy at only..... £14.95 (A)

2 for £22 (B). **10 for £95** (C). **100 for £650** (G)

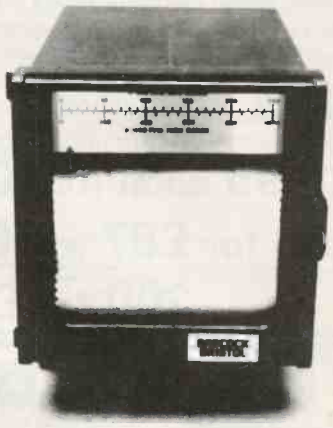
V22 1200 Baud Modems

We got a tremendous buy on further stocks of this popular **Master Systems 2/12** microprocessor controlled V22 full duplex 1200 baud modem - we can now bring them to you at ***half last advertised price!*** Fully **BT approved** unit, provides standard V22 high speed data comm, which at 120 cps, can save your phone bill and connect time by a staggering 75%! Ultra slim 45 mm high. Full featured with LED status indicators and remote error diagnostics. Sync or Async use; speech or data switching; built in 240v mains supply and 2 wire connection to BT. Units are in used but good condition. Fully tested prior to despatch, with data and a full 90 day guarantee. What more can you ask for - and at this price!!

Only £69! (D)

Precision Chart Recorder

Precision Chart Recorder Model WR6E by BABCOCK CONTROLS. A chart recorder has similar electrical characteristics to a volt or amp meter but records its output onto a moving roll of paper thus producing a permanent and accurate visual record in the absence of an operator. In the case of the WR6E this supurbly engineered unit features an electronic closed loop servo system and paper drive control (1 cm per 5 minutes) to give exceptionaly accurate measurements over long periods of time. Already fitted with an external shunt resistor of 75 ohms, the unit gives a linear FSD reading of 1mA. By using alternate series / shunt resistors the exceptionally high input impedance (typ 10 Mohms) will allow an almost infinate range of voltage/current measurements down to 75 mV FSD across the 4 inch paper roll scale!!. Many other features include: Fully sealed case with hinged glass window door, Panel mount or free standing, AC mains operation, Ink free chart recording system, Changeable scale plate etc. Dimensions 6"x 6"x 10" deep Supplied BRAND NEW at a fraction of its original cost...



Only £125 each (E)

Bundles

"Bundles" are assortments of various types of the same basic component. A bundle of relays for instance would contain the stipulated number of relays, of differing voltages, contacts and sizes. The majority of parts in a bundle are brand new, only a few are ex-equipment and only when they would present an extraordinary value to the customer. Bundles must be distinguished from Grab Bags which might contain any type of part.

Relays

You never have the right relay at the right time. Stock up at these prices! May be any mounting style. Single and multi pole, DC and AC, high or low voltages. But definitely a good mix !!

10 for £9.95 (B)

Integrated Circuits

A massive pool of ICs of all types makes this one of our most attractive bundles. Mostly dual in line, plastic and ceramic - digital and analogue many to military specifications. Op-amps and other linears, CMOS, TTL, LSI and others. Mostly regular types with some house numbers All fully guaranteed NO FALL OUTS. How can you go wrong at these prices?

100 for £11 - or - 200 for £20 (A)

Small Semi's

This bundle contains small semiconductors of all types. May contain small signal silicon transistors, LEDs of all shapes and sizes, diodes, character readouts and so on. All brand new of course.

100 for £7.95 - or - £500 for £35 (A)

Passives

All types of passive components includings pots, PC board mount resistor trimmers, variable and fixed capacitors, chokes, coils and many others. These passives are sold by weight. Very approximately 100 passives is equivalent to a half pound. Added bonus - six microswitches thrown in outside the weight!

½ kg for £7.95. 1 kg for £14 (A)

Crimp Connectors

Regular type crimp connectors, solder tags, solder lugs, spades, butt joiners open and closed ended etc - sold by the item in many car accessory shops for around 20p each !!! Our price

200 for £3.25 - or - 400 for £6 (A)

Quality Surplus and Support - only at Display!

U - Matic Video Cassettes

A scoop purchase allows us to bring you these Sony KCA60 U - Matic video cassette tapes which are normally so hard to find at a reasonable price. Especially in this professional grade, as used by TV stations, Universities and professional video companies. They are 60 minute length and are in excellent condition, having been used only once! They are supplied complete with standard plastic library cases.

£3.95 each (A). **10 for £22.50** (C)
50 for £87 (E). **100 for £125** (G)
200 for £180 (G)

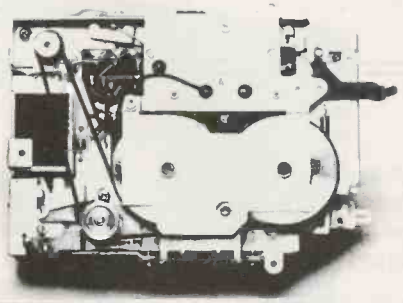
Miniature Ultrasonic Transducers

Two types of ultrasonic transducers, which are different only in the type of connection. UT-1 is an RCA female phono and UT-2 has two pins for solder or suitable socket. The resonant frequency is 40khz. Both types are 5/8" diameter. Ideal for ultrasonic experimenters and applications.

Either £1.95 each or 5 for £9 (A)

Extra High Quality Miniature Stereo Cassette Deck

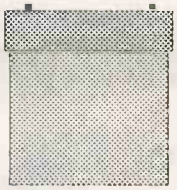
This is a professional type stereo cassette deck chassis featuring solenoid mechanism control and an ultra reliable drive motor from Mitsubishi. It also features auto-reverse and really nice firm mechanical action. We do not have any data (hence the price) but the connections are not hard to work out and it seems to use 12 volts DC. The front black lever is for fast forward and rewind; the lever to the right of it is for eject. Only measures 6" x 4-1/4 x 1-1/4".



£9.95 or 2 for £18 (B)

Heavy Duty Storage Battery

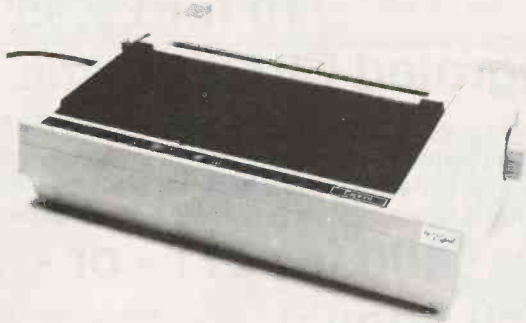
100 amp/hours at 6v!



A brand new heavy duty rechargeable battery made by Chloride, Powersafe Model CVB11. Sealed and maintenance free and complete with a snap-on security lid (not shown) for extra safety. Rated at 6 volts and 100 amp/hour. Measurements are 8"sq. x 9"H, including the lid. Connection is made by spade or bare wire as the lugs are nut on bolt. Perfect for backup or uninterruptable power supplies or as a portable 6 volt supply. Brand new and normally costing £80 - buy at under half price!

£39 each (E)

The Printer Bargain of The Century!



This amazing bargain is still on!

Only £99 each (E)

This has to be the bargain of the century. Hazeltine Esprint 100cps desktop printer with built in Centronics parallel and RS232 serial interfaces - and brand new in manufacturer's original cartons with manual, ribbon and power cord, just as if you bought it from Hazeltines distributor but at under a third of the cost! What's more it has full logic seeking bi-directional printing, 80 column printing, a nine wire head (9 x 11) and incremental printing. It has six integral character sizes including condensed and double width. Ideal for the European market as it features integral character sets for 7 of the EEC countries, all of them with the full 96 character set - no more searching for those funny accents and letters! You can use either tractor or friction feeds from 4.5 up to 10 inches wide paper. On top of all that this printer supports proportional printing in text mode and both single and double density bit image printing in the fully dot addressable graphics mode. This Esprint printer is the best deal in printers around and shows that we mean it when we say that only *Display News* brings to you genuine top of the line surplus bargains.

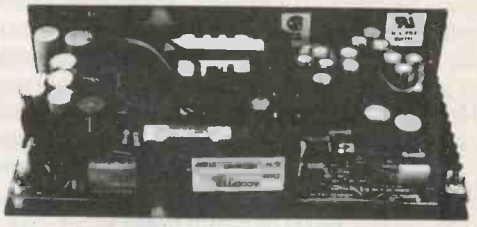
Panel Meters

Two panel meters. both about 2-1/2" square. PM-1, the one shown, is AC reading 0 - 300 volts graduated in 10 volt steps, which of course makes it particularly useful for direct mains reading. PM-2 is a DC dual scale meter scaled 0-15 vdc and 0-3 vdc. The basic movement is 1ma and therefore needs a 15K or 3K external resistor for full scale volts. We have a large quantity of PM-2 boxed in tens, so a special deal is available for that quantity! Both meter faces are very easy to read, even at a distance, with black markings on a bright white face.

PM-1... £7.95 or 3 for £21. PM-2... 2 for £3.95 or 10 for £15 (A)

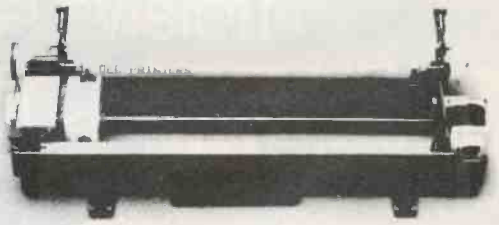
Switch Mode Power Supplies

This complete range of Switch Mode power supplies will cover all your applications. They are all similar in appearance to the photograph, which is of the 130 watt unit. They are also all dual input for 120 vac or 240 vac. The 60 watt unit is removed from equipment, tested and guaranteed. The other 3 are brand new.



Manufacturer and order No	Output Watts	Output VDC	Output Amps	Size	Price
Fine OP-8619	20	+5 +12 -12	2 1 0.1	5"L x 3"W 1-1/2"H	£15.95 (B)
Astec AC-8151	40	+5 +12 -12	2.5 2 0.1	6-1/4"L x 4"W 1-3/4"H	£19.95 (C)
Greendale 19AB0E	60	+5 +12 -12 +15 -15	6 1 1 1 1	8"L x 4"W 2"H	£24.95 (C)
Conver 130-300	130	+5 -5 +12 -12	15 1 6 6	10-1/2"L x 5"W 2-1/2"H	£49.95 (C)

Ball Point Pen Printer/Plotters



This is a full 40 character per line ball point pen printer plotter using standard 114mm wide paper. It is a high quality mechanism from Alps/ DED Ltd and comes complete with an 8 page data pack which includes the circuit diagrams for the simple electronics used to drive the stepper motors and pen control solenoid. It has two stepper motors to accurately control both paper and pen movement in either forward or backward directions enabling graphics and plotting to a resolution of 1/5th of a millimeter! Text printing is achieved by the mechanism lowering and raising the pen onto the paper then drawing lines in 0.2mm steps, giving extremely legible characters. Again this is carried out by the two stepper motors. Condensed characters can be printed at twice the number of characters per line giving 80 characters per line on paper only 4-1/2" wide!. Scaled enlarged characters are printed in a similar way. An additional feature of this model is that an integral sensor detects when the pen is at the carriage return position and closes a normally open switch, the contacts of which are available for external use. Typical print speed is 12 characters per second and plotting speed is 52mm per second in both horizontal and vertical mode. Along a 45 degree vector the speed is 73mm per second. Paper feed is approximately 6 lines per second. A single +5 vdc is used for power using under 1/2 amp.

AS RECOMMENDED IN EVERYDAY ELECTRONICS (Nov) FOR THEIR SEISMOGRAPH PROJECT!

£49 each or 3 for £120 (B)

Pens: Box of 4 for £5.50 (A)

Chassis Boxes

These are two part aluminium metal cases with an attractive hooded front and small lip at the bottom of the aperture which may be used as a support or for dressup, or it can be removed altogether. The overall dimensions are 7" x 7" x 2-3/4"H. The aperture measures 5"L x 1-1/2"H. There are two small flanges so that the box may be bolted down, if required. The box is finished in attractive matt black.

£3.95 each (B)

Quality Handtools for Electronics

SC-1 High quality US made diagonal side cutters by Hunter for electronic applications made of extra high quality semi-polished steel. 3/4" blade length with 3-1/2" insulated handles. Maximum jaw width at tips is 3/4". **£7.95 each**(A)

SC-2 Exactly the same as the above but miniature. 5/16" blade length with 2-1/2" insulated handles. Maximum jaw width at tips is 5/8". The nose is more tapered than SC-1. **£9.95 each** (A)

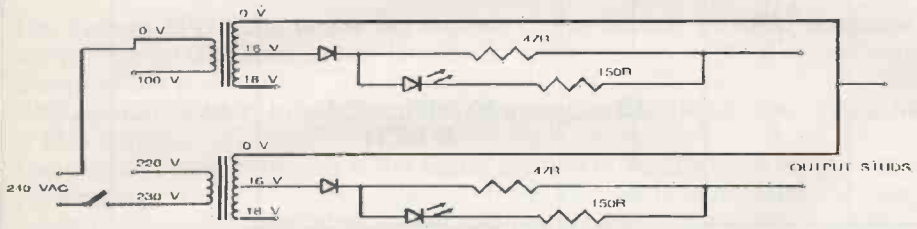
SD-1 US made quality slot head screwdriver from Challenger. High grade chrome plated steel round blade with flared tip. Yellow plastic grooved handle 3/4" diameter for a solid grip. The blade is 3-1/2" long. **£1.00 each** (A)

CT-1 Heavy duty precision hand tool for crimping 50 and 75 ohm connectors to RG-58/U, RG-59/U and RG-62/U coaxial cables. Manufactured from high grade steel with one movable and one fixed jaw plus ratchet release for ease of use. Normal distributor price for this precision tool is £60! **£29.95 each**(A)

Discounts: 5 to 10 less 5% (B). 11-25 less 10% (C). 26-100 15% (E). All tools may be mixed or matched for discounts.

Ni-Cad Battery Charger for Use or Parts

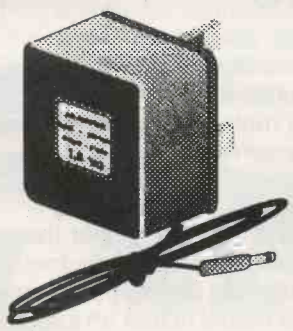
This is a useful piece of surplus. Originally intended as a 9 volt ni-cad battery recharger for walkie-talkies. One or two devices are stood on end in the box - connection being made by sprung loaded metal contacts in the bottom. It would be a simple matter to change this connection method and continue to use it as a charger or general purpose power supply. Alternatively it is well worth buying for the parts it contains. Apart from 2 LEDs and a subminiature toggle switch, a versatile transformer is included which a primary tapped at 110v, 120v and 230v. There are two identical secondary windings which are 0 - 16v - 18v each. So you finish up with a transformer which can be used on either 110v/120v or 230v mains with two secondaries of either 16 v or 18 volts or both!.



£6.95 (B) **each**

or 2 for £13 (C)

Heavy Duty Mains Adaptor

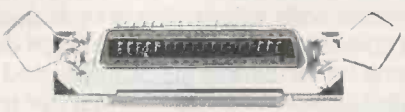


Heavy duty high quality 6 volts 1.8 va mains adaptor, UK made to BS415 Standard. Normal 13 amp integral plug with 7 foot lead terminating in a standard 2.1mm power plug. Measures 2.75" x 2" x 2". Do not confuse with cheaper adaptors because of the price!

£3.95 each

(A)

Centronics Connectors



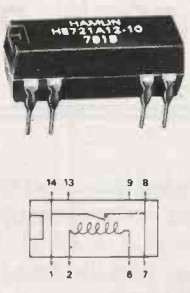
Regular 36 way Centronics type printer male plugs (CENP-1) and female sockets (CENS-1). The socket is a right angle printed circuit mount with metal shroud and retaining clip. The plug is a plastic shrouded insulation displacement type with shoulders to take the retaining clip.

£3.75 each. 4 for £14.

10 for £30 (A)

Types may be mixed as required.

DIL Reed Relays

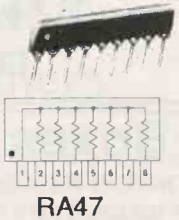


Lovely little Dual In Line single pole normally open dry reed relays. Coil voltage is minimum 3.75 volts and maximum 10 volts. Nominally 5 volts. Coil resistance is 500 ohms and maximum switch current 1/2 amp.

3 for £3.95. 10 for £9.50.

25 for £19.95 (A)

SIL Resistor Arrays



These highly compact single in line resistor arrays are perfect for all applications where space is tight in a project. They are are all commoned type where one pin is common to each resistor and adjacent pins are two resistors in series:

RA47	470 W	8 resistors. 9 pin package
RA68	680 W	8 resistors. 9 pin package
RA10K	10K W	12 resistors. 13 pin package

Any 10 for £2.95. 25 for £6.85. 100 for £25 (A)

VHS Video Tape Steal!

We had a bit of luck! A certain well known company uses extra high grade VHS tapes - mostly 120 mins, by **Scotch, BASF Fuji High Grade** etc, for a precision film application. Because of the application they can use them only once. Their loss is your gain. The oxide coating is virtually untouched. At these prices you can't even buy such quality from the manufacturers! This is one of the best deals we have ever been able to offer (mail order only) - first quality at a lowest ever price!

10 for £14 (B) **25 for £33** (C) **50 for £65** (C)

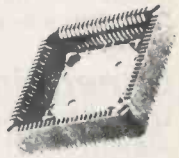
100 for £125 (E)

Telescopic Aerials

A standard heavily chromed telescopic aerial for portable radios and other applications. Screw (supplied) fixing at the base. It has 7 sections and the length varies from 4-5/8" to 17". Base diameter is 5/16". Makes a handy pointing tool as well!

3 for £3.95 or 10 for £10 (A)

PLCC IC Sockets



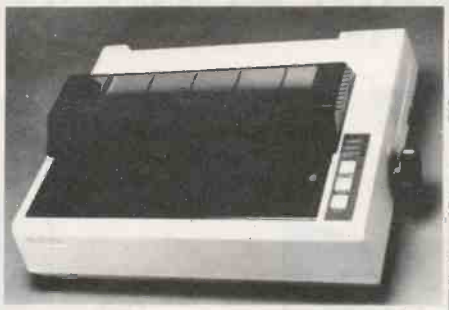
High quality sockets for ICs packaged in the Plastic Leaded Chip Carriers. Phosphor bronze pins with tin plated contacts and pins. For 44 or 84 pin packages - specify which required.

44 pin.....2 for £3.40 (A)

84 pin .....2 for £3.95 (A)

Epson MX-80 F/T Printer

A beautiful printer at a beautiful price! Workhorse of the Epsons, the MX-80 can be seen everywhere. It features bidirectional printing with logic seeking ability and a 9 x 9 dot matrix character formation for enlarged, condensed, bold, normal etc. Can handle fanfold, roller or individual sheets of paper. Parallel standard Centronics interface. One of the most versatile of the range. DIP switches provide Country and other selections. Compatible with IBM and most brands of personal computer.



Only £129! (C)

Push Action Solenoid

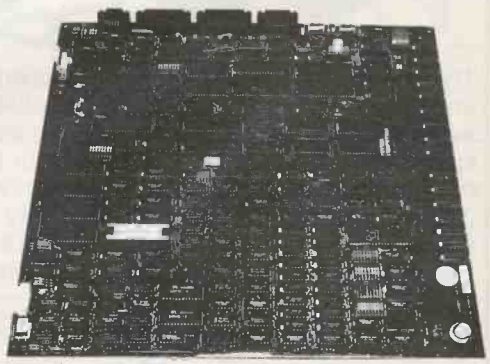
A brand new high speed solenoid used as the hammer operating solenoid for a high speed daisy wheel printer. Capable of switching up to at least 90 times per second; with many applications such as automation, robotics and other electro mechanical fields, in addition to daisywheels. Uses 5-6 vdc. Dims 1.5" x 0.75".

£3.95 or 3/£10 (A)

Jumbo Parts Board

This is the entire brain of the 16 bit 8088 system from Future Computers. It measures a whopping 14 inches square! We have no data so it is sold as a parts board and is not guaranteed to operate as a computer board. It contains about 200 ICs.The logic is TTL-LS. Included are eighteen 64K RAM chips,which are scarce nowadays! and a NEC D765A disk controller and 7220 graphics IC plus normal support LSI packages. A ni-cad battery is provided for calendar support and a nice low profile relay. Three crystals of 24, 25 and 8mhz are included plus a buzzer. We believe that these boards are ex working equipment so if you can get it going its a gift but anyway its a gift for the parts!

Only £13.95 each! (B)

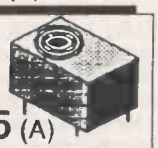


Acoustic Coupler Bargains

The bargain of the century! We still have a few of this popular item to clear! 240V mains operated Acoustic Coupler. 300 baud V21 modem with RS-232 serial output via standard 25 way 'D' connector. Mains switch and exterior fuse. Carrier and power indicators on front. Measures 28 x 15cm. Original boxes & BRAND NEW, but at this price untested and unguaranteed. How can you go wrong, its worth it for the parts alone!

Only £8.95 each or 2 for £17! (B)

Buzzer Alarm



Sub-miniature PC mount buzzer alarm. Uses 12vdc. Measures only 2 x 1.5 x 1.5cm. The sound is particularly attention getting! Perfect for most small alarms. **2 for £1.95** (A)

Floppy Disk Drives

As Low as £19.95 for a 3 ½ inch Drive!

3.5 inch	Canon MD353	40 T	SS	HH	Brand new	£19.95 each. 2 for £34.50. 5 for £82.50
5.25 inch	Shugart SA405	40 T	SS	FH	Brand new	£29.95 each. 2 for £55.00. 5 for £125.0
5.25 inch	Tandon TM-100-2A	40 T	DS	FH	RFE.Tested.	£39.95 each. 2 for £75.00. 5 for £175.00
5.25 inch	Teac FD55F	40/80T	DS	HH	Brand new	£90.00 each. 2 for £160.00
5.25 inch	Tandon TM100-4	80 T	DS	FH	RFE.Tested	£49.95 each. 2 for £95.00. 5 for £225.00
8 inch	Shugart 800/801	77 T	SS		RFE.Tested	£125.00 each
8 inch	Shugart 851	77 T	DS		RFE.Tested	£195.00 each
8 inch	Mitsubishi M2894-63	77 T	DS *		Brand new	£250.00 each. 2 for £475.00

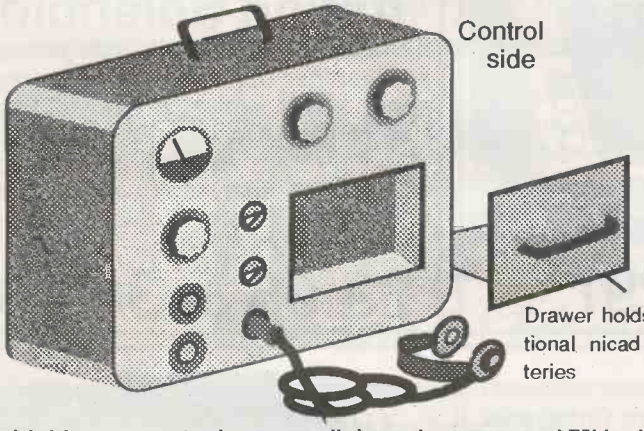
* Switchable soft or hard sectors. SS=single sided. DS= double sided. FH= full height. HH= half height. T=Track
RFE= Removed from equipment. Shipping codes: 3.5"=(B). 5.25"=(C). 8"=(D)

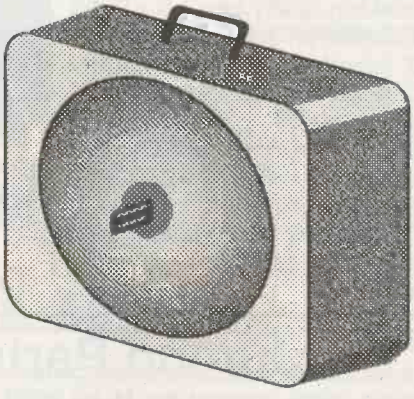
Super 8 inch Specials!

Dual drives housed in an attractive case complete with DC power supply. Total 2 megabyte capacity, makes a superb exterior drive unit where extra high capacity is required. Absolutely ready to go - all for only.... £499 (F)

End of line purchase scoop. Brand new NEC D2246 8" hard disk with 85 megabyte of hard disk storage. Full CPU control and industry standard SMD interface. Ultra high speed transfer and access time leaves the old ST506 standing! Brand new complete with manual. Only ... £199 (E)

50 km Microwave Speech/Data Links





These highly compact microwave links only measure 15"H x 14"W x 10"D yet include the microwave dish, all the electronics and the control panel - all in one portable unit. Made for the US military to the highest possible specifications, these units were originally designed as a very rugged portable point to point distance measuring set. Inbuilt in the unit is a full duplex speech link which may be used as is, or adapted for use as a data link. The extensive features include a generous 50 km point to point range, approximately 10.5 GHz operation to give maximum security, and low power consumption, typically 2 amps at 12 vdc. An optional integral 12 volt nicad power pack is also available which gives about 3 hours operation. The whole unit is enclosed in a fully portable weatherproof case. Supplied in good used condition, fully tested prior to despatch, complete with instructions and accessories.

Limited quantity - don't miss out on this one!!!

Only £295 per pair (F)
12v integral nicad pack (each) £22
May require licence for UK use

DISPLAY
-Electronics-

Mail: 32 Biggin Way, Upper Norwood, London SE19 3XF
Shop: 215 Whitehorse Lane, South Norwood, London.

Tel: 01-679-4414. Fax: 01-679-1927. Telex: 894502.
Distel: (300 baud) 01-679-1888. (1200/75) 01-679-6183 (1200/1200) 01-679-8769

All prices for UK Mainland. UK customers add 15% VAT to TOTAL order amount. Min. order £10. PO orders from Government,Universities,Schools & Local Authorities welcome-minimum account order £25. Carriage charges (A)=£2.00. (B)=£4.50. (C)=£8.50. (D)=£10.00. (E)=£12.00 (F)=£17.00 (G)=Call. All goods supplied subject to our standard Conditions of Sale and unless otherwise stated guaranteed for 90 days. All guarantees on a return to base basis.We reserve the right to change prices & specifications without prior notice. Drawings for illustration only, their accuracy not guaranteed.Orders accepted subject to stock.Quotations willingly given for higher quantities than those stated. Bulk surplus always needed for cash,

MOTOR SPEED CONTROL

Andrew Armstrong's answer to the caddy's prayer – trolley coarse control refined to fit you to the tee!

This month Ask PE answers a motor control problem. Gilbert Scobie writes: "I have built an electric golf trolley driven by a series wound 12V motor. This draws 12 to 15 amps from a 12V car battery. At present I control the speed inefficiently by switching resistors, but I would like to know how to control it electronically and thus more efficiently."

This seems an entirely reasonable aim. While the efficiency of the method you use is good near to or at full speed, the efficiency declines as the speed is reduced. Depending on the actual use cycle of the motor, an efficient control system could increase the range by up to 50%, though 30% is more probable.

A continuously variable high current regulated linear power supply would answer the need to control the speed accurately, but would not improve the efficiency. To do this we must use a switched mode design, in which the power to the motor is adjusted by varying the mark:space ratio of the drive to the motor. This method of control is illustrated in the block diagram Fig. 1. This circuit is, in effect, a switched mode buck regulator, but no inductor is shown. This is because the leakage reactance of the motor is adequate to smooth out the load current to the extent required.

The diagram shows another useful function, speed control feedback. If the power to the motor is increased gradually, it will start to move and then take off like a startled rabbit. This is because more power is required to start the movement than to keep it going. Equally, without some means of stabilising the speed, even minor inclines will bring the trolley to a halt.

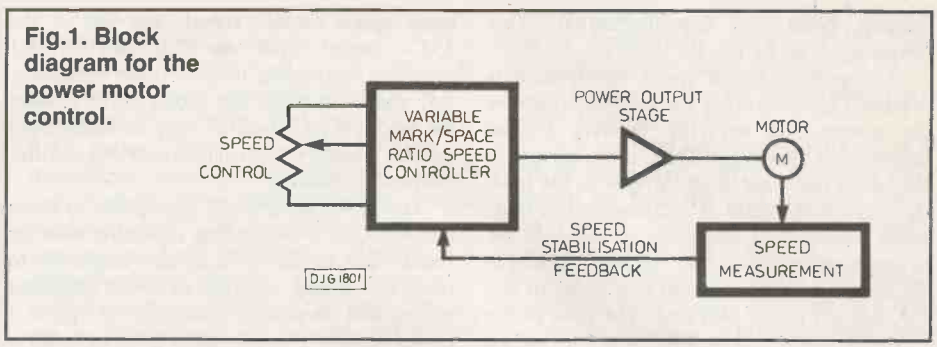


Fig.1. Block diagram for the power motor control.

FILLING IN THE BLOCKS

The main factor which makes the design of the circuit at all difficult is the need to control 15A. It can be difficult to switch this much current efficiently. Switching devices able to control this level of current are generally incapable of switching fast, or else are difficult to persuade to switch as fast as their maximum rating.

The easiest device to switch rapidly is probably a power mosfet, and such is the device chosen for this design. Mosfet chosen is an IRFZ30 hexfet made by International Rectifier. It is rated at 50V and 30A, and has an on resistance of 0.05Ω when fully switched on. This means that, when passing a current of 15A the voltage drop will be 0.75V, so the dissipation will be 11.25W. This is a worst-case dissipation, based on the assumption that the fet is switched on all the time. A heat sink of 3°C per watt or better would be suitable.

The gate to source capacitance of this hexfet is quoted as 1600pF, and the reverse transfer capacitance at 200pF. In order to switch the fet fully it is necessary to charge (or discharge) the gate capacitance over the power supply range, and to charge (or discharge) the reverse transfer capacitance over double the power supply range. This is because when the gate voltage swings in one direction, the drain voltage swings in the opposite direction, so the voltage across the reverse transfer capacitance changes by 24V from say +12V to -12V. The task of charging and discharging all this capacitance is equivalent to charging or discharging 2000pF over the power supply range. To make the circuit run efficiently, this capacitance must be charged or discharged in a small fraction of the switching cycle time.

ALL THE FIVES

Luckily, there is an ic almost ideally designed for this function, the 555. The 555 timer can provide an infinitely variable mark:space ratio output when used in the astable mode, and is rated to sink or source up to 200mA from its output, which is more than adequate to drive the hexfet as fast as required. The circuit of Fig. 2 shows a design using the 555 and the IRFZ30 hexfet. The switching frequency is approximately 1kHz, which is a suitable

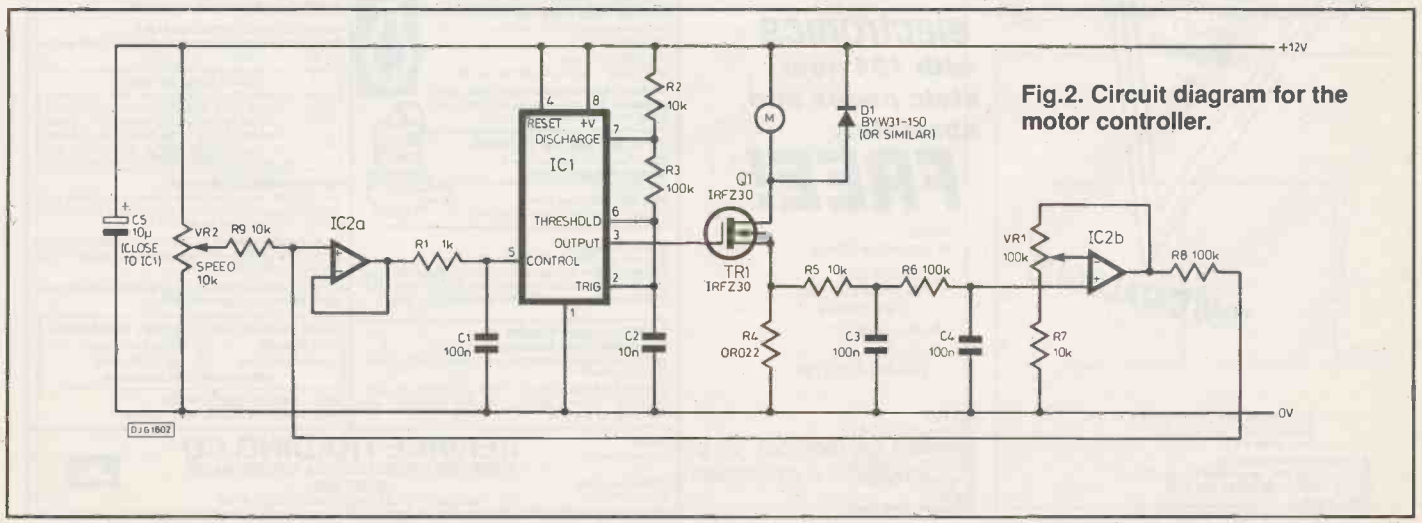


Fig.2. Circuit diagram for the motor controller.

starting point for experimentation. This frequency is set by R2, R3 and C2.

A degree of motor speed stabilisation is achieved by measuring the current drawn by the motor, and applying positive current feedback to the circuit. Thus, if the current in the motor rises due to an increase in the load, the mark:space ratio is increased to provide more power. It is necessary to measure the average current rather than the peak current in the motor, so a filter circuit consisting of R5, C3, R6 and C4 is provided. The gain of the feedback is adjusted by VR1, which should be set to provide reasonable speed stability without causing oscillation due to too much feedback. The feedback signal is added to the basic speed control signal, and fed to the 555's control input via IC2a and R1. C1 provides decoupling to give noise immunity. R4, which measures the motor current when the hexfet is switched on, may be made from several strands of resistance wire (eg old fire element) in parallel.

The 555 is notoriously susceptible to noise problems, so a decoupling capacitor must be fitted close to the ic. It is also important to route the wiring sensibly to avoid imposing spikes and switching transients on the ic's power supply. The only other point to make is that D1 needs to be rated at at least 15A and 15V, and to be a fairly fast switching device. There are no doubt a number of suitable devices, but the one chosen here is a BYW31. This diode must be mounted on a heat sink, and the heat sink must be isolated from the rest of the metal work, because the stud of the diode is one of the terminals.

This circuit has been designed without a detailed knowledge of the motor characteristics, including leakage reactance, so some experimentation with component values is likely to be necessary. PE

ERRATUM

Please accept our apologies for the duplication of January's page 40 in the February issue.

First, let's recap on last month's closing paragraph:

DISKS

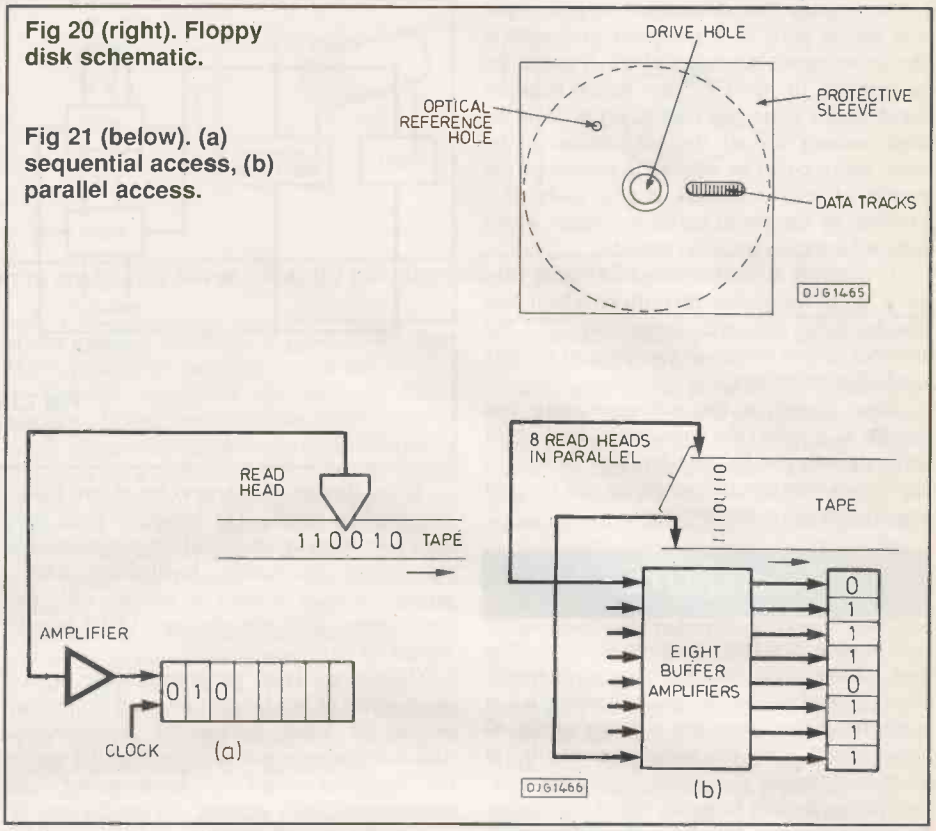
Whereas paper tapes and magnetic tapes are accessed serially, from the start and moving until the required point is reached, disks can be accessed at random. The disc has a drive hole, where the drive mechanism connects and revolves the disc until a beam of light shines through the optical reference hole. This is the reference point at which the floppy disc starts. In response to coded instructions, the disc revolves the required distance forward and the read head aligns on the correct track outwards from the centre, without having to read every track.

Floppy discs are thin sheets of plastic, coated with magnetisable ferrous material for storing information. Fig 20. Floppies can be removed from the disc drive unlike hard discs which are removed only when faulty. Floppies come in $3^1/_4$, $3^1/_2$, $5^1/_4$ and 8 inch diameter sizes. Both floppies and hard discs have tracks reserved for holding file directories and file management information.

Discs can be single or double sided (tracks on both sides) and single or double density.

Fig 20 (right). Floppy disk schematic.

Fig 21 (below). (a) sequential access, (b) parallel access.



COMPUTERS

Part two, in which Mike Sanders reveals the inner cpu world of disks, buses and architecture.

For double density, twice the amount of data is packed in the same space. Typical capacities are:

Single density and single sided :	256 Kbytes
Single density and double sided :	512 Kbytes
Double density and single sided :	512 Kbytes
Double density and double sided:	1 Mbyte

A single density disc drive cannot read a double density disc and a single drive cannot read a double sided disc. However, a double density disc can be formatted as single density before use.

Floppy discs rotate in the disc drive at about 360 revolutions per minute. Data corruption is less than 1 bit in a million which is quite remarkable since data transfer is by mechanical means.

The storage capacity of hard discs can be up to 40 Mbytes. The disc is around ten inches in diameter and rotates ten times faster then floppies (3600 rpm). Hard discs use two kinds of read/write heads : fixed and floating. The storage capacity of a 20 Mbytes hard drive is for a fixed head disc; the storage capacity with a floating head is up to 84 Mbytes. Then floating head rides on an air cushion and is physically closer to the disc than a fixed head, hence even fewer reading errors.

As we said before, tape is accessed in a serial manner whereas a disc can be accessed randomly. Quite apart from this matter, data can be accessed sequentially (serially) or in a parallel manner. Consider Fig. 21: with a single read head only one bit can be read at a time and shifted into a register. Fig. 21 a shows 3 bits read and shifted into the register. Consider now the same piece of tape or track with 8 bits across the tape or track and eight read heads in parallel. The 8 bits are instantly shifted into the register.

ASCII AND EBCDIC

All the input and output devices need some language for communicating with the processor; preferably the same language so that the machine has only one lot of instructions for converting to machine code (binary).

One form of code is the Extended Binary Coded Decimal Interchange Code (EBCDIC). This was introduced by IBM for its 360 computer models.

Another, more common code is the American Standard Code for Information Interchange, ascii (pronounced askey). The standard typewriter keyboard requires codes for letters, numbers, signs (+, - etc) as well as commands like carriage return. There are two versions of the ascii: a 6 bit ascii which excludes lower case characters and a 7 bit ascii called full ascii, extended ascii or United States (USascii). The 7 bit version uses an eighth bit for parity checks.

USARTS

A universal synchronous/asynchronous receiver - transmitter (usart) is a useful interface for a communications network connected to a computer. To save bandwidth, a communications network operates in a serial mode and for speed, a processor operates in a parallel mode so a usart converts from serial to parallel and vice versa.

Since ascii is not the only code used, some usarts are programmable. The usart can work at a wide range of speeds; teletype for low speeds, line printers for medium speed and visual display for fast speeds.

A problem that is common to both input and output ports of a computer processor is the above speed incompatibility. A processor is capable of working far faster than its input/output ports can feed it, so it could be kept waiting for all the information to be input and it could be waiting to unload all the results of a calculation. It gets round this problem by the use of buffer memories which hold information for short periods.

In addition to buffer memories, there may be a need for buffer amplifiers which can match two different impedances. For instance, a mos processor can drive ttl circuits via buffer amplifiers.

Even though a cpu addresses only one device at a time, the impedance loading of other devices can be considerable. This is an instance where a buffer amplifier can be used to decouple the other devices.

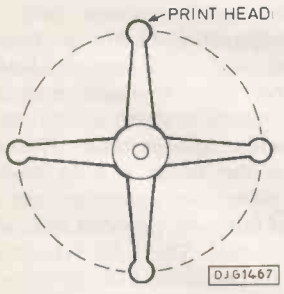
OUTPUTS

The same problem can occur as for an input port. There could be a large output of results from calculations that the cpu is throwing out at a rate faster than the output port can handle, so these results can be stored temporarily in memory buffers.

The commonest forms of output devices are vdus and printers. Of course the output could also be to magnetic tape is the results are not required immediately.

Printers are of four types: a) daisy wheel; b) dot matrix; c) thermal; d) laser. A daisy wheel is a rubber pad with letters and numbers on the end of arms, like spokes of a wheel, as in Fig. 22. This printer produces good quality print for letters and documents but these printers, like the Qume Sprint, are expensive and slow. A typical

Fig 22. Daisy wheel



speed is 120 cps (characters per second). High quality ribbons are also used.

Dot matrix printers are faster, 180 cps, but the quality is not as good as daisy wheels. However, dot matrix printers are adequate for labels, stores lists and forms. Thermal printers are cheap but the print copy is not durable. Heat sensitive paper is used with a dot matrix printing head, the printing head having a matrix of 5 x 7 dots typically. These printers are quiet but slow, from 10 cps to 30 cps.

Laser printers use a laser to beam the image to a rotating drum which then transfers data to paper in a manner similar to that used in photocopiers.

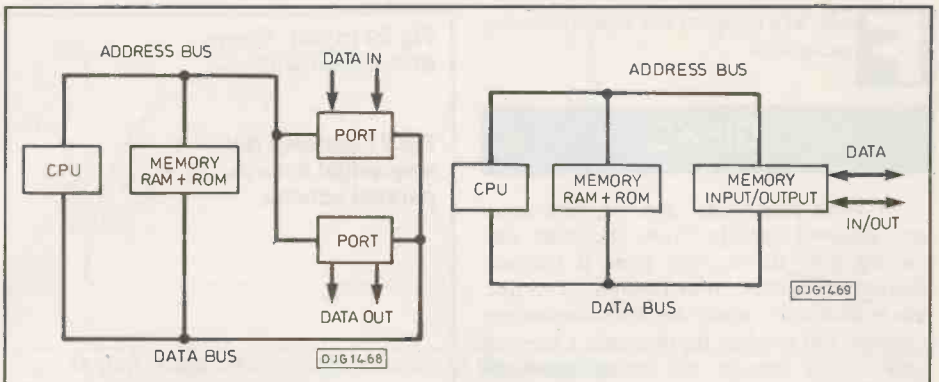


Fig 23 (left). Input/output ports.
Fig 24 (above). Memory-mapped input/output.

Visual display units (vdus) are of two kinds: intelligent or dumb. The intelligent ones have their own memory chips and are programmable for storing information, highlighting letters, setting a blinker to flash on and off, etc. The dumb ones.....well, say no more. VDUs operate around 960 cps.

Quite apart from peripherals there is one other aspect of input/output we need to consider before we leave input/output arrangements. This is the input/output arrangement (IO) within the computer itself. A processor can communicate with external devices by one of two methods: either input/output ports or memory mapped.

Simple input/output port access, Fig. 23, does not use memory space and the operations are limited to transferring output data to an accumulator.

Fig. 24 shows a memory mapped input/output arrangement and the whole instruction set of the processor is available for operating on inputs and outputs. The disadvantage is that memory space is used up for controlling input/output functions.

BUSES

It's a busy world inside a computer with clocks, buses and tri-state drivers all running to a strict timetable. The need for clocks and the use of clocks has been touched on earlier. Tri-state drivers have nothing to do with drunken driving! It refers to the state of the amplifiers which drive the data bus. These amplifiers can go low (Logic 1) for reading data in and high (Logic 0) for outputting data. The devices that are not being accessed could load the cpu, so the amplifier goes to a third stage : high impedance or open circuit.

In Fig. 2 (last month) we saw three buses: address bus, data bus and control bus. In small computers the same bus may be used for address and data. They are said to be multiplexed, they cannot use the bus at the same time and have to share it on a time basis.

The control and address buses are unidirectional since they only access devices, but the data bus is bidirectional since it inputs as well as outputs data. A data bus with 16 lines could access 216 = 65,536 different locations. The required chip is selected by means of a chip select (CS) signal. General purpose IBM computers with a 64 bit address word can address a memory of 1019 bytes.

A cpu has read and write pins. If the read pin goes low then a read operation is in progress and if the write pin goes low a write operation is in progress. However, control functions are not limited to read and write operations. Other important functions like interrupts and direct memory access are dealt with later.

Handshaking is a term often encountered in computer talk and data communications involving computers. This is merely the acknowledgement protocol for sending data and can be conducted in one of two ways. The transmitting device can signal 'transmitting data' on the control bus and the receiving device acknowledges with 'data received'. Alternatively, the receiver can request 'send data' and the transmitter responds with 'sending data'.

In a computer the bus itself may be copper tracks or, if boards need to be interconnected, cable may be used. A bus that is common to a lot of computers is the S100 which originated in the Attair 8800 microcomputer. The S-100 is not perfect but it is used in so many computers that it has become a standard by default and it is now too late to change. A 100 pin connector is also part of the S-100.

ADDRESSING MODES

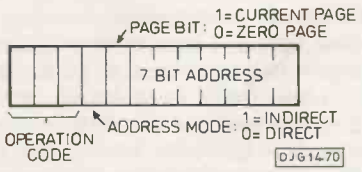
Addressing modes can be confusing because one form of addressing might be called something else by another manufacturer, for instance, 'indexed' may be called 'auto indexed'. What follows is a description rather than a definition of some of the addressing modes. This list is not complete; there are many hybrid modes that are difficult to describe.

1. Direct: The address in memory is contained in the instruction.
2. Indirect: The instruction points to a location which contains the address of the data rather than the data itself.
3. Register: The instruction refers to a register which contains the information.
4. Register-indirect: The address of the data is held in register.
5. Indexed: The correct address is obtained by adding the address in the instruction to the address in the index register. The advantage is that addresses can be abbreviated.

6. Auto-index: The index register is automatically incremented or decremented before or after use.
7. Page: This is a useful means of accessing data and saves on the number of addresses, particularly if whole chunks of data are on the specified pages. It's like reading a book. One can be told to look up the 40,000th word in which case one would have to count from the first word. Alternatively, using page addressing one can be told to go straight to the 140th page.
8. Immediate: The data is at an address immediately following the instruction.

To illustrate some of the above points, let us take a 12 bit machine. Now we can do what we like with the bits, trading address bits for instruction bits. Fig. 25 shows how three bits are allocated to the operation code (Load, Store, etc) and seven bits to the address itself.

Fig 25. Allocation of bits to instruction and address.



DECODING

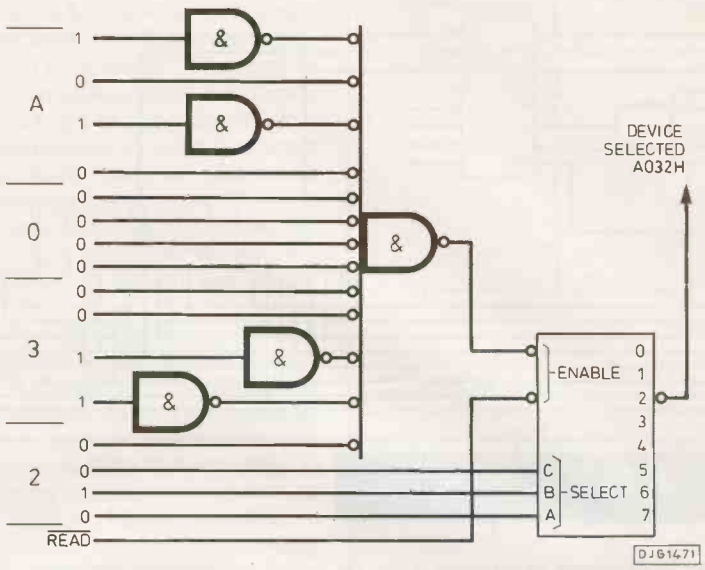
First of all, the correct device needs to be selected. Secondly, the required address within that device needs to be decoded. Fig. 26 shows how a device at address A032 (hex code) is selected. Since there is a READ line, an input port is selected. This is easily converted to work to an output port by connecting the enable line to WRITE.

We've seen how input or output ports are accessed. How do we access a rom, particularly if there is more than one? Table 3 shows how three roms can have their locations addressed. The low byte (bits 0 to 7) addresses the locations within each rom and the high byte (bits 8 to 15) select the required rom. Only bits 8 and 9 change in selecting the required rom. A 16 bit address bus is shown which can address 64K locations but the full addressing capability is rarely used.

Fig. 27 shows exactly how these roms would be connected, once again indicating how the high byte is used to select the device and the low byte to address each memory location within each rom. There is a READ line only since a WRITE line is irrelevant to a rom.

Rams on the other hand need both READ and WRITE lines and Table 4 shows the conditions for controlling rams. For both reading and writing the chip select must go low (0), then for writing into memory the WRITE line goes low and for reading from memory the WRITE line goes high (1). If chip select goes high, what happens to the write does not have any effect (Don't Care).

Fig 26. Device selection



MORE COMPUTER ARCHITECTURE

To summarise, we've looked at some of the important parts of a computer: the cpu, roms and rams, program and stack pointers, address data and control buses and C,Z,N,O flags.

We shall look at two other important matters: interrupts and dma, before passing on to general aspects like integrated peripherals and development aids.

Direct memory access (dma) is a means of transferring data in and out of a computer without first transferring it to an intermediate register. This is useful when a peripheral device is fast and capable of holding vast amounts of information. In some instances the cpu itself acts as the dma controller. In other instances a separate dma chip is required. Since the ram is connected directly to the address and data buses, the cpu needs to give up control of these during a dma transfer.

The cpu receives a 'hold request signal' from the control circuit where upon it saves the contents of its registers, stops processing and floats its buses (switches them to high impedance).

DMA transfer is usually used for transferring blocks of data and the information required is: start address of data block, number of bytes in data block, direction of transfer and input/output port to be used. A byte count register keeps a record of the number of bytes being transferred and a suitable signal sent when the count runs down to zero.

Word Line	Bit 3	2	1
1	0	0	0
2	0	1	0
3	0	0	1

Table 1. ROM output

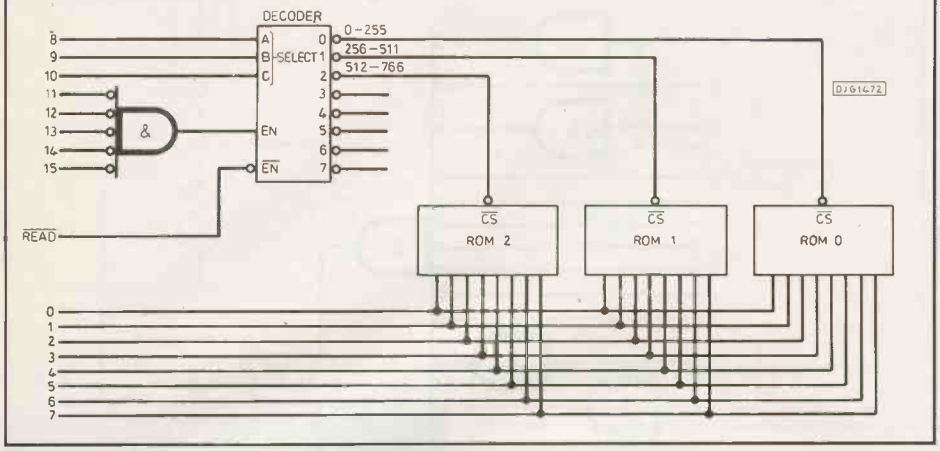
A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Table 2. Half adder outputs.

	Overall Address	ROM Number 15	14	13	12	11	10	9	8	Address within ROM 7	6	5	4	3	2	1	0
ROM 0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	.																
	.																
	255	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
ROM 1	256	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	.																
	.																
	511	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
ROM 2	512	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	.																
	.																
	766	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	1

Table 3. Addressing multiple roms

Fig 27. Addressing multiple ROMs.



INTERRUPTS

It may be necessary to interrupt a cpu for one reason or another, eg an external device asking for attention. Not all interrupts will have the same priority, eg the RESET button could be the highest priority since if the person running the machine decides to abandon the run, then all the registers are reset (cleared) immediately. In this instance there is little point in attending to other interrupt requests before attending to RESET.

One means of checking for interrupts is by means of polling, the cpu checks each device in turn to see if any require attention but this is wasteful of cpu time. It is better if the device calls for attention with an interrupt request.

If devices have equal priority then a rotating method can be used. This is similar to a roulette wheel with a rotating indicator. Table 5 shows five devices and what happens when device 2 interrupts. It is assigned the lowest priority - priority 5 being the lowest priority and 1 being the highest priority. Acknowledgement of the interrupt by means of handshaking is delayed until the cpu completes execution of its current instruction.

If interrupts have different levels of priority then a hierarchy needs to be established by means of a program subroutine or by means of logic circuits. A higher priority can always interrupt a lower one. If level 1 is the highest priority then a subroutine would look like this:

```
Run main program
|
|     Interrupt level 4
|
Save main program

Attend interrupt 4
|
|     Interrupt level 1
|
Save interrupt 4

Attend interrupt 1
|
|     Interrupt level 5
|
Complete interrupt 1

Return to interrupt 4

Attend interrupt 5

Return to main program
```

INTEGRATED PERIPHERALS

Since manufacturing technology is capable of including more and more on a single chip it is possible to include the ram and rom onto the cpu. The disadvantage is that it is difficult to expand the memory since the data and address buses do not usually appear at the pins of the chip.

Other peripheral facilities are analogue-digital interfaces on the cpu, and even microprocessors around a cpu. Each microprocessor can be programmed to perform particular functions and this is approaching the power of large computers which use satellite microprocessors to aid the cpu.

DEVELOPMENT AIDS

We saw in a previous section the use of a monitor program. Most manufacturers provide in addition sufficient software aids to help in debugging programs. These aids can be in the nature of register access where the contents of a register can be examined to check whether the program is running correctly. Another aid can be breakpoints; these stop the program at the desired points.

The above aids are valuable but they slow down or stop the program. If timing is critical to the operation of a particular equipment or program then an in-circuit emulator (ice) must be used. This is a high speed processor in place of the normal one and the same diagnostic functions can then be carried out.

PROGRAMMING LANGUAGES

No article on computers would be complete without a mention of programming languages. One could speak to a computer in binary, often called machine code, after all it's the only language the digital computer understands. But even 8 bit codes could become tedious to a human and therefore prone to error.

It would be nice to use semi-English statements or mnemonics and then an assembler to convert this source code into the object code that the computer understands, ie source code, assembler, object code. An example of assembly code is given below:

LDA = Load Accumulator

DCRB = Decrement register B

JNZ = Jump is not zero

A compromise between machine code and assembly code would be to use one of the easier codes like the hex code since one letter or number in hex represents several binary digits.

Fig. 25 showed how the instruction field is divided into operator and address. An example of this using hex code is 3E, 0F where 3E could stand for 'Move the immediate data into the accumulator' and 0F is the data.

We'll look further at languages next month, and consider the future for supercomputers. PE

$\overline{CS}$	$\overline{WR}$	Function	
0	0	Write	0 = Low
0	1	Read	1 = High
1	X	Nothing	X = Don't care

Table 4. Controlling RAMs

Device	Priority
5	5
4	4
3	3
2	2
1	1

Starting priority

Device	Priority
5	3
4	2
3	1
2	5
1	4

Device 2 interrupts.

Table 5. Rotating priority.

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74HC10	*14p*	*HCT14*	*25p*	*LS04*	*12p*	*C74*	*25p*
74HC14	*23p*	*HCT32*	*14p*	*LS10*	*12p*	*C150*	*710p*
74HC27	*21p*	*HCT74*	*18p*	*LS14*	*20p*	*C155*	*48p*
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74HC42	*30p*	*HCT139*	*25p*	*LS30*	*14p*	*C244*	*65p*
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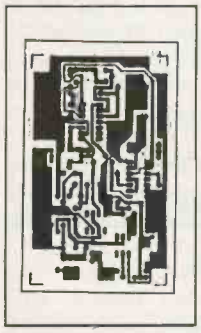

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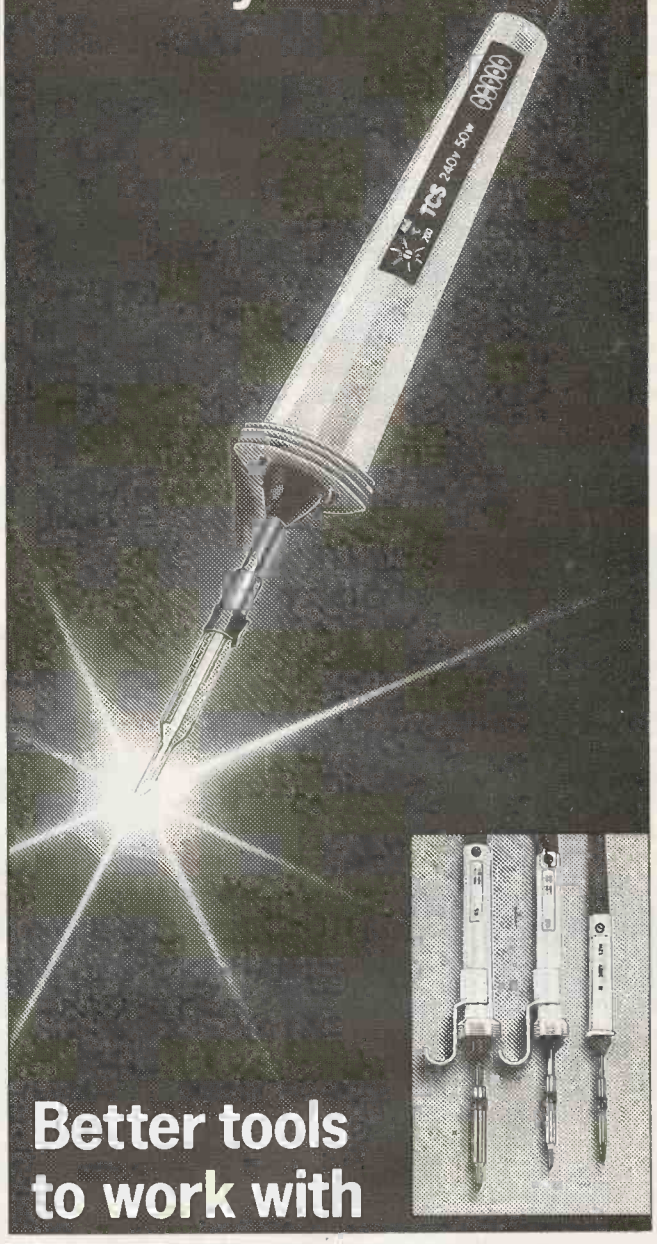

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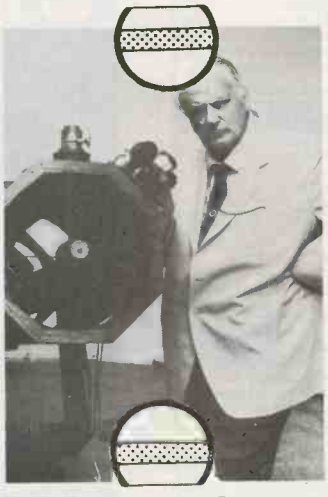

Recently we reported the re-opening of the Norman Lockyer Observatory in Devon, which had been largely derelict following a period of neglect when it was controlled by Exeter University. Donald Barber, the last Superintendent, who retired many years ago, has now been appointed Director Emeritus of the Observatory. Our congratulations to Mr Barber on this well-deserved honour.

Discussions are continuing about the future of Giotto, the European space-craft which passed through Halley's Comet in 1986. Many of its experiments are still functional; whether Giotto will be sent on to another comet remains to be seen. Meanwhile, Voyager 2 is making its way out of the Solar System, but remains under control; the Galileo probe makes its swing-by of Venus before looping back to an encounter with the Earth next December, while Magellan is also en route for Venus and will enter orbit round that planet in the coming August.

ADAPTIVE OPTICS

The main observatory of the ESO (European Southern Observatory) is at La Silla, in the Atacama Desert of Northern Chile. Here the latest instrument is the NTT or New Technology Telescope, with a 3.6-metre thin mirror. As a mirror is moved around, it is bound to distort; the principle of 'active optics' corrects for this - a system of 'pads' alters the shape of the mirror and allows for the distortions, so preserving the perfect curve.

But this cannot allow for the fluctuations in the Earth's atmosphere, and before long the NTT will be able to make use of the new principle of 'adaptive optics'. Twinkling, as we have noted, is the astronomer's enemy. High above the ground, at between 5 and 10 kilometres, there are small, moving cells of air; each cell produces a 'sub-image' of the same star, resulting in turbulent images and confusion. This is where adaptive optics comes in. It is based on a feedback loop; the optical system includes a deformable mirror which can change its shape in a way which compensates for the distortions of the light wave-front after it has passed through the atmosphere. The information about how to deform the mirrror comes from a wave-front sensor which measures the shape of the distorted light wave-front.

Obviously, this requires an ultra-modern, very fast computer, because the actuators behind the deformable mirror have to 'push' and 'pull' the mirror surface. The deformations have to be corrected around 100 times per second, which would have been completely out of the question until very recently.

Preliminary tests were made at the coudé focus of the 1.52-metre telescope at the Observatoire de Haute Provence, in France, last October. They proved to be extremely successful. Over ten nights, exposures were made of several bright stars through a number of infra-red filters; each exposure lasted

Un-twinkle, un-twinkle, little star

THE FEBRUARY SKY

Venus is the dominant planet this month. It is a morning object, reaching its greatest brightness on the 22nd; it is then of magnitude -4.6, far brighter than any other planet or star. The phase increases from 9 per cent at the start of the month to 31 per cent at the end, so that this is still a good time for observers to look for the elusive Ashen Light - the faint visibility of the unilluminated hemisphere.

Of the other planets, Mercury is too far south of the celestial equator to be well seen; Mars is visible before dawn, but is still a long way away, with an apparent diameter of less than five seconds of arc; Jupiter is still fairly well placed in the first half of the night, and is of special interest because of the slow reappearance of the Great Red Spot, while Saturn is out of view.

The Moon is at First Quarter on February 2, full on the 9th, Last Quarter on the 17th and new on the 25th. The main event is a total lunar eclipse on the 9th, which will be seen from almost the whole of Europe, including Britain. It begins at 17h 30m GMT, and ends at 20.54, with totality lasting from 18.51 to 19.33. Since this will be the last lunar eclipse for some time, we must hope for clear skies.

(Looking ahead, there will be a total eclipse of the Sun on July 22. It will not be seen from Britain, but if you want to enjoy totality you need go no further than Finland. Several parties are arranging trips, and it you make the journey and are frustrated by cloud, as can so easily happen, please don't blame me!)

There are no major meteor showers in February, and no bright comets are predicted. Comet Aarseth-Brewington, which was in the sky for much of December, has now passed too far south to be seen from Britain.

Orion is still on view for much of the night, and so is Sirius, the brightest star in the sky, which is rather low in the south. Sirius appears to twinkle violently, but of course this is due entirely to the Earth's atmosphere; Sirius itself is a pure white star, and is the supreme 'twinkler' partly because of its brilliance and partly because as seen from Britain, it is never very high up. Twinkling may look pretty, but it is far from welcome to the astronomer, and new optical methods are being developed to combat it as far as possible. Of Orion's retinue, Castor and Pollux are still prominent, though Gemini (the Twins) is dominated at the moment by the presence of Jupiter. Capella is high up, which means that Vega is low down in the north. We have lost the Square of Pegasus in the western twilight, but Leo, the Lion, has come into view in the east, and is unmistakable with its curved "Sickle" containing the bright star Regulus. Much of the south-east is occupied by Hydra, the Watersnake, which is actually the largest of all the 88 accepted constellations, but contains only one bright star, the reddish, solitary Alphard. To find Alphard, use Castor and Pollux as 'pointers'.

Ursa-Major, the Great Bear of Plough, is in the north-east. Follow round the curve of the Bear's 'tail', and you will come to the brilliant orange Arcturus, which rises late in the evening and is high well before dawn.

The W of Cassiopeia is in the north-west. Adjoining it is Perseus, with the famous eclipsing binary Algol, which 'winks' every 2.5 days when its brighter component is partly hidden by its fainter companion. There are two convenient minima of Algol this month: February 10 (half an hour after midnight) and February 12 (just after 21 hours). Look at the star around these times, and you will find that it looks a magnitude fainter than usual.

between 10 and 100 seconds. The results were striking. The uncorrected image was blurred; with adaptive optics, it became very much sharper, and the errors were reduced to less than half of a second of arc.

Of course, tests of this sort are experimental only, but it is hoped that within the next year adaptive optics will be brought into use at La Silla, notably on the NTT - which is without doubt the most advanced telescope in the world. Note that adaptive optics complement active optics; combined, they should give the NTT an efficiency which may even allow it to rival the Hubble Space Telescope.

Conditions at La Silla are as good as anywhere in the world, and there are several major telescopes there as well as the NTT. Most European nations are involved - with the sad exception of Britain; we were involved in the early talks, in the 1960s, but did not follow them through, which in retrospect is a tremendous pity. True, we have our own observatory at Los Muchachos in the Canary Islands, and the William Herschel telescope there is proving to be even better than had been hoped; still, it would have been pleasant to be involved in the ESO programme also. Perhaps it is not too late? PE

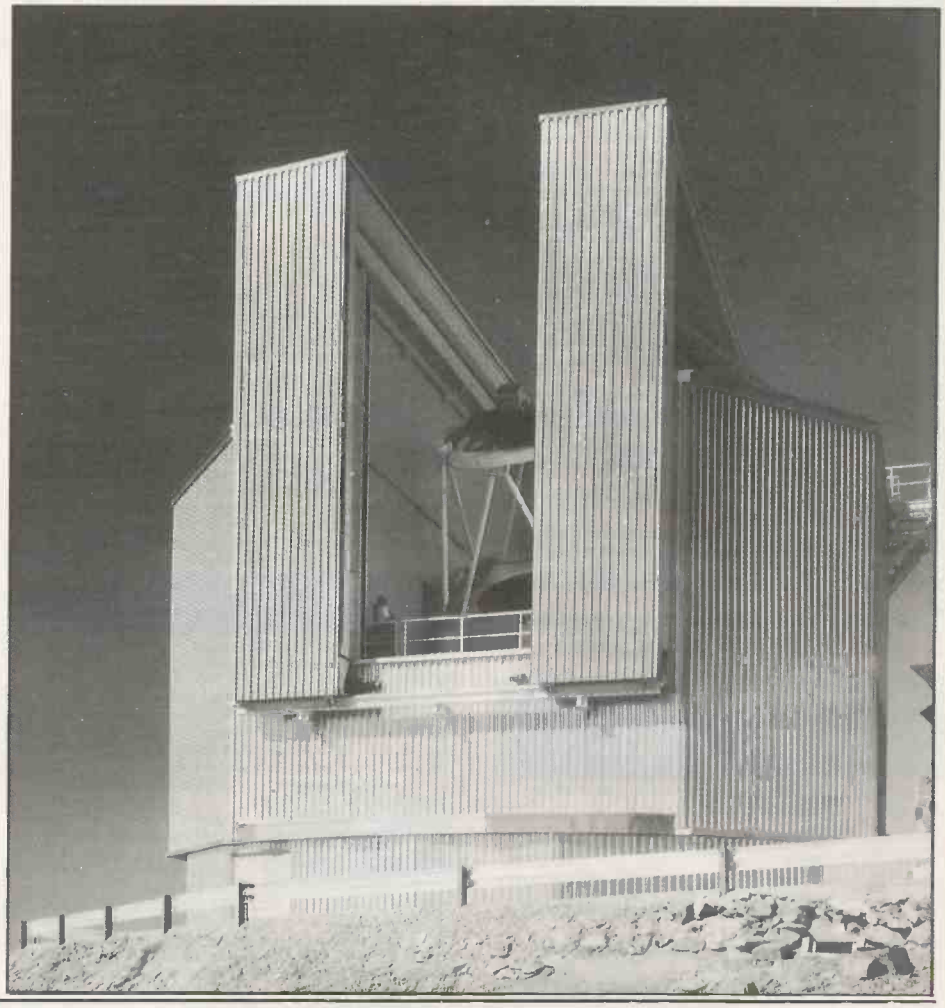

Photo: The revolutionary 3.6m ESO New Technology Telescope. The peculiar shape of the dome resulted from extensive wind-tunnel tests and ensures that there is a minimum of air-turbulence around the telescope. Photo by courtesy of the European Southern Observatory.

BAKERS DOZEN PACKS

All packs are £1 each, if you order 12 then you are entitled to another free. Please state which one you want. Note the figure on the extreme left of the pack ref number and the next figure is the quantity of items in the pack, finally a short description.

BD2 5 13A spurs provide a fused outlet to a ring main where devices such as a clock must not be switched off.
BD9 2 6V 1A mains transformers upright mounting with fixing clamps.
BD11 1 6.5-in speaker cabinet ideal for extensions, takes our speaker. Ref. BD137.
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BD22 2 25 watt loudspeaker two unit crossovers.
BD30 2 Nicad constant current chargers adapt to charge almost any nicad battery.
BD32 2 Humidity switches, as the air becomes damper the membrane stretches and operates a microswitch.
BD42 5 13A rocker switch three tags so on/off, or change over with centre off.
BD45 1 24hr time switch, ex-Electricity Board, automatically adjust for lengthening and shortening day, original cost £40 each.
BD49 5 Neon valves, with series resistor, these make good night lights.
BD56 1 Mini uniselector, one use is for an electric jigsaw puzzle, we give circuit diagram for this. One pulse into motor, moves switch through one pole.
BD67 1 Suck or blow operated pressure switch, or it can be operated by any low pressure variation such as water level in water tanks.
BD103A 1 6V 750mA power supply, nicely cased with mains input and 6V output leads.
BD120 2 Stripper boards, each contains a 400V 2A bridge rectifier and 14 other diodes and rectifiers as well as dozens of condensers, etc.
BD128 10 Very fine drills for pcb boards etc. Normal cost about 80p each.
BD132 2 Plastic boxes approx 3in cube with square hole through top so ideal for interrupted beam switch.
BD134 10 Motors for model aeroplanes, spin to start so needs no switch.
BD139 6 Microphone inserts - magnetic 400 ohm also act as speakers.
BD148 4 Reed relay kits, you get 16 reed switches and 4 coil sets with notes on making c/o relays and other gadgets.
BD149 6 Safety cover for 13A sockets - prevent those inquisitive little fingers getting nasty shocks.
BD180 6 Neon indicators in panel mounting holders with lens.
BD193 6 5 amp 3 pin flush mounting sockets make a low cost disco panel.
BD199 1 Mains solenoid, very powerful, has 1in pull or could push if modified.
BD201 8 Keyboard switches - made for computers but have many other applications.
BD211 1 Electric clock, mains operated, put this in a box and you need never be late.
BD221 5 12V alarms, make a noise about as loud as a car horn. Slightly soiled but OK.
BD242 2 6in x 4in speakers, 4 ohm made from Radiomobile so very good quality.
BD252 1 Panostat, controls output of boiling ring from simmer up boil.
BD259 50 Leads with push-on 1/4in tags - a must for hook-ups - mains connections etc.
BD263 2 Oblong push switches for bell or chimes, these can mains up to 5 amps so could be foot switch if fitted into pattress.
BD268 1 Mini 1 watt amp for record player. Will also change speed of record player motor.
BD283 3 Mild steel boxes approx 3in x 3in x 1in deep - standard electrical.
BD305 1 Tubular dynamic mic with optional table rest.
BD400 4 Books, useful for beginners, describes amplifiers equipment and kit sets.
BD653 2 Miniature driver transformers. Ref. LT44, 20k to 1k centre tapped.
BD548 2 3.5V relays each with 2 pairs changeover contacts.
BD667 2 4.7 uf non-polarised block capacitors, pcb mounting.

There are over 1,000 items in our Bakers Dozen List. If you want a complete copy please request this when ordering.

TOASTERS 2 SLICE toasters - may need slight attention only £3 each ref 3P84.

PERSONAL STEREOS Again customer returns but complete and with stereo head phones a bargain at only £3.00 each. Our ref 3P83.

MAINS OPERATED MICROWAVE CONTROL PANEL with Touch switches. This unit has a 4 digit display with a built in clock and 2 relay outputs - one for power and 1 for pulsed power level. Could be used for all sorts of timer control applications. Only £6.00. Our ref 6P18.

EQUIPMENT WALL MOUNT It is a multi-adjustable metal bracket that could be used for mounting flood light, loudspeaker, TV camera, even a fan and on almost any sort of wall or ceiling even between wall and ceiling. The main fixing brackets rotate such that an inward or an outward corner can be accomodated. Front panel also tilts upward or downwards to a reasonable angle and can be easily removed separately for wiring. A very useful bracket. Regular price would be around £6 each. Our price only £3. Our ref 3P72. Or 2 for £5. Our ref 5P152.

SUB-MIN TOGGLE SWITCH Body size 8mm x 4mm x 7mm SBDT with chrome dolly sixing nuts. 3 for £1. Order ref BD649.

COPPER CLAD PANEL for making PCB. Size approx 12in long x 8.5in wide. Double-sided on fibreglass middle which is quite thick (about 1/16in) so this would support quite heavy components and could even form a chassis to hold a mains transformer, etc. Price £1 each. Our ref BD683.

REAL POWER AMPLIFIER for your car, it has 150 watts output. Frequency response 20hz to 20Khz and signal to noise ratio better than 60dB. Has built in short circuit protection and adjustable input level to suit your existing car stereo, so needs no pre-amp. Works into speakers ref. 30P7 described below. A real bargain at only £57.50. Order ref: 57P1.

REAL POWER CAR SPEAKERS. Stereo pair output 100W each. 4-Ohm impedence and consisting of 6.5in woofer, 2in mid range and 1in tweeter. Each set in a compact purpose built shelf mounting unit. Ideal to work with the amplifier described above. Price per pair £29.96. Order ref: 30P7.

STEREO CAR SPEAKERS. Not quite so powerful - 70w per channel. 3in woofer, 2in mid range and 1in tweeter. Again, in a super purpose built shelf mounting unit. Price per pair: £27.95. Order ref: 28P1.

VIDEO TAPES These are three hour tapes of superior quality, made under licence from the famous JVC Company. Offered at only £3 each. Our ref 3P63. Or 5 for £11. Our ref 11P3. Or for the really big user 10 for £20. Our ref 20P20.

ELECTRONIC SPACESHIP. Sound and impact controlled, responds to claps and shouts and reverses when it hits anything. Kits with really detailed instructions. Ideal present for budding youg electrician. A youngster should be able to assemble but you may have to help wiht the soldering of the components on the pcb. Complete kit £10. Our ref. 10P81.

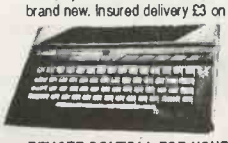
12" HIGH RESOLUTION MONITOR Black and white screen, beautifully cased for free standing, needs only a 12v 1.5 amp supply. Technical data is on its way but we understand these are TTL input. Brand new in makers' cartons. Price: £22.00 Free delivery. Order ref: 25P10.

14" COLOUR MONITOR made by the American Display Tek Company. Uses high resolution tube made by the famous Japanese Toshiba company. Beautifully made unit intended for console mounting, but top and sides adequately covered by plated metal panels. Full technical spec, on its way to us. We have a limited number of these. All brand new still in maker's cartons. Price: £89 each plus £6 insured carriage. Order ref: 89P1.

COMPOSITE VIDEO KITS. These convert composite video into separate H sync, Vsync and video. Price £8.00. Our ref 8P39.

BUSH RADIO MIDI SPEAKERS Stereo pair. BASS reflex system, using a full range 4in driver of 4 ohms impedance. Mounted in very nicely made black fronted walnut finish cabinets. Cabinet size approx 8.5in wide, 14in high and 3.5in deep. Fitted with a good length of speaker flex and terminating with a normal audio plug. Price £5 the pair plus £1 post. Our ref 5P141.

3.5in FLOPPY DRIVES We still have two models in stock: Single sided, 80 track, by Chinon. This is in the manufacturers metal case with leads and IDC connectors. Price £40, reference 40P1. Also a double sided, 80 track, by NEC. This is uncased. Price £59.50, reference 60P2. Both are brand new. Insured delivery £3 on each or both.



ATARI 65XE COMPUTER At 64K this is most powerful and suitable for home and business. Brand new, complete with PSU, TV lead, owner's manual and six games. Can be yours for only £45 plus £3 delivery.

REMOTE CONTROL FOR YOUR 65XE COMPUTER With this outfit you can be as much as 20 feet away as you will have a joystick that can tramsmit and a receiver to plug into and operate your computer and TV. This is also just right if you want to use it with a big screen TV. The joystick has two fire buttons and is of a really superior quality, with four suction cups for additional control and one handed play. Price £15 for the radio controlled pair. Our ref 15P27.

ASTEC PSU. Mains operated switch mode, so very compact. Outputs +12v 2.5A, +5v 6A, +-5v .5A, +-12v 5A. Size: 7.5in long x 4.75in wide x 2.25in high. Cased ready for use. Brand new. Normal price £30+, our price only £12.95. Order ref 13P2.

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PHILIPS LASER

This is helium-neon and has a power rating of 2mW. Completely safe as long as you do not look directly into the beam when eye damage could result. Brand new, full spec. £30 plus £3 insured delivery. Mains operated power supply for this tube gives 8kv striking and 1.25kv at 5mA running. Complete kit with case £15. As above for 12V battery. Also £15. Our ref 15P22.

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

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HIGH RESOLUTION MONITOR. 9in black and white, used Philips tube M24/306W. Made up in a lacquered frame and has open sides. Made for use with OPD computer but suitable for most others. Brand new. £16 plus £5 post. Our ref 16P1.

12 VOLT BRUSHLESS FAN. Japanese made. The popular square shape (4.5in x 4.5in x 1.75in). The electronically run fans not only consume very little current but also they do not cause interference as the brush type motors do. Ideal for cooling computers, etc., or for a caravan. £8 each. Our ref 8P26.

MINI MONO AMP on p.c.b. size 4in x 2in (app.) Fitted Volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with amp. Brand new, perfect condition, offered at the very low price of £1.15 each, or 13 for £12.00.

POWERFUL IONISER

Generates approx. 10 times more IONS than the ET1 and similar circuits. Will refresh your home, office, workroom etc. Makes you feel better and work harder - a complete mains operated kit, case included £12.50 + £2 p&p. Our ref 12P5/1.

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POPULAR ITEMS - MANY NEW THIS MONTH

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

TELEPHONE TYPE KEYPAD. Really first class rear mounting unit. White lettering on black buttons. Has conductive rubber contacts with soft click operation. Circuit arranged in telephone type array. Requires 70mm by 55mm cutout and has a 10 IDC connector. Price £2.00. Ref. 2P251.

SUB-MIN PUSH SWITCHES Not much bigger than a plastic transistor but double pole PCB mounting. 3 for £1.00. Our ref BD688.

AA CELLS Probably the most popular of the rechargeable NICAD types. 4 for £4.00. Our ref. 4P44.

20 WATT 4 OHM SPEAKER With built in tweeter. Really well made unit which has the power and the quality for hifi 6.5in dia. Price £5.00. Our ref; 5P155 or 10 for £40.00 ref. 40P7.

MINI RADIO MODULE Only 2in square with ferrite aerial and solid dia. tuner with own knob. It is superhet and operates from a PP3 battery and would drive a crystal headphone. Price £1.00. Our ref. BD716.

BULGIN MAINS PLUG AND SOCKET The old and faithful 3 pin with screw terminals. The plug is panel mounted and the socket is cable mounted. 2 pairs for £1.00 or 4 plugs or 4 sockets for £1.00. Our ref. BD715, BD715P, or BD715S.

MICROPHONE Low cost hand held dynamic microphone with on/off switch in handle. Lead terminates in 1 3.5mm and 1.25mm plug. Only £1.00. Ref. BD711.

MOSFETS FOR POWER AMPLIFIERS AND HIGH CURRENT DEVICES 140v 100watt pair made by Hitachi. Ref 2SK413 and its complement 2SJ118. Only £4.00 a pair. Our Ref. 4P42.
Also available in H pack Ref 2SJ99 and 2SK343 £4.00 a pair. Ref 4P51.

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

A REAL AIR MOVER Circular axial fan moves 205 cubic foot per min which is about twice as much as our standard 4.5in fans. Low noise mains operated 6.5in dia, brand new. Regular price over £30.00. Our price only £10.00. Our ref 10P71.

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EX-EQUIPMENT SWITCHED MODE POWER SUPPLIES Various makes and specs but generally +-5, +-12V ideal bench supply. Only £8.00. Our ref 8P36.

ACORN DATA RECORDER Made for the Electron or BBC computer but suitable for others. Includes mains adaptor, leads and book. £12.00. Ref. 12P15.

PTFE COATED SILVER PLATED CABLE 19 strands of .2mm copper will carry up to 30A and is virtually indestructible. Available in red or black. Regular price is over £120 per reel. Our price only £20.00 for 100m reel. Ref. 20P21 or 1 of each for £35.00. Ref 35P2. Makes absolutely superb speaker cable!

NEW PIR SENSORS Infra red movement sensors will switch up to 500w mains, UK made, 12 month manufacturers warranty, 15-20m range with a 0-10min timer, adjustable wall bracket. Only £20.00. Ref 20P24.

MITSUBISHI 3.5IN DISC DRIVES Brand new drives, 1/2 height double sided, double density warranted. Our price £60.00. Ref. 60P5.

10 MEMORY PUSHBUTTON TELEPHONES These are customer returns and sold as seen. They are complete and may need slight attention. Price £6.00 Ref 6P16 or 2 for £10.00 Ref 10P77 BT approved.

NON-MEMORY PUSHBUTTON TELEPHONES. Same condition as above with redial £3.00. Our ref. 3P79. BT approved.

DEHUMIDIFIERS Domestic mains powered dehumidifiers these are customer returns and sold as seen. Price £30.00. Our ref 30P9. Callers only please. Also working dehumidifiers at £99.00 each.

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

SPECTRUM SOUND BOX Add sound to your Spectrum with this device. Just plug in. Complete with speaker, volume control and nicely boxed. A snip at only £4.00. Our ref. 4P53.

BBC JOYSTICK INTERFACE Converts a BBC joystick port to an Atari type port. Price £2.00. Our ref. 2P261.

TELEPHONE EXTENSION LEAD 5m phone extension lead with plug on one end, socket on the other. White. Price £3.00. Our ref. 3P70 or 10 leads for only £19.00! Ref. 19P2.

LCD DISPLAY 4.5in digits supplied with connection data £3.00. Ref. 3P77 or 5 for £10. Ref. 10P78.

CROSS OVER NETWORK 8 Ohm 3 way for tweeter midrange and woofer nicely cased with connections marked. Only £2.00. Our ref. 2P255 or 10 for £15.00. Ref. 15P32.

REVERSING LIGHT ALARM Fits to car reversing light and sounds when reversing. Only £2.00. Our ref. 2P248.

BASE STATION MICROPHONE Top quality uni-directional electret condenser mic 600r impedence sensitivity 16-18KHz - 68db built in chime complete with mic stand bracket. £15.00. Ref. 15P28.

MICROPHONE STAND Very heavy chromed mic stand, magnetic base 4in high. £3.00 if ordered with above mic. Our ref. 3P80.

SOLAR POWERED NICAD CHARGER 4 Nicad AA battery charger. Charges 4 batteries in 8 hours. Price £6.00. Our ref. 6P3.

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

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

PIR SENSORS Suitable for alarm systems etc. Nicely boxed. Priced at only £10.00. Our ref. 10P79.

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HI-TECHING TRAMS

Neil Harding describes how modern electronics has retrained ancient technology and steers trams to the Future.

Even though the Adelaide-Glenelg tramway system, in South Australia, employs trams which are now over 50 years old, some of the latest technologies available are installed within the system. This article looks briefly at the history of the tramway and the use of those technologies.

Trams have been operating on the 11-kilometre double track lines from Adelaide to Glenelg since 1923, using 64 seater vehicle. At that time the main offices and depot were situated in Victoria Square in Adelaide, with the depot having the use of 19 tramway bays, although there were only formally 11 in use.

NEW DEPOT

In 1986 a new depot and administration offices were opened at Glenowrie and all maintenance and operation facilities were transferred to the Glenowrie centre, called the Morphetville Tram Depot.

The previous method of permitting tram movements into and out of the old depot in Adelaide had been by the use of mechanical point switches operated by mechanical levers and rodding. This system was a very time consuming operation as the driver/motorman of the tram would have to stop the tram, secure the parking brakes, disembark, operate the point levers and then re-embark.

This method, whilst it worked and was acceptable for the old depot, was clearly not feasible for access to and from the new Morphetville Tram Depot as the latter lies in such a position that it can only be accessed by the trams via the traversing of one or two road/rail crossings. Fig.1 shows the layout of the depot in relation to the tramways and the roads. It can very clearly be seen that a tram entering or leaving the depot from or towards the Glenelg direction would have to traverse Maxwell Terrace. A tram from or to the Adelaide direction, though, would not only have to cross Maxwell Terrace but would also have to cross Morphet Road. if the driver/motorman had to go through the old procedure every time his tram had to enter or leave the depot, the queues of road traffic waiting at the two road/rail crossings would be very large.

FEASABILITY

Hence the only feasible solution for this problem at Glenowrie would be to have motor operated point switches which could be remotely controlled from the driving cabs of the trams. But, then, some form of signalling system would have to be introduced, to ensure that trams could not negotiate the point switches whilst those switches were still traversing. In turn, it would be essential to interlock the signalling system to the road/rail crossings to ensure that road traffic movements and tram movements which conflicted could not possible be made simultaneously. Thus here is a perfect example of a simple concept developing into a very complex system indeed.

POINTING OPTIONS

The administrative body looked at several options available to solve the problem before selecting the system which is actually in use today.

Operation of the point switches is made by the use of standard "railway signalling" type motorised point machines. These machines are used by several railway administrations on their main line railway systems. At Glenowrie the point switches are only operated when a tram is required to enter or leave the depot. Otherwise tram movements are on the main tramway lines only and the point machines are therefore not required at that time.

The actual operation of the point machines is controlled by a very complex and high technological process. In each of the driving cabs of the 22 trams fitted out with the system, there is installed a selector device which bears the nomenclature of *left* and *right*. The selectors are electrically connected to an electronic system which automatically records the direction chosen and transmits a frequency which is unique to the direction selected. This transmission is made via an antenna which is centrally configured on the underbody of the chassis of each tram.

At the depot exit, prior to reaching the exit point swtiches, and at 600 metres away from the depot on the main lines, are located trackside loops of cable connected to receivers installed in an equipment location case alongside. These loops are indicated in the signalling layout shown in Fig. 1. The receivers are able to detect the two frequencies in use on the system, that is, those corresponding to *left* and *right* only.

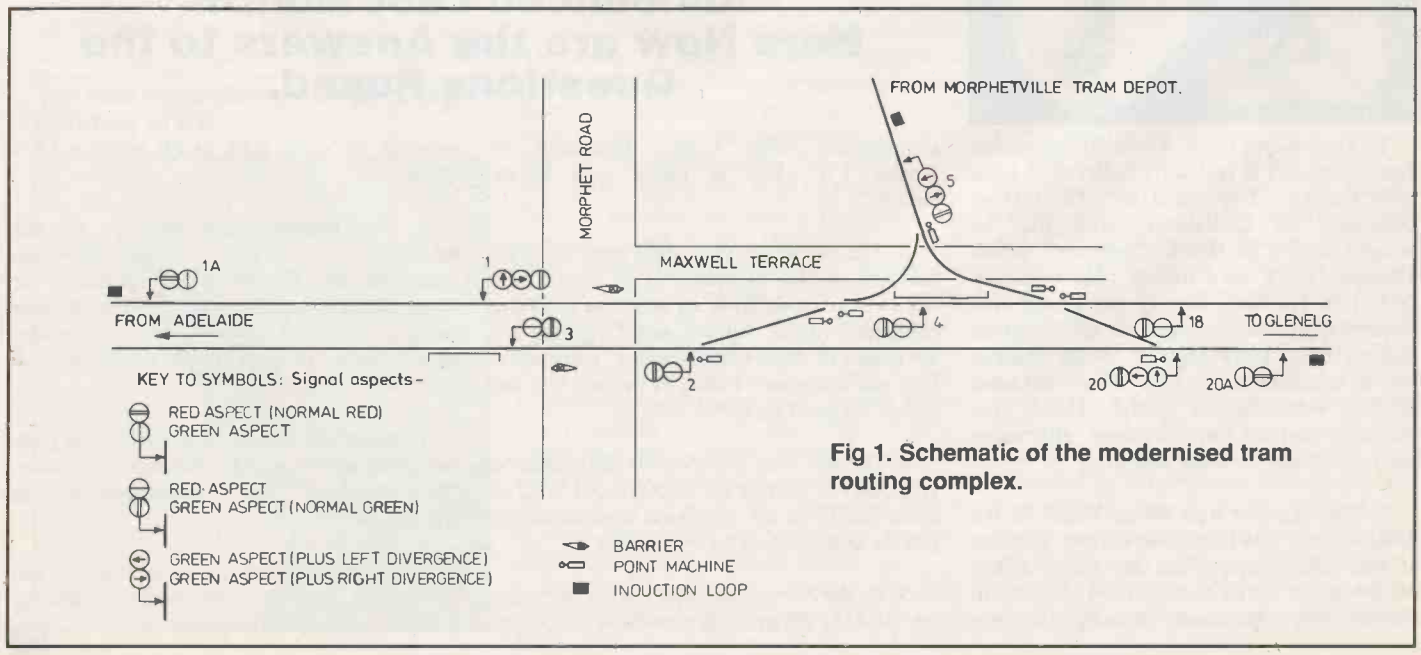

Fig 1. Schematic of the modernised tram routing complex.

SELECTIONS

When the motorman wishes to take the tram through the points he operates the selector corresponding to the direction while passing over one of the track-side loops, indicated by trackside signposts.The transmitter relevant to that direction is activated and this automatically transmits an electronic signal to the loop. This, through inductance, detects the signal and passes it to the receiver, which registers that a request for a route in the respective direction has been made. This request is passed to the signalling interlocking which, providing it is safe to do so, permits operation of the point switches as required, throughout the extent of the route into or out of the depot.

If the motorman does not operate the selector whilse immediately over the inductive loops, he is able to stop the tram and operate a manual lineside operating panel. This is situated in a locked, secure box at the trackside and repeats the selection available from the driving cab. The panel is linked to the receiving equipment as before.

INDICATORS

In order that the motorman knows that the point switches have been operated and the desired route selection has been secured, some form of indication system is required. In a main line signalling installation, this would be via the use of 2, 3 or 4 aspect signals, which are different in profile when compared to a road traffic signal. Since the motormen, being non-railway personnel, would not be familiar with railway type signals, road traffic type signals of the "stop/go" type were installed, with the amber aspect not being used. In addition, in order to incorporate a form of "junction indication", the green aspect is, in some cases, in the form of a direction arrow. The profiles of the signals actually used are also indicated in Fig.1.

INTERLOCKING

In order to provide a safe system of operation, a railway-type route relay interlocking system is used. Thus points can only be selected and set in their required positions if all the signal routes are first determined to be in their fully normalised positions. That is, all respective signals are at red without the possibility of being allowed to show a proceed aspect. Conversely, no signal will be allowed to display a proceed aspect until all required points have been called and locked in the correct position for the signal route in question. As previously described, the point *calling* is carried out by the operation of the motorman's selector in the cab or by the lineside panel. After the points have been set and locked, the signals are cleared to proceed aspects automatically, providing all requirements of the interlocking have been met. After the tram has passed through the signalled route, the signals are then restored to danger (red) aspect and the point switches are "self-restored" to their normal positions for main line running.

In addition, the integrity of the Maxwell Terrace traffic lights and the Morphet Road barriers and road lights is ensured, as their controls are also incorporated into the interlocking system.

Track circuitry is provided throughout the signalled area thus ensuring the safety of the trams as well as permitting full control of the signalling to be made.

PANTOGRAPHS

Thus, in a tramway system that is over 50 years old, up-to-date technology is employed to ensure its swift and efficient operation. But the high technology does not end there. Gone are the sprung contact pick-up rods which provided the electrical energy to the trams in the past. Instead, modern pantograph pick-ups, as fitted to main line railway electric rolling stock, are used to provide continuous energy both efficiently and with less overall wear to contact supply wires, for the operation of the trams.

All of which proves you don't necessarily have to scrap a system just because it becomes old. PE

CELEBRATED ANSWERING!

The Winners of our Fabulous 25th Anniversary Competition were Announced Last Month. Here Now are the Answers to the Questions Posed.

1. Archimedes (after whom Acorn named their computer) is popularly believed to have said "Eureka - I've found it!". The Oxford Dictionary of Quotations states that he actually said it in Greek, "ευπνκα", which translates as "I have found!". He reputedly said it in his bath, having recognised that water displacement related to an immersed object's bulk, knowledge of which enabled him to calculate that a gold crown had been alloyed with another metal. Hence the reasoning behind my fictitious alternative answers relating to water and gold!

2. The "Lovely Rita Meter Maid" in the Beatles' song was Rita. (Not Cirkita, as some of you said, spotting that the meter aspect related to to Cirkit's meters!) I decline to answer any questions relating to my acquaintance with Lolita, Margarita or Annita. I'll admit to liking pitta bread, though!

3. The tree which you might associate with the Archimedes computer is of course the oak, which grows from an acorn, as does the computer! Apple, Apricot and Tangerine are the names of other manufacturers' computers. Elm and Sycamore were just thrown into the woods for good measure.

4. The hex code for 25 is 19 (26 would be 1A). XXV is Roman for 25,00011001 is 25 in binar, but TF is not a numeric representation, just the initial letters for twenty five.

5. At the November 1989 UK subscription rate of £15, the minimum monetary value of winning 25 years subs to PE is 25 x 15 = £375.

6. The common link between Sinclair Radionics, Shaye Communications, Anamartic and Cambridge Computers is Sir Clive Sinclair, who was responsible for their creation. You had access to this info in my potted history of Sir Clive in the same issue as the competition.

Thanks to all of you who entered this great competition; we had an enormous response. Congratulations and commiserations as appropriate!

Our special thanks, too, to Acorn and Cirkit for their kind generosity in making available such splendid prizes. PE

TRACK FEEDBACK

SAGELY ANSWER

Dear John

I was interested to read the 'Ask PE' section of Sept 89 on dc analogue control since this is something I have been connected with for many years. In fact I even wrote an article which was published in PE Sept 86 describing how to achieve dc control very simply at low cost and low distortion by using diodes. It gives better performance, is less complex and lacks the switching noise of Andrew Armstrong's solution. I also described how to achieve series or parallel control, plus tone control, all with diodes. Your readers may care to read the article.

Thank you also for printing my open letter to the Recording Industry in PE Nov 89.

Les Sage, Sage Audio Electronics, Bingley, W. Yorks.

Thanks for the reminder Les. Andrew, of course, does not necessarily claim that his answers to the Ask PE questions are the ultimate solutions, only that they represent one possible approach. Photocopies of Les's Sept 86 article are available from our offices at £1.00 (overseas £1.50) postage included; it is entitled 'DC Control of Analogue Signals'. Ed.

PLEAS AND THANKYOUS

Dear Ed,

I am writing to thank you, your staff and Atari for the Atari Portfolio which I won in your July 89 competition.

I have now received the Portfolio and I must admit to being pleasantly surprised by its design. My expectation that it would be little more than a toy (with membrane keyboard and abs case that would fall apart in a week) could not have been more wrong. The keyboard is small but very usable and the inbuilt applications are much more useful than I had expected.

May I also occupy a bit of space in your magazine with a plea on behalf of the Queen's University of Belfast Radio Club, of which I am the secretary. We have recently received a DEC PDP11/23 computer which was, very generously, donated to us by British Telecom. However, we are in need of various expansion boards for it. So if any of your readers know of any old Q-Bus boards which might be donated then we would be very pleased to hear from them. (Our Club callsigns, by the way, are G13llQ and G18FQB.)

Mike Harron, Lisburn, Co Antrim.

Another happy reader! Can anyone make him even happier by answering his plea? If you can, call him direct on the daytime number of 0232 245133 ext 3777, or via the club call signs. (Not via PE please!) Ed

GREAT SCOPE

Dear Ed,

As one of the winners in the Maplinoscopy competition, I would like to thank you for this excellent piece of equipment. I was absolutely delighted to receive it.

I am currently a second year Electronic Engineering student at Southampton University, and due to limited funds could never afford such equipment. As well as studying electronics, I am also a keen electronics hobbyist and this oscilloscope will be very useful in helping me to get my projects working.

I have subscribed to PE for about seven years and have always found it very informative and interesting.

Geoffrey A. Harris, Bromyard, Herefordshire.

What a worthy winner! We all send our very best wishes for a successful career in electronics. Ed.

PRIME NOTE

Dear Sir,

I wish to thank you for the £5 award in connection with your recent survey.

Congratulations also on the 25th Anniversary. I am an avid reader of PE and still have the first copy that was published.

N. Dobson, Carrville, Durham.

Although I too have read PE since Issue One, I don't have a personal copy of it. (We have a couple at the office though!)

There's a sad tale regarding my early back issues. As you may have read in PE Nov 89, I used to be a film editor and sound recordist . Electronics at that time was simply a hobby. It was a hobby, though, that began to interfere with film making.

In about 1968, I rashly decided to finally rid myself of the electronics problem. Consequently, one dull day, I had a bonfire of all my electronics mags! And all my stock of electronic bits and pieces were given to a local school.

The drastic action didn't work, though, and within a year or two I'd bought a new soldering iron and reinstated my order for regular copies of PE. Such is life! Ed.

BOOKED

Dear Mr Becker,

Having just received and read with the usual interest the December PE issue, I found especially interesting and helpful your Bookmark section, and hope that as opportunity occurs, you will continue to present this occasional feature.

R.T. Lovelock, Exeter, Devon.

It is a feature which, from time to time, I shall continue to present. I know that many people find the column of interest, and I too find interest from perusing the new books that come in.

Thank you also, Mr Lovelock, for the comments and suggestions you made concerning my Amstrad 1640 computer. Ed.

CAT FLAP

Dear Ed,

My son and myself are trying to design a catch for a cat flap which would be operated by a solenoid which in turn would be activated by a magnet on the cat's collar.

Has PE published anything on these lines?

W.R.Peach, Letchworth, Herts.

Not yet, but I'm working on it! My wife and I have a cat, an extremely contrary cat (Rosie by name, but not by nature!), and she will only use her cat door if the flap is either left fully open, or if someone opens it for her. This contrariness has on occasion resulted in unexpected carpet- cleaning expenses.

Animated by the thought of a technological answer I started work on a fully automated flap controller that would open the door on feline demand. When half way into experimental research other obligations pushed the experiments to one side: summer hols came along, then PE's anniversary issue, then my signal generator and echo station and other projects had to be designed, and so it goes on - not yet completed. Despite the cold weather, we have simply left the cat flap fully open. One day though, I might get time to automotivate moggy's doorway, an action which hopefully will cut out the cost of unwittingly feeding all the other local cats who cannot resist an open invitation to an illicit free feast! Ed

MONUMENTAL TECHMOLEGY

Dear Editor,

My own battles with a valiant mole were vividly recalled on reading Edwin Chicken's description of an electronic deterrent in PE Sept 89 and your footnote on the subject (Nov 89 Letters).

I had tried most of the remedies in Mr Chicken's list and many others designed to discourage rather than to maim. What was to be my 'final solution' resembled Mr Chicken's device in attacking the mole via its auditory canal. It consisted of a string of six audible warning devices inserted in the network of runs under my lawn. The 1600Hz signal was emitted in one second bursts controlled by a pair of slugged relays in the 12V power supply.

Victory at last! I could now look forward to long hours in a deck chair in place of the unremitting task of mole hill removal. A barrow load and a half was an average night's work for my mole.

Peace reigned, until about a week later I was awakened at 2am by an instantly recognisable noise. Investigation revealed three bleepers bleeping on top of three truly monumental mole hills. My wife and I moved house shortly afterwards - our final solution!

Geoffrey Fallon, Melbourne, Derbyshire.

One of my animal books suggests that to be totally sure of being mole-free you may need to move to Ireland, the Shetlands, Orkneys, Outer Hebrides or the Isle of Man which, apparently, are uninhabited by moles!

However, there might be another less drastic solution offered by technology. Moles cannot bear strong light, so perhaps those who are mole-ested could try installing strip-lighting along the mole tunnels! Ed

Keep the letters coming, folks! We're always pleased to hear what you think and say.

POINTS ARISING

Video AGC (Dec 89)
Fig 2. 2nd TR1 is TR2.
Fig 4. Reverse positions of R1 and R2.

Eeprom Programmer (Jan 90)
Fig 4. IC5 pin 4 also goes to IC2 Pins 3 and 15.
Fig 10. The link to IC3 pin 21/R6 should go to IC3 pin 20. Arrow 14 then goes on IC3 pin 21.

LOW BATTERY WARNING

The circuit shown in Fig 1. provides a flashing warning when the battery supply voltage drops to around 8V, and increases in rate as the voltage drops further, indicating the need for battery replacement, or recharging if a nicad is used. Additionally, the led will flash once at switch on and again at switch off. The circuit takes up little space and draws only a few tens of μA in the off condition.

The circuit is essentially an emitter coupled bistable or Schmitt trigger with an RC network between TR1 collector and TR2 base. The low level trip point is set by the preset pot.

At battery levels above the set trip point, TR1 is on, holding TR2 off. As the battery voltage falls towards the cut off point of TR1, TR2 should turn on sufficiently. The capacitor charges up enough to allow TR2 to turn on, briefly flashing the led.

The on time is approximately (at the trip point):

100k x 0.22μF = 22ms

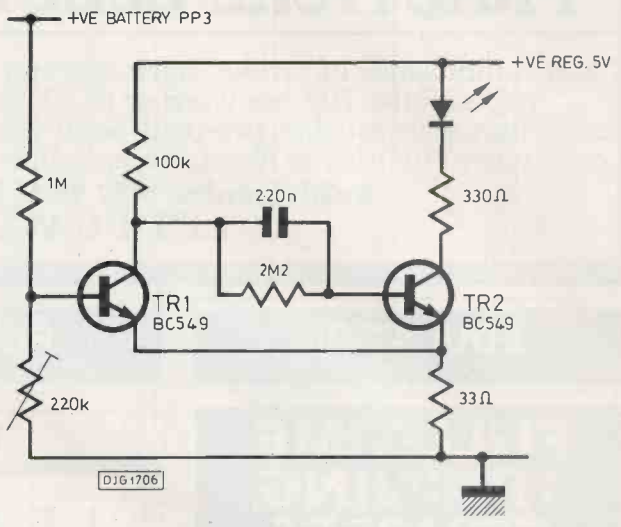

Fig 1. Circuit diagram for the low battery warning idea.

A selection of novel ideas from enthusiastic readers

PE has not tested the ideas presented in Ingenuity Unlimited and cannot guarantee that they will always behave as described. We offer them to you as a source of inspiration!

INGENUITY UNLIMITED

and the off time is

2M2 x 0.22μF = 0.48s.

The Shmitt action, via the shared emitter resistor on the Vbe of TR2, and decreasing hysteresis as the primary voltage falls, causes the rate of flash to increase until the battery voltage is so low that the circuit ceases to function, the led only glowing faintly.

If required, other devices may be inserted in the TR2 collector path, for example, a self flashing led or a 555 timer driving an audible warning device. In these cases the RC network is deleted, the collector of TR1 being connected directly to the base of TR2 restoring full Schmitt action. That is when the lower trip point starts the warning signal it will continue during recovery of the supply voltage until the upper trip point is reached. The hysteresis voltage is determined by the shared emitter resistor, as mentioned above.

The circuit may be used with a common positive supply rail but of course the preset will have to be adjusted to set the lower trip point. The warning circuit was developed as a means of limiting the damage to rechargeable NiCd batteries either by running them to exhaustion or by unnecessary recharging at minor levels of discharge. The lower trip point may be set so that there is an adequate level of reserve capacity. For example, if a NiCd PP3 battery is the primary source the trip level may be set at about 7.5 volts.

Nigel Chaffery, Forest Hill

VOLTAGE TRIMMING

Dear Ed,

Here's a nice simple circuit in Fig 2 which PE readers might find useful: fine and coarse voltage trimming with two pots in series.

VR1 dual linear pot - Resistance R1
VR2 single linear pot - Resistance R2
(R2 <<R1)

As the wipers of VR1A and VR1B are connected in mirror image P1 + P2 = R1 at all times. Thus:

$$V1 - V2 = V1x \left(\frac{P2 + R2}{R1 + R2} - \frac{P2}{R1 + R2} \right)$$

$$= \frac{V1xR2}{R1 + R2}$$

The range of VR2 is constant and is moved up and down by VR1. The system is equal to one pot with a two speed drive but is far cheaper. Here under some examples of ranges:

VR1	VR2	VR2 range
100	47	0.3 Vi
100	22	0.18 Vi
100	10	0.090Vi

B. Balet, Castlecove, Eire.

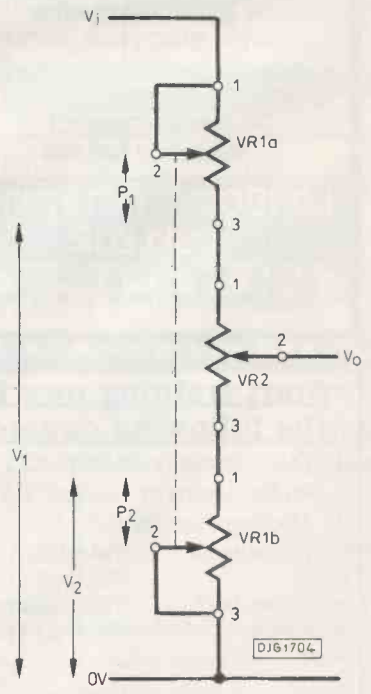

Fig 2. The simple but useful method suggested for voltage trimming.

PE

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2·2/35, 4·7/25, 10/5 – 15p 4·7/35, 6/8/16 – 16p 10/16,22/6 – 20p
22/16 – 30p 33/10 – 30p 47/10 – 35p 100/6 – 40p

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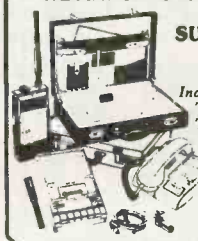

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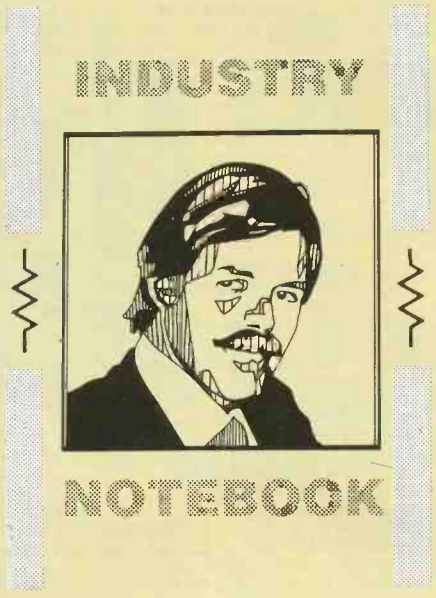
ELECTRONICS IN A NEW EUROPE

By Tom Ivall

Even 1992 may bring fewer changes than the end of the Cold Wars.

"History is speeding up", said Jacques Delors, president of the European Commission, in a recent oration. Nobody watching the astonishing tide of political change sweeping across Eastern Europe in the last few months of 1989 could fail to agree with him. Democracy sprang into vigorous life, seemingly out of its coffin, and overcame totalitarianism. State controlled economies suddenly recognised the superior efficiency of the free market. Cold War warriors who had lived on 40 years of confrontation between capitalism and communism were swiftly packed off into retirement.

But what does all this mean for the electronics industry in particular? Obviously there is the potential for a much bigger common market - bigger than the present 12-member EEC. Trade would expand generally and with it the European electronics industry (including the Japanese investment input already well placed to cash in).



How all this would work out in detail we can't yet know. At one extreme there is the grandiose idea of an integrated Europe of 36 countries stretching from the Urals to the Atlantic. At the other extreme we are now busying ourselves with the nitty-gritty of making the existing, 30-year-old EEC actually work as a true common market.

When the EEC was formed by the Treaty of Rome in March 1957 many people, including myself, naively thought that trade between the member countries would automatically be freed from impediments in a matter of a year or two. But it didn't happen. Even when the UK joined the Community (in 1972) trade was still gummed up by all manner of restrictions. Then in 1983 an international group of economists told the European parliament that its failure to achieve a full common market in goods and services was leaving the EEC further and further behind the USA and Japan. In other words the system wasn't working.

This situation led to what is now called, somewhat cryptically, "1992". The EC heads of governments got together and in 1985 brought out the Single European Act. By this they committed themselves to achieve a true common market by the end of 1992. Officially this single European market is defined as "an area without internal frontiers in which the free movement of goods, persons, services and capital is ensured in accordance with the Treaty of Rome."

In our own field of electronics manufacturing one of the main impediments to this free movement of goods has been the lack of technical standardisation. We all know about it, from simple plugs and sockets upwards. In fact there are so many different 'standards' around that the term itself has become a bit of a joke. All honour to Philips who, years ago, gave away their patent on the audio tape cassette to the rest of the world so that any cassette could be recorded or played on any machine anywhere.

In Europe these technical barriers to trade are now being broken down by a centralised authority for standardisation. It's called CENELEC, an acronym meaning the European Committee for Electrotechnical Standards. The individual countries contribute to its work through their own national standards organisations, like our BSI.

Once CENELEC has brought out a particular standard all the countries concerned have to produce identical national standards. Manufacturers everywhere have to demonstrate that their equipment conforms to the agreed standard, and only then is the product given the EC stamp of approval for general sale throughout the Community. The whole system has the authority of Community law behind it, as arrived at democratically by the European Parliament, Council of Ministers and Commission.

On the commercial side there are various other obstacles to the free movement of electronics goods throughout the EC. These include such things as national subsidies and government purchasing policies. They distort the normal competition of a free market. If "1992" is to be a reality, all these barriers to trade will have to be swept away.

A particular sector of electronics manufacturing which could be greatly affected by the political changes in Eastern Europe is military electronics. Unless anything dramatic happens just before this report appears in print, it looks as though the Cold War has really ended. The ideological bigotry, political fanaticism and irrational hatred on both sides which kept the whole thing going for nearly half a century are at last being seen for what they really are: frightening aberrations of the human mind.

On a more mundane level, the USSR doesn't want its economy to be permanently crippled by military spending. The USA too is glad to be able to save money in this part of its national budget and is already getting down to details.

Electronic technology accounts for an enormously wide range of aids to destruction in modern warfare. Radar, computers, radiocommunication, surveillance satellites, missile and torpedo control systems, navigation, sonar, electronic countermeasures, sensors, imagers, simulators, are probably the main items in a lengthening list of applications. But if armaments are reduced generally as a result of lessening tension between the NATO and Warsaw Pact blocs then the demand of these electronic systems will decrease as well. Military electronics manufacturers will feel the pinch in reduced orders, sales and profits.

Speaking for myself, I am glad about this. I'm not particularly proud to have worked in an industry which makes substantial profits out of death, suffering or the threat of these. Like the Quakers, I believe that the worst aspect of war is the hatred it engenders between people. Mere possession of weapons, loaded and ready, has the same effect.

Imagine, for example, that the people in the house opposite yours started to fit up their front garden with machine-guns, mortars, missile launchers and the like, all pointed directly at your home. In response to your alarmed enquiry about this, the head of the household opposite says: "Please don't worry. We're a peaceful family. It's all purely for defence." How would you feel? Would you be reassured by this explanation? The most likely outcome is that you would feel threatened and would start to do the same - purely for defence, of course.

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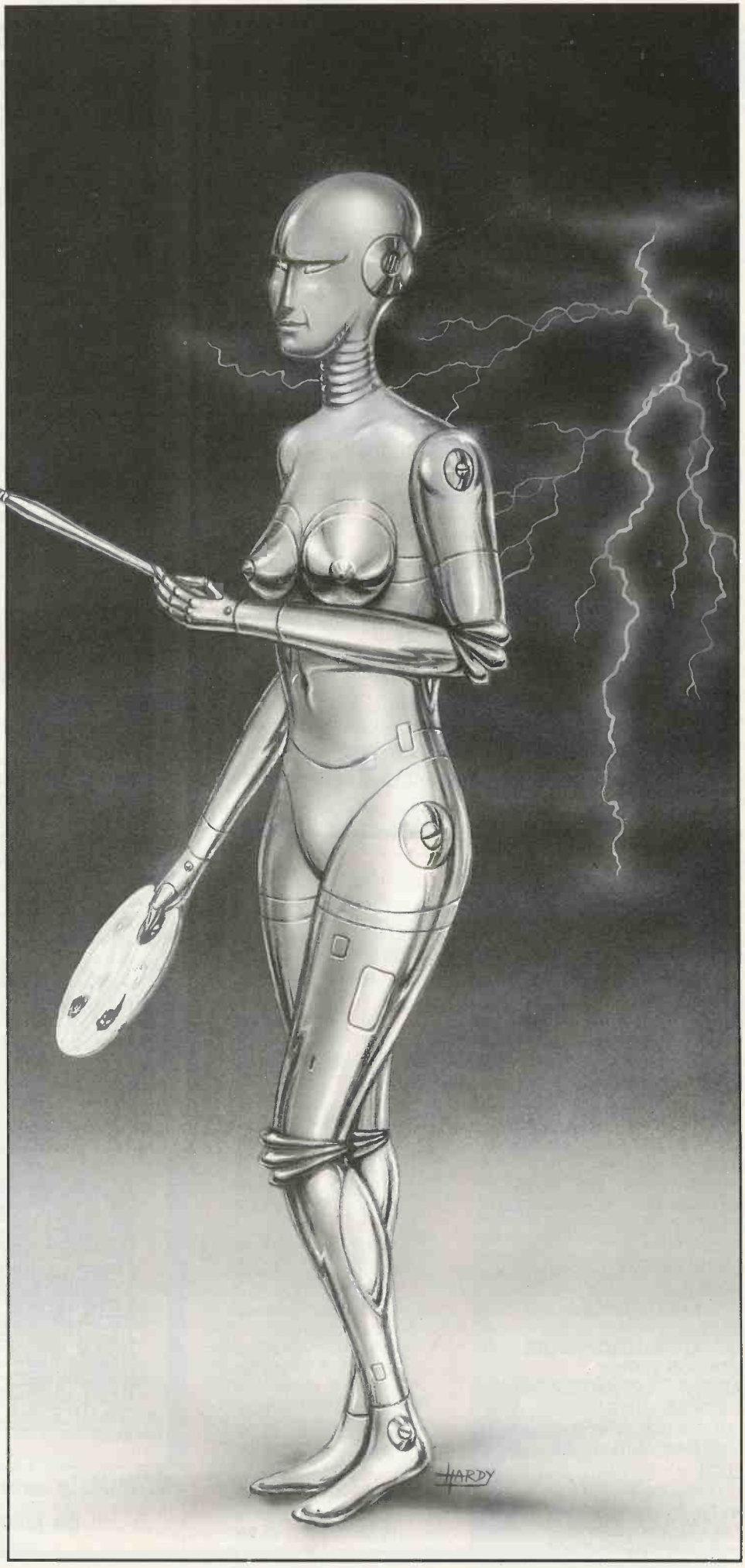

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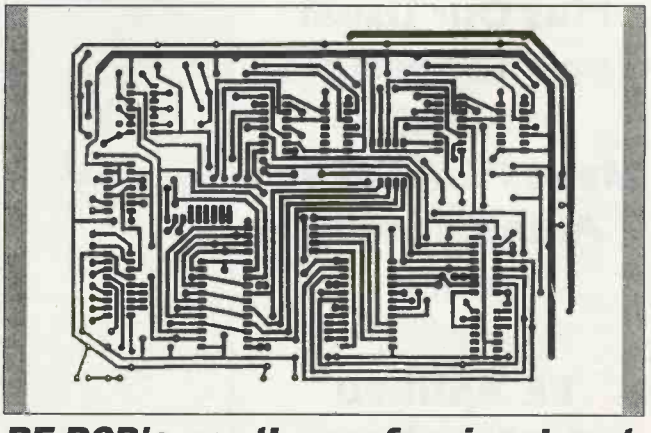

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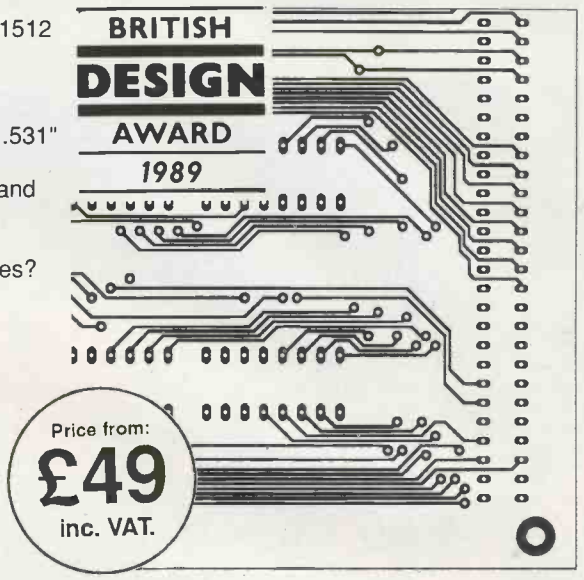

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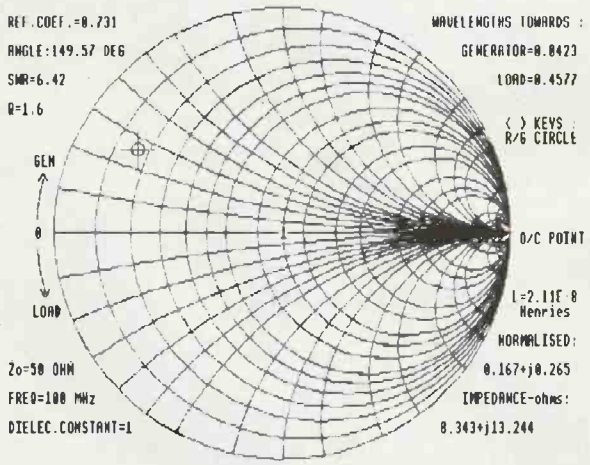

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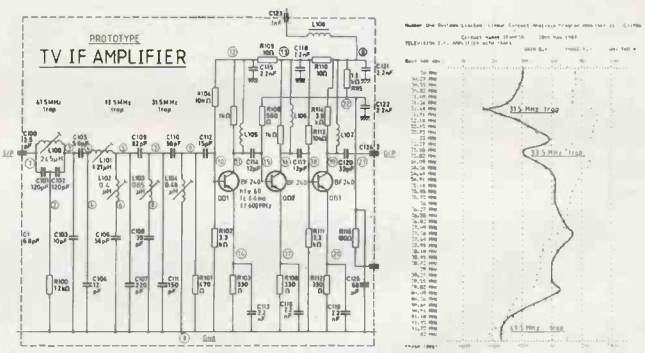

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