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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
ON SALE FROM FRIDAY MARCH 2ND
YOU CAN'T BEAT OUR VALUE
OR OUR CELEBRATED OFFERINGS!
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 equipment 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.

Ward Electronics are a company devoted to addicted electronic divers! If you want to make your own pcb, you really should have Ward’s list of pcb materials.

Verospeed’s massive new catalogue has an enticing flash across its front cover: “Stop dreaming, start collecting”. The slogan is appropriate in two worldwide ways since the catalogue is not only one you should collect, and because Verospeed are a member of the Air Miles scheme. There are several worthwhile ways since the catalogue is most certainly one you should collect, and cover: “Stop dreaming, start collecting”. The slogan

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 returns when you order your goods from their detailed selection. Electrovalue Ltd. 28 St Judes Road, Englefield Green, Egham, Surrey, TW20 0HB. Tel: 0784 43,3603.

Litesold have a range of products that are vital to any electronics constructor. Whether an early starter still hitching his way through homemade 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 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 test, or when front panels, no doubt!). Litesold can be more formally addressed as Light Soldering Development 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 : 0659 884585.

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Texas Instruments Ltd (TIL) has once again contributed itself to the programme. 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.

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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 the vcr that previously was recording connections so that the playback front panel transposes all the relays in the unit. A switch on the recorders to be permanently and changeover kit has been

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

The Video dubber kit is coded LM71N and costs £49.85, 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.
LINE LOGGING

Rnowned for their Revox tape recorders, 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 peak to peak.

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 4.5% 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, LL21 2BP. Tel: 0978 833920.

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.


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


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 rings, 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.

SWITCH APPEAL
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 complementary 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 7m long monobeam 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 Raychem, Wards, Faraday Road, Dorcan, Swindon, Wiltshire SN3 5HF. Tel: 0793-482138.

SPASHPROOF 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 annunciation. 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. 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 221bs and is weather resistant. Battery life is in excess of four hours and can be extended by invoking a snooze mode. 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

A 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 200µF and frequency to 20kHz. 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 OQA. 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 up 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 Minnikin, Bruel and Kjaer (UK) Ltd, 92 Oakridge Road, Harrow, HA3 6BZ. Tel: 01-954 2366.
PLUGGING THE GAP

11 Come and help us celebrate the opening of our new Northern Warehouse”, invited Doug Simmons of Maplin. “Be there or be over 200”, 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 rate, 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, gloved 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, automotive 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 nmos 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 micromamps. 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 dip 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.
Sunezshi 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 must 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 1/2in 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 Mb/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 too slow to transmit a full 954 Mb package of data for each picture streaming to disc without any compression. To provide sound with the pictures, two discs are run together in synchronism, one storing conventional cd stereo and the other hdv 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.

When a 1125 line high definition still video picture is converted into digital code 954 Mb/s 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, without any compression. To provide sound with the pictures, two discs are run together in synchronism, one storing conventional cd stereo and the other hdv 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 hdv stills on a cd, 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 keyframe and updating information between them is clearly inappropriate.

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.

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 hdv 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 Mb/s 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
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 to 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.

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?

Ed. Davis

Cover Photo: Ed. Davis

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John Becker shows you how to pluck precision time and calendar 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 led 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.

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 controlled system is 9,192,631,770 Hz, within an accuracy of one part in 10^{13}. Frequency synthesizers 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.

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 determined the time of day, while the number of pulses (0 to 31) determined the time of day, while the number of pulses (0 to 31) determined the number of seconds.

The resonator is based on 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.

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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 calendar 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 month 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 day 0.

The technique for transmitting the code might reasonably be described as brute-force modulation! The entire 60kHz signal is switched on and off to produce the pulses, the off-duration determining whether the signal is switched on and off to produce the amplitude.

CHOPPED BITS

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 the one described in the April 85 article, or the 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.

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

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

Fig. 5. The Rugby pulse waveforms and their timings.

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 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.

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 not to scale, but if you refer back to Fig. 3 you'll get some idea of the fast code timing sequence, which takes place within 330ms.

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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.)

**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...
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 straightforward 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 500nV 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.
or if you are using too long an aerial, resulting
could arise if you are in a bad reception area,
noise in the received signal. Such a situation
could also cause problems if there is a lot of
signal output at TR2 is too low in p-p
a full logic swing at the output of IC2a, pin 2,
swing is even better. Check now that you see
scope trace should be seen swinging up and
and monitor the junction of R11 and C9. The
(2 off), printed circuit board.
T1
IC21
C11
R13, R14
all 0.25W 5% carbon film or better
L1, L2
IC5
IC3
IC2
IC1
TR1, TR2
C10, C12, C13
C9, C14-C17
C5
C3, C4, C6, C7
C2
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)
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.

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
you are in a bad reception area, or if you are using too long an aerial, resulting in noise in the received signal. Such a situation could arise if you are using too long an aerial, resulting in noise in the received signal. Such a situation could also cause problems if there is a lot of signal output at TR2 or the 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 double pulses per second only occurring between the DUT code between seconds 1 to 16.

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

RECEIVER AND PULSE COMPONENTS

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 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.

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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,
for the hex dump of the machine code program routines.

Fig 11. Hex dump of the machine code

DECODER AND DISPLAY COMPONENTS

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

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

SEMICONDUCTORS
D1-D4 1N4148 (4 off)
TR3-TR7 BCS49 (5 off)
IC6 4518
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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:

\[ R = \frac{V}{I} \quad I = \frac{V}{R} \quad V = IR \]

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

\[ R = R_1 + R_2 \]

* For two resistances in parallel:

\[ R = \frac{R_1 R_2}{R_1 + R_2} \]

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

\[ V_{\text{out}} = V_{\text{in}} \times \frac{R_2}{R_1 + R_2} \]

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 hi-fi 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.

Ratings of audio systems are on average lower than those of lamps. An 8W system is not considered to be high power. 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 than the low wattage types, so are to be avoided.

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

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**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: \( I = \frac{V}{R} = \frac{3}{6.8} = 0.444 \). Now calculate the power:

\[ P = IV = 0.444 \times 3 = 1.324W \]

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 wattage resistor would be required?
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 thermometer 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 >2k carbon resistor
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. Thermists of this type, which have reduced resistance and increased temperature, are known as negative temperature coefficient or ntc thermistors.

This is indicated by the ‘-’ 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.

**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 (csc cells).

**Investigation 2 - LDRs**

You need: battery box (6V)
R1 2k 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.
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 or leaving a car park, objects on a conveyor belt, or horses passing the winning post.

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.

Using LDRs

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 not as high as in the first tank but the amount of water in it is much greater.

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 µF, 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

![Circuit for Investigation 2, (Fig 5), and its breadboard layout (Fig 6).](image-url)
Capacitances), (iii) they are rapidly destroyed working voltage (up to 35V - less for higher pressures). 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 very soon.

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 10μF).

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 10μF.

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 capacitance. 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 through 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.

Tantalum 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 470μF 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 wired (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 position 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 flows 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).
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:

\[ t = RC \]

where 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 = 0.00047, so:

\[ t = 22000 \times 0.00047 = 103s \text{ (approx)} \]

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%.

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.
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 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?
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 seesaw 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 seesaw 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 between 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 crystal, 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.

ANSWERS AND DISCUSSION

Power: (1) P = 8 x 240 = 1920W. (2) \[ I = \frac{V}{R} = \frac{100}{2000} = 0.05A; \quad P = IV = 0.05 \times 100 = 5W. \]

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 kid 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 kid 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 (I = 6/22/00 = 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.
Welcome Readers!

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.

Display Electronics

Display -Electronics-  01-679-4414

Name: ____________________________  Address: ____________________________

Daytime Tel: ____________________________  ☐ ☑ If your first order.

Item  |  QTY  |  Unit Cost  |  Total

Method of payment: ☐ Cheque  ☐ Visa  ☐ Cash  ☐ Post Office  ☐ Access  ☐ Account

Sub-Total

Carriage P/P

VAT on both

TOTAL
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 assembly. 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 elsewhere 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 between 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 Price 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

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 MICROMITEC, 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 compatibility - 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

Data sheets on request. PAL overseas version please call. SECAM not available.
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 megaribytes 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 £299!

**Only £299! (E)**

**BRAND NEW & BOXED!**

**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!

| 16K DRAM | 250 nanosecond or better | 75p each or 100 for £59.00 |
| 64K DRAM | 300 nanosecond or better | 9 for £6 or 18 for £11.50 |
| 256K DRAM | 200 nanosecond or better | 9 for £8 or 18 for £15.50 |
|  | 150 nanosecond or better | 9 for £10 or 18 for £19.00 |
|  | 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/lift 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 or 240v for AC fans.

<table>
<thead>
<tr>
<th>Size</th>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>3 inch</td>
<td>AC 1.5&quot; thick</td>
<td>£8.50</td>
</tr>
<tr>
<td>3 inch</td>
<td>AC 240v. Papst Slimline 25mm (1&quot;) thick. Low noise</td>
<td>£9.95</td>
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<tr>
<td>3.5 inch</td>
<td>AC ETRI Slimline - only 1&quot; thick.</td>
<td>£9.95</td>
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<tr>
<td>4 inch</td>
<td>AC 110/240v. 1.5&quot; thick.</td>
<td>£10.95</td>
</tr>
<tr>
<td>4 inch</td>
<td>AC 1.5&quot; thick</td>
<td>£9.95</td>
</tr>
<tr>
<td>4 inch</td>
<td>As above RFE and fully tested</td>
<td>£4.95</td>
</tr>
<tr>
<td>10 inch</td>
<td>AC. Round 3.5&quot; thick. 110v. Special: suitable 230v transformer for mains operation when bought with this fan - £5.00 only.</td>
<td>£10.95</td>
</tr>
<tr>
<td>3 inch</td>
<td>DC 1&quot; thick. Order no. 812 for 6/12v or 814 for 24v.</td>
<td>£15.95</td>
</tr>
<tr>
<td>4 inch</td>
<td>DC 12v. 12 watts. 1.5&quot; thick.</td>
<td>£12.50</td>
</tr>
<tr>
<td>4 inch</td>
<td>DC 24v 8 watts. 1&quot; thick.</td>
<td>£14.50</td>
</tr>
</tbody>
</table>

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!

Special Offer!

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 superbly engineered unit features an electronic closed loop servo system and paper drive control (1 cm per 5 minutes) to give exceptionally 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 infinite 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!

1/2 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 Hazeltine 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)
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.

<table>
<thead>
<tr>
<th>Manufacturer and order No</th>
<th>Output Watts</th>
<th>Output VDC</th>
<th>Output Amps</th>
<th>Size</th>
<th>Price</th>
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<td>Fine OP-8619</td>
<td>20</td>
<td>+5</td>
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<td>5&quot;L x 3&quot;W 1-1/2&quot;H</td>
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<td>Astec AC-8151</td>
<td>40</td>
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<td>Conver 130-300</td>
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<td>+5</td>
<td>15</td>
<td>10-1/2&quot;L x 5&quot;W 2-1/2&quot;H</td>
<td>£49.95 (C)</td>
</tr>
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<td></td>
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<td></td>
<td></td>
<td>-12</td>
<td>6</td>
<td></td>
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</tr>
</tbody>
</table>

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/DDC 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.

£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)

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)

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.

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 all commoned type where one pin is common to each resistor and adjacent pins are two resisters 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) |

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)

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)

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)

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)

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.

£3.95 or 3/£10 (A)

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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
- Shugart SA405 40 T SS FH Brand new £29.95 each. 2 for £55.00. 5 for £125.0
- Tandon TM-100-2A 40 T DS FH RFE Tested £39.95 each. 2 for £75.00. 5 for £175.00
- Tandon TM100-4 80 T DS FH RFE Tested £99.95 each. 2 for £195.00. 5 for £475.00

5.25 inch
- Teac FD55F 40/80T DS HH Brand new £90.00 each. 2 for £160.00
- Shugart 800/801 77 T SS FH RFE Tested £125.00 each
- Shugart 851 77 T DS FH RFE Tested £195.00 each
- 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, 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

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.

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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.

**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 hextet made by International Rectifier. It is rated at 50V and 30A, and has an on resistance of 0.055Ω 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 hextet 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.

![Fig.1. Block diagram for the power motor control.](image)

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

**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 hextet as fast as required. The circuit of Fig. 2 shows a design using the 555 and the IRFZ30 hextet. The switching frequency is approximately 1kHz, which is a suitable...
the feedback. The feedback signal is added to the set 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 current motor 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.

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**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 3¼, 3½, 5¼ 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.

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 than 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.

**COMPUTERS**

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

As we said before, tape is accessed in a serial manner whereas a disc 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 drivettl 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 vdu's and printers. Of course the output could also be to magnetic tape or 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 labels, stores lists and forms. Thermal printers are quiet but slow, 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.

Visual display units (vdu's) 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 (I/O) 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 0) for reading data in and high (Logic 0) for putting data out. 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 26 shows exactly how these roms are 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).

**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.

---

**Table 1. ROM output**

<table>
<thead>
<tr>
<th>Word Line</th>
<th>Bit 3</th>
<th>Bit 2</th>
<th>Bit 1</th>
<th>A</th>
<th>B</th>
<th>Sum</th>
<th>Carry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table 2. Half adder outputs.**

<table>
<thead>
<tr>
<th>Address</th>
<th>ROM Number</th>
<th>Address within ROM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0000000000</td>
</tr>
<tr>
<td>1255</td>
<td>0000000000</td>
<td>1111111111</td>
</tr>
<tr>
<td>1256</td>
<td>0000000001</td>
<td>0000000000</td>
</tr>
<tr>
<td>2511</td>
<td>0000000010</td>
<td>1111111111</td>
</tr>
<tr>
<td>2512</td>
<td>0000000010</td>
<td>0000000000</td>
</tr>
<tr>
<td>766</td>
<td>0000000010</td>
<td>1111111111</td>
</tr>
</tbody>
</table>

**Table 3. Addressing multiple roms**
**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.

---

**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
    Interrupt level 1
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
```

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.

---

**INTEGRATED PERIPHERALS**

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

---

**Table 4. Controlling RAMs**

<table>
<thead>
<tr>
<th>CS</th>
<th>WR</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Write</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0 = Low</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>Read</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1 = High</td>
</tr>
<tr>
<td>1</td>
<td>X</td>
<td>Nothing</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>X = Don't care</td>
</tr>
</tbody>
</table>

**Table 5. Rotating priority**

<table>
<thead>
<tr>
<th>Device</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Starting priority

**Table 5. Rotating priority**

<table>
<thead>
<tr>
<th>Device</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

Device 2 interrupts.
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PRACTICAL ELECTRONICS MARCH 1990

45
Recently we reported the re-opening of the Norman Lockyer Observatory in Devon, which had been largely deserted 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 mirror 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 coude 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

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**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 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.

---

PRACTICAL ELECTRONICS MARCH 1990
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 Las 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?

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.
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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 vehicles. 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 switches, and then re-embark.

**HI-TECHING TRAMS**

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 depot in relation to the tramways and the depot having the use of 19 tramway bays, although there were only formally 11 in use.

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

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.

**FEASIBILITY**

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.

At the depot exit, prior to reaching the exit point switches, 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.
**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 point switches have been operated and the required route selection has been secured, some form of indication system is required.

**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 motorman, 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.

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**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, “εὕρηκα”, 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 Amnita. 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 binary, 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.
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PRACTICAL ELECTRONICS MARCH 1990
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 was 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 built-in applications are much more useful than I had expected. I may also occupy a bit of space in your magazine with a plea on behalf of the Queen’s University of Belfast staff and Atari for the Atari Portfolio, plus tone control, all

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 bought a new soldering iron and reinstated my order for regular copies of PE. Such is life! Ed.

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 1777, or via the club call signs. (Not via PE please!) Ed

SAGELY ANSWER

Dear Ed,
As one of the winners in the Maplincompetition, 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.

FLAT CAT

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 came in.

Thank you also, Mr Lovelock, for the comments and suggestions you made concerning my Amstrad 6400 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 halfway into experimental research other obligations pushed the experiments to one side: summer holidays 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 automate my 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

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

GREAT SCOPE

Dear Ed,
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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):

\[ 100k \times 0.22\mu F = 22\text{ms} \]

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.³

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:

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

= \( V1xR2 \)

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:

<table>
<thead>
<tr>
<th>VR1</th>
<th>VR2</th>
<th>VR2 range</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>47</td>
<td>0.3 Vi</td>
</tr>
<tr>
<td>100</td>
<td>22</td>
<td>0.18 Vi</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
<td>0.090Vi</td>
</tr>
</tbody>
</table>

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B. Balet, Castlecove, Eire.
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"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).

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 this industry which makes substantial profits out of death, suffering or the threat of these. But if armaments are reduced the hatred it engenders between people. Mere possession of weapons, loaded and ready, has the same effect. 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 between your garden and its national budget and is already getting down to details.

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